• 15R0102B200 •

SINUS PENTA
PENTA MARINE

MULTIFUNCTION AC DRIVE

USER MANUAL

-Programming Guide-

English

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REVISION INDEX

Modifications with respect to Programming Guide 15R0102B200, release R.05, SW version 4.21x dated 07/03/2022.

The following subjects covered in this Programming Guide R.06 (SW version 4.22x) have been added, changed or removed with respect to previous version R.05 (SW version 4.21x).

Flowchart for Autotune modified
RESET command made programmable on all Digital Inputs (not only on MDI3)
M106 Active Motor measure added
Limits of parameters **P245**, **P246**, **P247**, **P248**, **P445**, **P446**, **P447** and **P448** modified
Torque limits in VTC and FOC splitted; parameters **C049**, **C092** and **C135** added
Modbus address of **C068** Rotor Time Constant M2 modified
C236 parameter for Output phase failure alarm enabling added and, consequently, note "*This alarm may be enabled only by Enertronica Santerno and is to be explicitly requested at the time when ordering the drive."* in correspondence with **A129** removed
Section List of the DRIVECOM Alarm Codes removed
References to CANOpen® on B40 added

USER MANUALS MENTIONED IN THIS PROGRAMMING GUIDE

The following User Manuals from Enertronica Santerno are mentioned throughout this Programming Guide:

- **15P0102B100** SINUS PENTA - Installation Guide
- **15Q0102B00** SINUS PENTA - Guide to the Regenerative Application
- **15Q0102B200** SINUS PENTA - Guide to the Synchronous Motor Application
- **15W0102B300** SINUS PENTA Safe Torque Off Function - Application Manual
- **15W0102B500** Motor Drives Accessories - User Manual
- **15G0010B1** PROFIdrive COMMUNICATIONS BOARD - Installation and Programming Guide
- **15G0851B100** DATA LOGGER ES851 - Programming Guide
- **15P4600B100** BRIDGE MINI - User manual
- **15J0901B100** RemoteDrive DRIVE REMOTE CONTROL - User Manual

0. TABLE OF CONTENTS

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0.4. Scope of this Manual

Enertronica Santerno is committed to update its User Manuals available for download from santerno.com with the latest software version officially released. Please contact Enertronica Santerno if you require technical documents related to previous software versions.

0.5. How to Use this Manual

0.5.1. Overview

This User Manual (Programming Guide) provides any information required to setup and monitor the drives of the Sinus Penta series manufactured by Enertronica Santerno SpA.

Setup/monitoring may be obtained using one of the following options:

- Display/keypad unit;
- Serial link through RS485 standard port or ES822 (isolated optional serial board) RS485/RS232;
- ES851 (optional Data Logger and communications board).
- ES1007 (Bridge Mini optional board).

For the instructions on how to use and remote the display/keypad unit, please refer to the Installation Guide and the Motor Drives Accessories - User Manual.

Any information sent to/from the drive via the display/keypad unit may be obtained also via serial link using the RemoteDrive software application offered by Enertronica Santerno. This application allows the following functions: image acquisition, keypad simulation, oscilloscope functions and multifunction tester, data logger, table compiler including history data, parameter setup and data reception-transmission-storage from and to a computer, scan function for the automatic detection of the connected drives (up to 247 drives may be connected).

You can also create your own dedicated software via serial communication link. This manual provides any information concerning addressing (Address field) and scaling (Range field) for the drive interfacing.

0.5.2. Special Applications Dedicated to Sinus Penta Drives

Special software is supplied with the drives of the Sinus Penta series, that can be used for particular applications. The menu tree, the programming mode and navigation mode of the Sinus Penta are used; parameters or menus will be added/(removed) whether required/(not required) for the implemented application.
The dedicated applications implement the most common automation applications, thus replacing PLCs or dedicated control boards, and they reduce to a minimum the electric equipment required, thus ensuring lower maintenance costs.
Such operating modes can be implemented through the firmware updating and/or through additional interface boards.
The following applications are currently available:

Identifier	Application
PD	Sinus Penta Drive (Asynchronous Motor control)
PR	Regenerative Sinus Penta (see Guide to the Regenerative Application)
PS	Sinus Penta – Synchronous Motor Control (see Guide to the Synchronous Motor Application)

NOTE In order to install your application SW and update the firmware packages of the SINUS PENTA drive, you can use the RemoteDrive software provided by Enertronica Santerno. Please refer to the RemoteDrive DRIVE REMOTE CONTROL - User Manual for detailed instructions.

0.5.3. Menus and Submenus

This User Manual (Programming Guide) is divided into different Menus. Their sequence is the same as their display sequence in the display/keypad and the RemoteDrive software.

Programming parameters and Measure parameters are divided into:

Mxxx Measures (always Read Only):

Mxxx	**Range**	Drive representation (integer)	Display on the display/keypad and the RemoteDrive (may be a decimal figure) plus unit of measure
	Active	Type of control (IFD / VTC / FOC) the measure is related to	
	Address	Modbus address which the measure can be read from (integer)	
	Function	Measure description	

Pxxx Parameters (always R/W):

Pxxx	**Range**	Drive representation (integer)	Display on the display/keypad and the RemoteDrive (may be a decimal figure) plus unit of measure
	Default	Factory-setting of the parameter (as represented for the drive)	Factory-setting of the parameter (as displayed) plus unit of measure
	Level	User level (BASIC / ADVANCED / ENGINEERING)	
	Address	Modbus address which the parameter can be read from (integer)	
	Control	This optional field is displayed when a parameter is not active for all types of motor controls (IFD / VTC / FOC)	
	Function	Parameter description	

Cxxx Parameters (Read Only when the drive is running and the motor is operating; R/W when the drive is in stand-by or in Run, but the motor is stopped: see **P003** in PASSWORD AND USER LEVEL MENU).

Cxxx	**Range**	Drive representation (integer)	Display on the display/keypad and the RemoteDrive (may be a decimal figure) plus unit of measure
	Default	Factory-setting of the parameter (as represented for the drive)	Factory-setting of the parameter (as displayed) plus unit of measure
	Level	User level (BASIC / ADVANCED / ENGINEERING)	
	Address	Modbus address which the parameter can be read from/written to (integer)	
	Control	This optional field is displayed when a parameter is not active for all types of motor controls (IFD / VTC / FOC)	
	Function	Parameter description	

Rxxx Parameters (Read Only when the drive is in Run; R/W when the drive is in stand-by or in Run, but the motor is stopped: see **P003** Condition required for changing C parameters in the PASSWORD AND USER LEVEL MENU).

Rxxx	**Range**	Drive representation (integer)	Display on the display/keypad and the RemoteDrive (may be a decimal figure) plus unit of measure
	Default	Factory-setting of the parameter (as represented for the drive)	Factory-setting of the parameter (as displayed) plus unit of measure
	Level	User level (BASIC / ADVANCED / ENGINEERING)	
	Address	Modbus address which the parameter can be read from/written to (integer)	
	Control	This optional field is displayed when a parameter is not active for all types of motor controls (IFD / VTC / FOC)	
	Function	Parameter description	

NOTE

Unlike **Cxxx** parameters, **Rxxx** parameters become active only after the drive has been switched off and switched on again, or after resetting its control board (by holding down the **RESET** button for more than 5 seconds or by sending the **I014** command via serial link).

Ixxx Inputs. These are not parameters, but inputs (the values allocated to these inputs are not stored to non-volatile memory. Ixxx value is always 0 when the drive is powered on).

Ixxx	**Range**	Drive representation (integer)	Display on the display/keypad and the RemoteDrive (may be a decimal figure) plus unit of measure
	Level	User level (BASIC / ADVANCED / ENGINEERING)	
	Address	Modbus address which the input can be read from/written to (integer)	
	Control	This optional field is displayed when a parameter is not active for all types of motor controls (IFD / VTC / FOC)	
	Function	Input description	

NOTE Use the **ESC** key to enter the value of an **Ixxx** input.
If the **SAVE/ENTER** key is used, **W17 SAVE IMPOSSIBLE** (warning) is displayed.

NOTE When changing a **Pxxx** or **Cxxx** parameter via the display/keypad, you may activate its new value immediately (flashing cursor) or when you quit the programming mode (fixed cursor). Typically, numeric parameters immediately come to effect, while alphanumeric parameters have a delayed effect.

NOTE When changing a **Pxxx** or **Cxxx** parameter via the RemoteDrive, the drive will immediately use the new parameter value.

0.5.4. ALARMS AND WARNINGS

The last part of this User Manual covers alarms **(Axxx)** and warnings **(Wxxx)** displayed by the drive:

Axxx	**Description**	
	Event	
	Possible cause	
	Solution	

1. USING THE DISPLAY/KEYPAD UNIT

1.1. Overview

This section contains several examples about navigating in the display/keypad unit and the UPLOAD and DOWNLOAD functions of the programming settings of the drive when using the keypad.

More details about the keypad settings (contrast, backlight, etc.) are given in the section covering the display/keypad in the Installation Guide. Details about custom navigation in the root page, the measures in the Keypad page and the Root page and the custom unit of measure of the PID controller are given in the DISPLAY/KEYPAD MENU in this manual.

When using the navigation “by menu” mode (**P264** = BY MENU), the structure of the menu tree that can be explored using the display/keypad is described in the Menu Tree section.

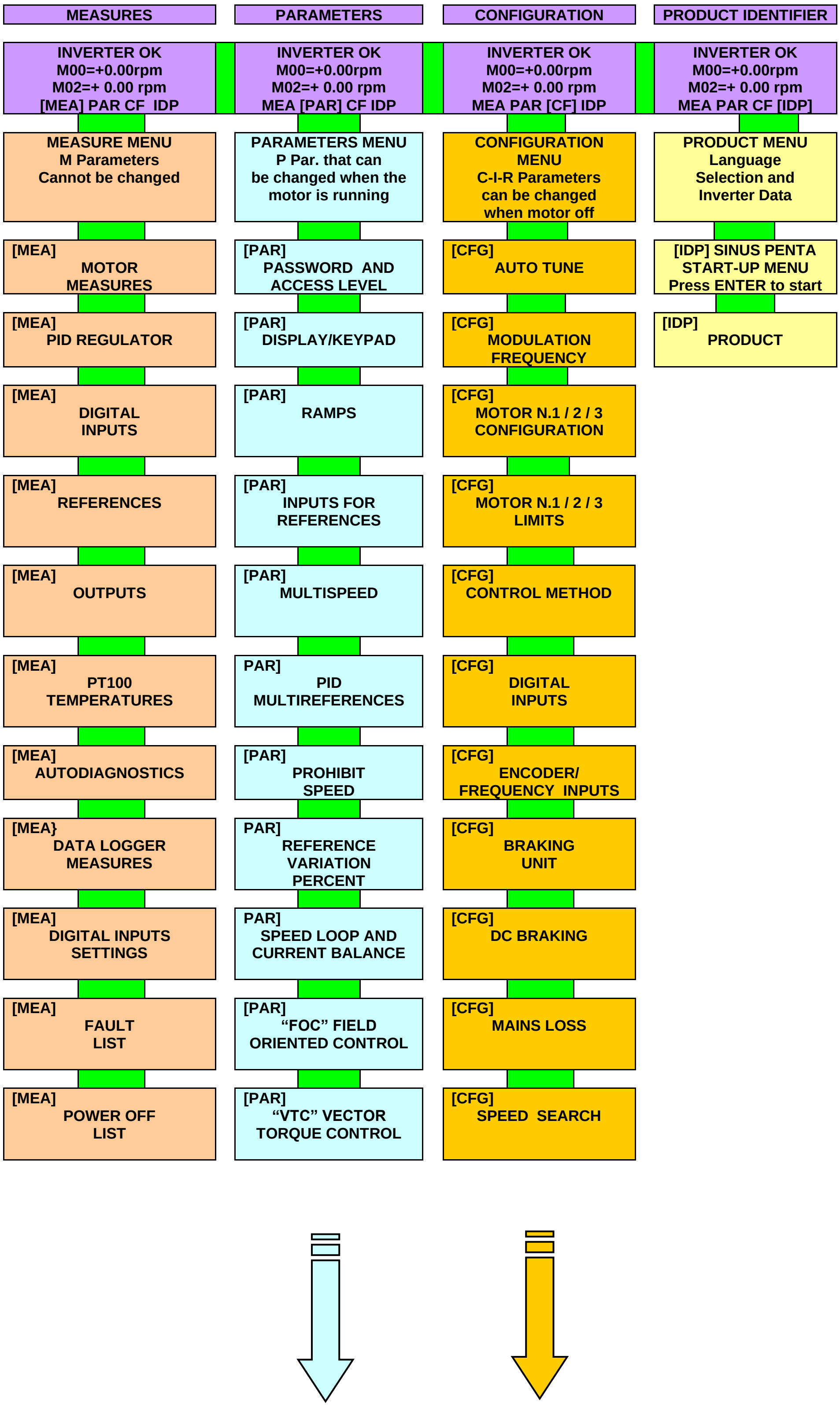
The complete tree structure is displayed, but the actual structure depends on the user level set in **P001** and on the implemented programming. For example, if only motor 1 is programmed (**C009**=1), the menus relating to motors 2 and 3 will not be displayed (Motor 2/3 Configuration and Motor 2/3 Limit). Also, if the type of motor control is **C010**=IFD Voltage/Freq., the BRIDGE CRANE MENU will not be displayed.

When **P264** = Linear (linear navigation), the parameters displayed are no longer grouped into menus, and you can scroll through all parameters using the ▲ and ▼ keys.
When **P264** = Modified Pars. Only, only the parameters having different values than the factory settings are displayed, and you can scroll through all parameters using the ▲ and ▼ keys.

The Navigation section shows how to use function keys to navigate through the parameters and to change parameter values (**P264** = BY MENU).

The function keys and their functionality are described below.

1.2. Menu Tree


MEASURES
PARAMETERS
CONFIGURATION
PRODUCT IDENTIFIER
INVERTER OK M00=+0.00rpm M02=+ 0.00 rpm [MEA] PAR CF IDP
INVERTER OK M00=+0.00rpm M02=+ 0.00 rpm MEA [PAR] CF IDP
INVERTER OK M00=+0.00rpm M02=+ 0.00 rpm MEA PAR [CF] IDP
INVERTER OK M00=+0.00rpm M02=+ 0.00 rpm MEA PAR CF [IDP]
MEASURE MENU M Parameters Cannot be changed
PARAMETERS MENU P Par. that can be changed when the motor is running
CONFIGURATION MENU C-I-R Parameters can be changed when motor off
PRODUCT MENU Language Selection and Inverter Data
[MEA] MOTOR MEASURES
[MEA] PID REGULATOR
[MEA] DIGITAL INPUTS
[MEA] REFERENCES
[MEA] OUTPUTS
[MEA] PT100 TEMPERATURES
[MEA] AUTODIAGNOSTICS
[MEA} DATA LOGGER MEASURES
[MEA] DIGITAL INPUTS SETTINGS
[MEA] FAULT LIST
[MEA] POWER OFF LIST
[PAR] PASSWORD AND ACCESS LEVEL
[PAR] DISPLAY/KEYPAD
[PAR] RAMPS
[PAR] INPUTS FOR REFERENCES
[PAR] MULTISPEED
PAR] PID MULTIREFERENCES
[PAR] PROHIBIT SPEED
PAR] REFERENCE VARIATION PERCENT
PAR] SPEED LOOP AND CURRENT BALANCE
[PAR] “FOC” FIELD ORIENTED CONTROL
[PAR] “VTC” VECTOR TORQUE CONTROL
[CFG] AUTO TUNE
[CFG] MODULATION FREQUENCY
[CFG] MOTOR N.1 / 2 / 3 CONFIGURATION
[CFG] MOTOR N.1 / 2 / 3 LIMITS
[CFG] CONTROL METHOD
[CFG] DIGITAL INPUTS
[CFG] ENCODER/ FREQUENCY INPUTS
[CFG] BRAKING UNIT
[CFG] DC BRAKING
[CFG] MAINS LOSS
[CFG] SPEED SEARCH
[IDP] SINUS PENTA START-UP MENU Press ENTER to start
[IDP] PRODUCT

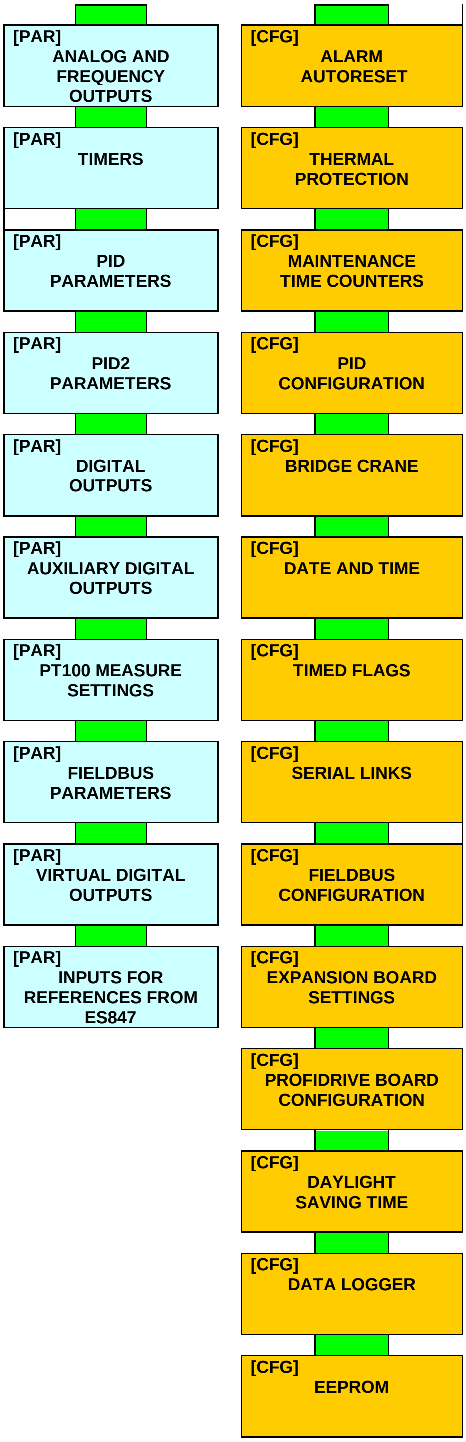
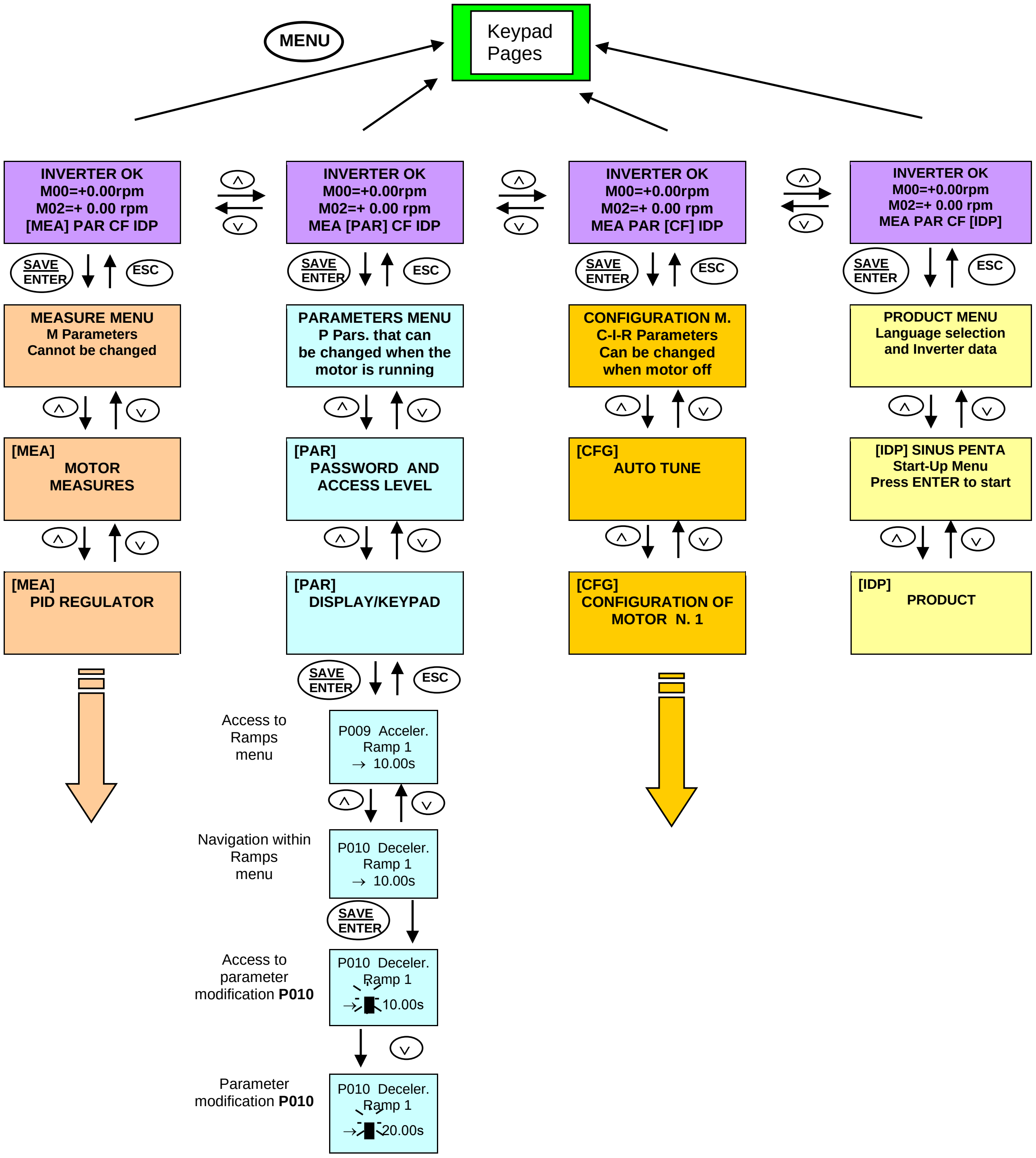


Figure 1: Menu Tree

1.3 Navigation

Figure 2: Navigation example



If the **ESC** key is pressed to quit, the new parameter value will be acknowledged but not saved to non-volatile memory, and will therefore be lost at power off. Press **SAVE/ENTER** to confirm parameter alteration.

1.4. Parameter Modification

Factory setting allows parameter modification. The parameters included in the Parameters Menu (**Pxxx** parameters) can be changed at any moment, whereas the parameters included in the Configuration Menu (**Cxxx**, **Rxxx**, **Ixxx** parameters) can be changed only when the motor is stopped.
For safer operating conditions, the configuration parameters must be changed only when the drive is disabled (the **ENABLE-A** and **ENABLE-B** commands are inactive): to do so, **P003** must be set to **0 (stand-by only)**.

To disable parameter changes, just change **P000** (write enable) and save its new setting. **P000** and **P002** (password) are both factory-set to 1. If **P000=0**, an inexpert user cannot change parameter values, but if **P000=1,** an advanced user will be able to change the parameter values.
For even safer operating conditions, you can change the password stored in **P002**; in that case, you must set **P000** accordingly.

NOTE Note down and keep at hand the value set in **P002**.

Press the **SAVE/ENTER** key for parameter modifications; when a flashing cursor appears, press ▲ and ▼ to change the parameter value. Do one of the following to quit the editing mode:
Press **ESC** with **P269b** = 0: [No] → the parameter value used by the drive is changed and is maintained until the drive is shut down, then the value is lost when the drive is powered on again.
Press **ESC** with **P269b** =1: [YES] → the previous value is restored.
Press SAVE/ENTER → the parameter value is used by the inverter and stored to non-volatile memory and is not deleted when the drive is shut down.
Inputs (**Ixxx**) cannot be saved to non-volatile memory and are automatically set to their default values.
Rxxx parameters become active only when the drive control board has been reset (by holding down the **RESET** button for more than 5 seconds or by sending the **I014** via serial link) or after powering the drive off and on again.

1.5. Programming the Root Page

When the drive is turned on, the Root page is displayed as the starting page. The Root page allows you to access the main menus (Measures, Parameters, Configuration, Product ID) or to shift to the Keypad pages using the **MENU** key.

Root page

```
  INVERTER   OK
    +  1500.00rpm
    +     0.00rpm
 MEA[PAR]CF  IDP
```

You can customise the root page using parameter **P265** (see the DISPLAY/KEYPAD MENU).

1.6. Using the MENU Key

The **MENU** key allows going to the next menu. From the Root page, press the MENU key to enable circular navigation.

```
ANY PAGE
IN A MENU
```

Start-Up Menu [*]

```
[IDP]SINUS PENTA
 START-UP MENU
  Press ENTER
    to start
```

MENU

Measures KEYPAD Page

```
→      +      0.0Hz
→       +      0.0A
→    +     0.00rpm
→    +     0.00rpm
```

MENU

other KEYPAD Pages (if any…) [**]

```
→      +      0.0Hz
→       +      0.0A
→    +     0.00rpm
Ref  + 1500.00rpm
```

MENU

…other KEYPAD Pages (continued) [**]

```
→      +      0.0Hz
→       +      0.0A
→    +     0.00rpm
TLim  +    150.0Nm
```

MENU

Root Page

```
  INVERTER  OK
    + 1500.00rpm
    +    0.00rpm
 MEA  PAR  CF[IDP]
```

NOTE [*] The Start-Up menu is available only if **P265**=3: Start-Up (see the DISPLAY/KEYPAD MENU).

NOTE [**] The other Keypad pages are available only if the relevant References / Feedback / Limits are activated (see the CONTROL METHOD MENU and the PID CONFIGURATION MENU).

1.7. ESC Key

Press the **ESC** key and to do the following:

1. move up one level in the menu tree;
2. go to the next field when changing a parameter having multiple value fields;
3. quit the editing mode without storing the value to EEPROM, or go back to the previous value based on **P269b.**

1. In the example below, starting from parameter **C015** in the MOTOR CONFIGURATION MENU inside the Configuration Menu, you can move up to the Root page by pressing the **ESC** key.

Page C015 Parameter of Configuration Menu, Motor 1

```
C015  Rated
Frequency
Motor     1
→             50.0Hz
```

ESC or ▲ + ▼

Startup Page of Configuration Menu, Motor 1

```
[CFG]     C008–C042
 CONFIGURATION
   MOTOR    N.1
```

ESC or ▲ + ▼

Root page

```
   INVERTER  OK
     +  1500.00rpm
     +     0.00rpm
 MEA  PAR[CF]IDP
```

2. When using the **SAVE/ENTER** key to change a parameter including multiple fields (ESC> is displayed for the **ESC** key) press **ESC** to move to the next field. In the example below, 2 programmable fields are displayed for **P269**:

```
P269  Disable
Keys:
 LOC/REM  FWD/REV
ESC> NO       NO
```

SAVE ENTER

Press “SAVE/ENTER” to enter the editing mode

```
P269  Disable
Keys:
 LOC/REM  FWD/REV
ESC>■NO       NO
```

▼

Press “▼” to change the parameter value

```
P269  Disable
Keys:
 LOC/REM  FWD/REV
ESC>■YES      NO
```

ESC

Press “ESC” to move to the next field

```
P269  Disable
Keys:
 LOC/REM  FWD/REV
ESC> YES     ■NO
```

3. Press the following keys to quit the last page displayed:
- **ESC** without saving the value to EEPROM if **P269b** = **0:[No]** → press **ESC** to confirm the parameter, that will not be saved (the previous value will be restored at next power on);
- **ESC** without saving the value to EEPROM if **P269b** = **1:[No]** → press **ESC** to restore the previous value;
- **SAVE/ENTER** (new values are saved to EEPROM).

1.8. RESET Key (Alarm and Control Board Reset)

The **RESET** key is used to reset the drive after an alarm trips and the cause responsible for the alarm has been removed.
Press the **RESET** key for **more than 5 seconds to reset the control board and reinitiate it.** This procedure may be useful when changes made to **Rxxx** parameters (which activate only after resetting the equipment) must immediately come to effect, with no need to power the drive off and on again.

1.9. TX/RX Key (Download/Upload from/to the display/keypad)

Use the display/keypad to perform the following functions:
1. UPLOAD (parameters stored in the drive are copied to the display/keypad);
2. DOWNLOAD (parameters stored in the keypad are copied to the drive, but they are not automatically saved, see next note).

Press the **TX/RX** key to go to the UPLOAD page; press the **TX/RX** key again to toggle between the UPLOAD and DOWNLOAD pages.

CAUTION

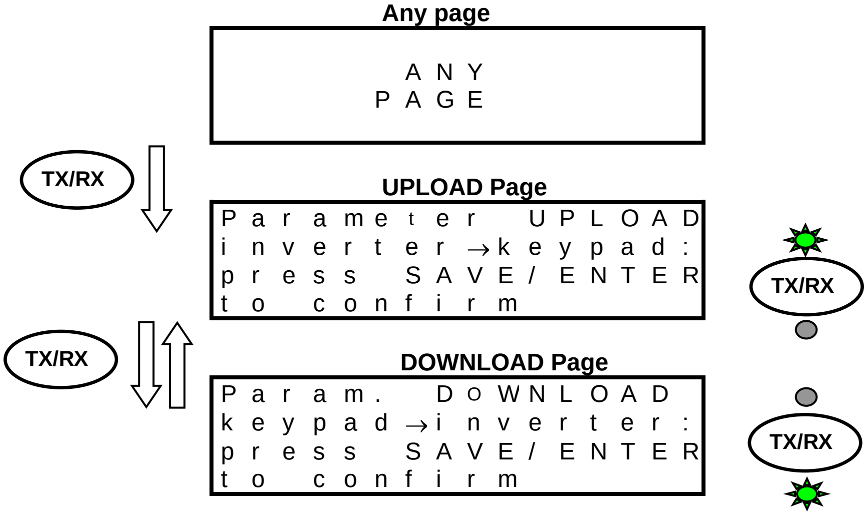
A Warning is displayed (one among **W41** to **W46**) when trying to DOWNLOAD parameters to a drive whose SW Version, IDP, PIN or current/voltage classes are different from those of the drive previously used for parameter UPLOAD. In that case, download is not allowed. See Warning List.

NOTE

The DOWNLOAD function allows the parameters stored in the keypad to be copied to the drive. However, parameters are not stored to the non-volatile memory of the drive.
To store the downloaded parameters to the non-volatile memory of the drive, go to the EEPROM menu and execute a “Save Work” command once the download procedure is complete. Otherwise, when power is lost, the parameters downloaded to the drive are lost. See EEPROM MENU.

The **TX/RX** key is disabled under the following conditions:
- no password is entered in **P000**
- the OPERATOR mode is activated with the **MENU** Key (**P264b** = OPERATOR)
- the drive is running.

In the example below, you can go to the UPLOAD page from any page (the upper LED starts flashing). If you then press the **TX/RX** key, you can go to the UPLOAD and DOWNLOAD pages.



Press **SAVE/ENTER** from the UPLOAD (/DOWNLOAD) page to confirm UPLOADING (/DOWNLOADING). The relevant LED will come on (fixed light).

If the **SAVE/ENTER** key is not pressed for confirmation within 10 seconds from the selection of the UPLOAD (/DOWNLOAD) page, the starting page is automatically displayed.

While UPLOADING, **W08 UPLOADING (**flashing warning) appears.
If parameters are successfully uploaded, the following warning appears:
W11 UPLOAD OK
If not, the **W12 UPLOAD KO** warning appears. Retry parameter upload.

While DOWNLOADING, **W07 DOWNLOADING (**flashing warning) appears.
If parameters are successfully downloaded, the following warning appears:
W09 DOWNLOAD OK
If not, alarm **A073** trips, and download must be retried before restarting the drive.

1.10. LOC/REM Key (Keypad Pages)

To enable the Local/Remote operating mode (Remote sources are command and/or reference sources other than the display/keypad) press the **LOC/REM** key in the display/keypad, or use a digital input configured as **Loc/Rem** (see **C180**).

NOTE

The **LOC/REM** key is enabled when no digital input is configured as **Loc/Rem**, or when a digital input is configured as a **Loc/Rem** button (see **C180a**).
The **LOC/REM** key is disabled when a digital input is configured as a **Loc/Rem** selector switch (see **C180a**).

C148 sets whether toggling between Remote mode and Local mode is activated only when the drive is disabled, or whether toggling from Remote to Local mode does not affect the drive running conditions (bumpless commands), but it does affect the reference. You can also choose to keep running conditions and reference unaffected (any command is bumpless). For more details, please refer to the description of parameter **C148** (CONTROL METHOD MENU).

In LOCAL mode (the L-CMD and L-REF LEDs come on), when drive references and commands are sent via display/keypad, the Keypad page allows changing the given reference using the ▲ and ▼ keys (see **P266** in the DISPLAY/KEYPAD menu).
When not in LOCAL mode, press the **MENU** key to access the Keypad pages from the root page. Only the Keypad pages relating to the Keypad source will be displayed along with the Measure Keypad page.
Example: Parameter **C147** (Torque/Speed Limit Reference Selection) is set to Keypad. From the root page, press the **MENU** key once to display the Measure Keypad page, and press the **MENU** key twice to display the Keypad page relating to the torque/speed limit and allowing changing the torque or speed limit reference using the ▲ and ▼ keys.
The Keypad page allows entering custom measures (see parameters **P268b** to **P268e** in the DISPLAY/KEYPAD menu).

From the Keypad pages, press the **SAVE/ENTER** key to access the Keypad Help page containing any details about the measures displayed in the Keypad page.

1.11. SAVE/ENTER Key

The **SAVE/ENTER** key allows selecting a lower level when navigating within the programming menus. It also allows changing a parameter value (to change a parameter value, press the **SAVE/ENTER** key from the page of the parameter you want to change). An example is given in **Errore. L'origine riferimento non è stata trovata.**.
From the Keypad pages, the **SAVE/ENTER** key allows accessing the Keypad Help page containing the description of the displayed measures.

1.12. Indicator LEDs on the Display/Keypad

Eleven LEDs are located on the keypad, along with a 4-line, 16-character LCD display, a buzzer and 12 function keys. The display shows the parameter values, the diagnostic messages and the variables processed by the drive.
The figure below shows the location of the indicator LEDs and their functionality.

Figure 3: Display/keypad

P000307-0

REF LED - Green

●	Reference for speed, frequency or torque=0
✳	Motor acceleration or deceleration
◯	Reference on

RUN LED - Green

●	Motor not powered
✳	Motor powered, but no torque (idle)
◯	Motor powered and running

ALARM LED - Red

●	Inverter OK
◯	Alarm tripped

TX and RX LEDs - Green

TX	R	
●	●	No parameter transfer in progress
✳	●	Download: waiting for confirmation
●	✳	Upload: waiting for confirmation
◯	●	Parameter downloading from keypad to inverter
●	◯	Parameter uploading from inverter to keypad

FWD and REV LEDs – Green

FWD	REV	
●	●	Total reference = 0
◯	●	Total reference of frequency/ speed/torque is being sent and is positive
●	◯	Total reference of frequency/ speed/torque is being sent and is negative.

LIMIT LED - Yellow

●	No active limit
◯	Voltage or current limit active

BRAKE LED - Yellow

●	Ordinary run
◯	Either one is active: - DC current brake - IGBT braking - Ramp extension.

L-CMD LED – Green

●	Commands sent from sources other than keypad
✳	Commands sent both from keypad and terminal board
◯	Commands sent from keypad only

L-REF LED - Green

●	Reference sent from sources other than keypad
✳	Reference sent both from keypad and terminal board
◯	Reference sent from keypad only

KEY

●	LED off
✳	LED flashing
◯	LED on (fixed)

NOTE See also the OPERATING AND REMOTING THE KEYPAD section in the Motor Drives Accessories - User Manual.

2. DESCRIPTION OF INPUT AND OUTPUT SIGNALS

The control board of the drives of the Sinus Penta series is provided with the following inputs/outputs:

- **3 Analog Inputs** (single-ended REF input, differential AIN1 & AIN2 inputs) that can be programmed as voltage/current inputs via SW1 DIP-switch (see DIP-switches Configuration in the Sinus Penta's Installation Guide).
- **3 Analog Inputs** that can be programmed as voltage/current inputs via SW2 DIP-switch (see Configuration DIP-switches in the Sinus Penta's Installation Guide).
- **8 MDI Multifunction Digital Inputs;** 3 of them (MDI6, MDI7, MDI8) are fast-acquisition inputs allowing acquiring frequency signal or encoder signals.
- MDI6 can be used to acquire a frequency signal called FINA; if used in conjunction with MDI7, it also allows acquiring a push-pull encoder signal called Encoder A.
- MDI8 can be used to acquire a frequency input called FINB (this avoids acquiring encoder B via **ES836**, **ES913** or **ES861** optional board).
- **4 MDO Multifunction Digital Outputs**; MDO1 is a Push-pull output, MDO2 is an Open Collector output and MDO3-4 are relay outputs.

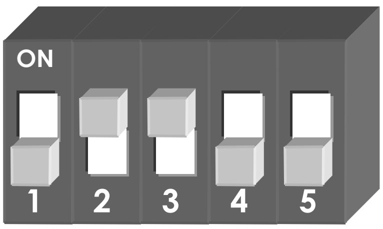
NOTE Relay digital output **MDO4** is allocated to the **Safe Torque Off** (STO) function and cannot be configured by the user.

Electrical ratings of the control board inputs/outputs are given in the Sinus Penta's Installation Guide.

When programming:
- **Analog Inputs**, see the INPUTS FOR REFERENCES MENU
- **Analog Outputs**, see the ANALOG AND FREQUENCY OUTPUTS MENU
- **Digital Inputs**, see the DIGITAL INPUTS MENU
- **Digital Inputs used as Frequency/Encoder Inputs**, see the ENCODER/FREQUENCY INPUTS MENU
- **Multifunction Digital Outputs**, see the DIGITAL OUTPUTS MENU

CAUTION The drive is factory-set with the REF input configured as 0-10V and AIN1-AIN2 inputs configured as 4-20mA.
SW1 DIP-switches, which are located on the control board, must be set as follows:

SW1



3. REFERENCES AND FEEDBACKS

The drive references are the following:

- Main speed/torque reference
- Speed/torque limit reference
- PID reference
- PID feedback

3.1. Main Speed/Torque Reference

If a speed control (e.g. **C011 = Speed** for Motor 1) is used, the main reference is a speed reference, while if a torque control is used (e.g. **C011=Torque** or **C011=Speed** for Motor 1, but the digital input is closed for the Slave programmed with **C170**), the main reference of the drive is a torque reference.
The main reference can be one of the following:

- Analog/digital inputs programmed as sources (see parameters **C143-C146** in the CONTROL METHOD MENU)
- PID output if **C294 PID Action = Reference**
- Digital inputs programmed as Multispeed (see MULTISPEED MENU) only when the main reference is a speed reference.

3.2. Speed/Torque Limit Reference

If a speed control is used (e.g. **C011 = Speed** for Motor 1) and a VTC or FOC algorithm is used, you can program a source as an external torque limit (see parameter **C147** in the CONTROL METHOD MENU).
If a torque control is used and an external speed limit has been set up (e.g. **C011 = Torque with Speed Limit** for Motor 1) and a FOC algorithm is used, you can program one source as an external speed limit (see parameter **C147** in the CONTROL METHOD MENU).

3.3. PID Reference

If the internal PID regulator is enabled (**C291 different from Disabled**), its reference is given by default by the sum of the three sources programmed as references (see parameters **C285-C287** in the PID CONFIGURATION MENU).
Different types of PID reference control (Two PIDs and 2-zone mode) are available based on the setting in parameter **C291a** (PID Control Mode).

3.4. PID Feedback Reference

The PID feedback by default is the sum of the three sources programmed as feedback (see parameters **C288-C290** in the PID CONFIGURATION MENU).
Different types of PID feedback control (Two PIDs and 2-zone mode) are available based on the setting in parameter **C291a** (PID Control Mode).

4. PROGRAMMABLE FUNCTIONS

4.1. Multimotor

The Sinus Penta drive provides 3 separate sets of parameters allowing configuring three control algorithms for 3 types of motors:

- **C009** Number of configured motors =2
- **C173** Digital input for Motor 2 = MDI6

When MDI6 is open, the parameters relating to Motor 1 are used for the motor control; when MDI6 is closed, the parameters relating to Motor 2 are used for the motor control (see the MOTOR CONFIGURATION MENU and the MULTISPEED MENU).

4.2. Voltage/Frequency Pattern

When using the Volt/Freq IFD control algorithm (e.g. **C010 = V/F IFD** for Motor 1), you can select different types of V/f patterns (see the V/f Pattern (IFD Only) section in the MOTOR CONFIGURATION MENU).

4.3. Slip Compensation

When using the Volt/Freq IFD control algorithm (e.g. **C010 = V/F IFD** for Motor 1), you can set the slip compensation function for a more accurate speed control (see the Slip Compensation (IFD Only) section in the MOTOR CONFIGURATION MENU).

4.4. Speed Searching

When using the Volt/Freq IFD or VTC VectorTorque control algorithm (e.g. **C010 = V/F IFD** for Motor 1), you can set the speed searching function for the motor speed of rotation, which is useful when the drive controls a motor which is already running (as for motors connected to fans). See the SPEED SEARCHING MENU for more details.

4.5. Controlled Stop in Case of Power Failure (Power Down)

See the POWER DOWN MENU to set a controlled stop in case of power failure.

4.6. DC Braking

When using the Volt/Freq IFD or Vector Torque VTC control algorithm, you can set DC braking at start or at stop. The DCB Hold function can be set for the Volt/Freq IFD function. See the DC BRAKING MENU for more details.

4.7. Motor Thermal Protection

The Motor Thermal Protection function protects the motor against possible overloads. This function can be obtained via a PTC acquired in AIN2 analog input—up to 6 PTCs can be series-connected—or it can be a software protection implemented through an algorithm reproducing the motor thermal image.
See the MOTOR THERMAL PROTECTION MENU for more details.
For more details about using AIN2 input, please refer to the Sinus Penta’s Installation Guide**.**

4.8. Prohibit Speeds

Prohibit speeds are speed ranges corresponding to mechanical resonance frequencies. They prevent the drive from running at the preset speed ranges.
See the PROHIBIT SPEED MENU for more details.

4.9. Digital PID Regulator

The Sinus Penta drive is provided with a digital PID (proportional, integral, derivative) regulator that can be used to implement the following:

- Analog output
- Main reference of the drive (Speed/Torque reference)
- Correction of the main reference
- Correction of the output voltage (only for Volt/Freq IFD control)

See the PID PARAMETERS MENU and the PID CONFIGURATION MENU for more details.

4.10. Bridge Crane Application

For hoisting applications, such as a bridge crane, it may be useful to consider the actual time required to release the safety electromechanical brake (the delay between the electrical command and the actual opening of the brake) and the closure of the electromechanical brake.
For a detailed description of the benefits offered by the parameters relating to hoisting applications, see the BRIDGE CRANE MENU.

4.11. Setting Two Alternative Command Sources and Reference Sources

You can set a digital input as a selector switch allowing selecting two alternative command sources and reference sources.
Example:
A selector switch is required to select **control mode B** (the drive references and commands are sent via fieldbus) and **control mode A** (the drive reference is sent via AIN1 analog input and commands are sent via keypad).
The following parameters shall be set up accordingly:

C179 MDI for source selection= **MDI6**
C140 Selection of command source n. 1 = **Keypad**
C141 Selection of command source n. 2 = **Fieldbus**
C143 Selection of reference n. 1 = **AIN1**
C144 Selection of reference n. 2 = **Fieldbus**

When MDI6 digital input in the terminal board is open (terminal 19), the command sources and reference sources n. 1 are selected (Keypad and AIN1 analog input, control mode A). When MDI6 is closed, the command sources and reference sources n. 2 are selected (Fieldbus, control mode B).

CAUTION In the example above, if **C179 = Disable**, the OR logic for the Keypad and Fieldbus is considered, whereas the Fieldbus and AIN1 command sources are considered as summed up.

As an alternative to parameter **C179**, parameters **C179a** and **C179b** allow setting two digital inputs as independent selectors for the commands and the reference.
See also parameters **C179, C179a, C179b** in the DIGITAL INPUTS MENU.

4.12. Fire Mode

When the digital input programmed as FIRE MODE is activated, all the protecting functions of the drive are ignored, so that no alarm trips when the drive is operating.

CAUTION

The Fire Mode function must be used only when it is strictly necessary, such as in fire pumps, to protect human lives.
This function must never be used to prevent alarms from tripping in domestic or industrial applications.

NOTE

To activate the parameters relating to the Fire Mode, enter the Password in the PRODUCT MENU.
This Password is provided by Enertronica Santerno's Service Department. The drive Serial Number is required (see the Serial Number parameter in the PRODUCT MENU).

The following parameters can be accessed only after entering the Password enabling the Fire Mode:

- **P032** Acceleration Ramp in Fire Mode (see the RAMPS MENU)
- **P033** Deceleration Ramp in Fire Mode (see the RAMPS MENU)
- **P099** Speed Fire Mode (see the MULTISPEED MENU)
- **C186** MDI Enabling Fire Mode (see the DIGITAL INPUTS MENU)

The Fire Mode is enabled when closing the MDI set through **C186**. The drive will use the speed reference set in **P099** and the ramp times set in **P032**, **P033.** All alarms will be ignored, except for the following:

A041	IGBT FAULT Side A	IGBT Hardware, general alarm
A044	OVERLOAD SW	Software Overcurrent
A048	OVER VOLTAGE	DC-bus voltage exceeding Vdc_max
A050	IGBT FAULT A	Hardware Fault from IGBT Driver
A051	OVERLOAD HW A	Hardware Overcurrent
A053	PWMA Not ON	Hardware Failure, IGBT cannot be fired
		Control Board Failure

When the Fire Mode is active, innumerable alarm autoresets are automatically enabled.

CAUTION

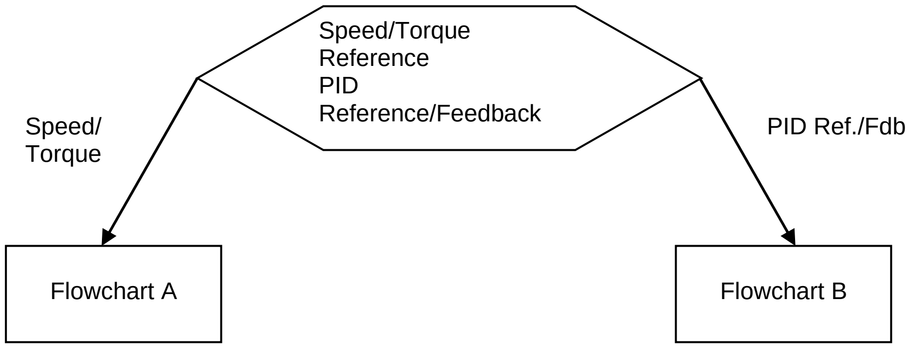
If an asterisk (*) appears next to INVERTER OK on the display, the product warranty is no longer valid.
The asterisk appears if at least one condition requiring the activation of a protection feature occurs when the inverter is running in Fire Mode.

5. PROGRAMMING EXAMPLES

5.1. Overview

This section illustrates some programming examples for particular functions of the Penta drive. Flowcharts are used for easier reference.
For any detail concerning individual parameters, see the relevant sections in this manual.

5.2. Programming a Reference



FLOWCHART A

Setting
P000 Write Enable
P001 = Eng. (User Level)

Selecting the Reference Sources

In the **Motor 1 Control** menu, select the type of speed/torque reference (**C011**). The **Control Method** menu includes the parameters selecting the reference source.
You can set up to four sources, which are summed up to each other. For speed control, and if references are to be sent also from **digital inputs**, see the **Multispeed** menu**.**

Forcing the Reference Sources

Sources:

REF	Ref Analog Input
AIN1	AIN1 Analog Input
AIN2	AIN2 Analog Input
Pulse Input	Frequency Input (MDI8)
Encoder	Encoder Input

The reference scaling is obtained through the parameters included in the **Input Reference** menu. Each source is assigned to a parameter setting its min. value and max. value for the min./max. speed/torque reference of the connected motor (e.g. Motor 1 speed reference: **C028** for min. speed, **C029** for max. speed.
Torque reference:
C047 for min. torque, **C048** for max. torque)

Sources:

Serial Link	Reference from serial link
Fieldbus	Reference from fieldbus
Keypad	Ref. from display/keypad
Preset Speed	Reference from digital input

No reference scaling is required. Speed references are expressed in rpm, torque references are expressed as a percentage of the motor rated torque. Saturation of the reference values depends on Min. Speed and Max. Speed parameters (speed control), and on Min. Torque and Max. Torque parameters (torque control). (E.g. Motor 1 speed: **C028** for min. speed, **C029** for max. speed; Motor 1 torque: **C047** for min. torque, **C048** for max. torque)

FLOWCHART B

Setting
P000 Write Enable
P001 = Eng. (User Level)

Selecting the Ref/Feedback Sources

The **PID Configuration** menu includes the parameters selecting the reference/feedback source.
You can set up to three sources, which are summed up to each other.

Forcing the Reference/Feedback Sources

Sources:

REF	Ref Analog Input
AIN1	AIN1 Analog Input
AIN2	AIN2 Analog Input
Pulse Input	Frequency Input (MDI8)
Encoder	Encoder Input

The reference scaling is obtained through the parameters included in the **Reference** menu. Each source is assigned to a parameter setting its min. value and max. value for the min./max. PID Reference/Feedback value.
See the **PID Parameters** menu.

Reference	**P245** Min., **P246** Max.
Feedback	**P247** Min., **P248** Max.

Sources:

Serial Link	Reference from serial link
Fieldbus	Reference from fieldbus
Keypad	Ref. from display/keypad

Feedback reference only :

Iout	Output current
Vout	Output voltage
Vdc	DC bus voltage
Pout	Output power

No reference scaling is required. References are expressed as a percentage. As a feedback reference, output current (Iout), output voltage (Vout), DC bus voltage (Vdc) are available, which refer (as full-scale values) to the following:
Rated current of the selected motor (Mot.1 **C018**)
Rated voltage of the selected motor (Mot.1 **C019**)
DCb Bus 1500 V.

EXAMPLE:

The speed of a motor is to be controlled via a 0 ÷ 5 V analog input. Speed range is 0 ÷ 1500 rpm; two digital inputs are available to increase three speed values with steps of 100rpm.

Setting the min. and max. speed:
The parameters for the motor min./max. speed are **C028** = 0 rpm, **C029** = 1800 rpm.

Setting the analog reference:
Default setting: the analog reference is sent from REF input (**C143** = REF).
The speed range for the analog input must be 0 ÷ 1500 rpm.

Default setting in the INPUTS FOR REFERENCES MENU for REF analog input:
P050 = 3: 0 –10 V   Type of reference for REF input
P051 = 0.0 V   Min. value for REF input
P052 = 10.0 V   Max. value for REF input

P052 is the voltage value for REF input for a speed reference of 1800rpm (**C029**)
For a speed reference of 1500rpm with 5 V, **P052** is to be set as follows:
(Max. speed REF): (5 V) = (**C029**): (Vx)
Vx = 5 V *1800rpm /1500rpm = 6 V
If **P052** = 6V, a speed reference of 1500rpm is set for REF with 5V.

Setting the reference from digital inputs:

Default setting: two digital inputs for multispeed values.
Digital Inputs Menu: **C155** = MDI4; **C156** = MDI5
Depending on the status of digital inputs MDI4 and MDI5:

MDI4	MDI5	Multispeed
0	0	0
1	0	1
0	1	2
1	1	3

In the MULTISPEED MENU, set the speed steps as follows:

P080 = 1: Sum Speed
P081 = 100rpm Multispeed 1
P083 = 200rpm Multispeed 2
P085 = 300rpm Multispeed 3

P080 → Multispeed function: the selected multispeed is summed up to the reference for the analog input.
P081, **P083**, **P085** are the steps depending on the selected multispeed for digital inputs MDI4, MDI5.

5.3. Configuring the External Torque Limit

Setting
P000 Write Enable
P001 = Eng. (Access Level)

Selecting the Reference Source

The **Control Method** menu contains parameter **C147** for the selection of the torque limit source.

Forcing the Reference Sources

Sources:

REF	REF Analog Input
AIN1	AIN1 Analog Input
AIN2	AIN2 Analog Input
Pulse Input	Frequency Input (MDI8)
Encoder	Encoder Input

The reference scaling is obtained through the parameters included in the **Reference** menu. Each source is assigned to a parameter setting its min. value and max. value for the min. /max. torque of the connected motor (e.g. Motor 1: **C047** for min. torque, **C048** for max. torque).

<u>The torque ramp set in parameters **P026- P027** of the **Ramps** menu is assigned to the limit torque reference</u>.

Sources:

Serial Link	Reference from serial link
Fieldbus	Reference from fieldbus
Keypad	Ref. from display/keypad

No reference scaling is required. References are expressed as a percentage of the motor rated torque. Saturation of the reference values depends on min./max. torque parameters (e.g. Motor 1: **C047** for min. torque, **C048** for max. torque).

<u>The torque ramp set in parameters **P026- P027** of the **Ramps** menu is assigned to the limit torque reference</u>.

5.4. Configuring the Feedback from Incremental Encoder

Setting
P000 Write Enable
P001 = Eng. (Access Level)

Setting the Speed Feedback

In the **Motor Control** menu, set **C012** as a speed feedback from Encoder.

Selecting the Encoder

ENCODER A
Push-Pull, single-ended 24V encoder connected to digital inputs **MDI6** and **MDI7.**
NOTE: In the **Digital Inputs** menu, do not set any function for **MDI6** and **MDI7.**

In the **Encoder/Frequency Input** menu, set the source for Encoder A speed feedback: set **C189** [A=FBK B=NO] (if also encoder B or frequency input FIN B are used, see the programming options for **C189** in the Encoder/Frequency Input section).
Set the number of pls/rev for the encoder being used (parameter **C190**).

ENCODER B
Encoder acquired via option board **ES836, ES913 or ES861** (see the Installation Guide for the Configuration of the jumper and the DIP-switches for the encoder type and supply).

In the **Encoder/Frequency Input** menu, set the source for Encoder B speed feedback: set **C189** [A=NO B=FBK] (if also encoder A or frequency input FIN A are used, see programming options for **C189** in the Encoder/Frequency Input section).
Set the number of pls/rev for the encoder being used (parameter **C191**).

Checking the Encoder

Check to see if the encoder is properly connected.
CAUTION: the motor must start running.
In the **Autotune** menu, set **I073** = Encoder Tune and close the enabling contact of the drive **(MDI2)**. When autotune is over, one of the following messages is displayed:
•**W31 Encoder Ok** (encoder direction matches with the motor direction of rotation)
•**A059 Encoder Fault** (wrong encoder reading: check parameters in the Encoder/Frequency Input menu and check wiring. If encoder B is used, check the configuration of the DIP-switches in the encoder board and the configuration of the jumper selecting the encoder supply mode.)
When performing the Autotune function, the encoder signal used as feedback is automatically corrected (see **C199**).

5.5. Configuring a Reference from Incremental Encoder

Setting
P000 Write Enable
P001 = Eng. (Access Level)

See flowchart A for the reference selection and set the encoder as the reference source

Selecting the Encoder

ENCODER A
Push-Pull, single-ended 24V encoder connected to digital inputs **MDI6** and **MDI7.**

NOTE: In the **Digital Inputs** menu, do not set any function for **MDI6** and **MDI7.**

ENCODER B
Encoder acquired with option board **ES836, ES913 or ES861** (see the Installation Instructions manual for the configuration of the jumper and the DIP-switches for the encoder

In the **Encoder/Frequency Input** menu, set the source for Encoder A speed reference: set **C189** [A=REF B=NO] (if also encoder B or frequency input FIN B are used, see programming options for **C189** in the Encoder/Frequency Input section).
Set the number of pls/rev for the encoder being used (parameter **C190**).

In the **Encoder/Frequency Input** menu, set the source for Encoder B speed reference: set **C189** [A=NO B= REF] (if also encoder A or frequency input FIN A are used, see programming options for **C189** in the Encoder/Frequency Input section).
Set the number of pls/rev for the encoder being used (parameter **C191**).

Checking the Reference

If the sign for the reference from encoder is not correct, you should reverse it by setting **C199** =[FBK XX REF YES].

6. START-UP MENU

6.1. Overview

For easier startup of the Penta drive, you can activate the Start-Up Menu. The Start-Up Menu is a wizard allowing programming the main parameters for the connected motor and the parameters for PID control.
The parameters in this menu are the same as described in the FIRST STARTUP section.

The Start-Up Menu is displayed when the Penta drive is first started. The Start-Up Menu can be reactivated at any time. To do so, set **P265** in "Start Up" mode (see the DISPLAY/KEYPAD MENU) and power on the Penta drive again.

The following is the root page of the Start-Up menu:

```
[IDP]SINUS PENTA
 START-UP MENU
  Press ENTER
   to start
```

Press **ENTER** to enter the wizard.

Before entering the control parameters, you are asked to choose a dialogue language:

```
P263 Language


→@@@@@@@@@@@@@@@
```

then you are asked to choose the display mode of the Start Up Menu:

```
When does the
Start-Up Menu
activate?
→@@@@@@@@@@@@@@@
```

Choose one of the following:

```
1:EVERY START-UP
2:ONLY NOW
3:NEXT START-UP
4:NEVER
```

If you select "EVERY START–UP", the wizard appears whenever the Penta drive is powered on;
if you select "ONLY NOW", you can scroll through the menu and the wizard is disabled as soon as you quit the menu;
if you select "NEXT START–UP", the menu is displayed only when the Penta drive is next started up;
if you select "NEVER", the Start-Up menu is disabled.

Parameters included in the Start-Up menu:

Parameter	Description	Visibility
C008	Rated mains voltage	
C010	Type of control algorithm	
C012	Speed feedback from encoder	[only if FOC is active]
C013	Type of V/f pattern	[only if IFD is active]
C015	Rated motor frequency	
C016	Rated motor rpm	
C017	Rated motor power	
C018	Rated motor current	
C019	Rated motor voltage	
C021	No-load current of the motor	[only if FOC is active]
C028	Min. motor speed	
C029	Max. motor speed	
C034	Voltage preboost	[only if IFD is active]
P009	Acceleration ramp time	
P010	Deceleration ramp time	
C043	Current limit while accelerating	[only if IFD is active]
C044	Current limit at constant rpm	[only if IFD is active]
C045	Current limit while decelerating	[only if IFD is active]
C048	Torque limit motor	[only if VTC/FOC are active]
C049	Torque limit brake	[only if VTC/FOC are active]
C189	Encoder operating mode	[only if FOC is active]
C190	Encoder A pls/rev	[only if FOC is active]
C191	Encoder B pls/rev	[only if FOC is active]
I073	Autotune selection	[only if VTC/FOC are active]
I074	Motor tuning selection	[only if VTC/FOC are active]
C265	Motor thermal protection	
C267	Motor thermal time constant	[only if protection is active]

After setting the last parameter and moving the cursor forward, the following page will appear:

```
Press UP ARROW
to quit
DOWN ARROW
to continue
```

Press ▲ to quit the Start-up menu. The default page of the system will be displayed.

7. FIRST STARTUP

For the signal wiring and power wiring, please refer to the Sinus Penta's Installation Guide.
Parameter programming is detailed in the START-UP MENU.

7.1. "IFD" Control Algorithm

SINUS PENTA drives are factory set with the IFD (**C010**) control algorithm for the first startup of the equipment. The default functions of the drive terminals are given in the table below. For more details, please refer to the Sinus Penta's Installation Guide.

1) Wiring: Follow the instructions stated in the "Caution Statements" and "Installation" sections (Installation Guide).

2) Power on: Power on the drive and do not close the link to the **ENABLE-A** and **ENABLE-B** inputs to prevent the motor from running. Check if the display/keypad turns on.

3) Parameter setting: The equipment startup is made easier by the START-UP MENU, which is a wizard for the set-up of the main motor control parameters.

From the START-UP MENU, set the following:

1. The actual power supply voltage in **C008**. It is possible to select the rated mains voltage range or the power supply from a DC-bus stabilized by a Regenerative Penta;
2. The motor ratings by way of:

- **C015** (fmot1) rated frequency
- **C016** (rpmnom1) rated rpm
- **C017** (Pmot1) rated power
- **C018** (Imot1) rated current
- **C019** (Vmot1) rated voltage
- **C029** (Speedmax1) max. allowable speed.

The motor V/f pattern may be programmed in **C013**. For loads with quadratic torque in respect to the rpm (centrifugal pumps, fans, etc.), set **C034** (preboost1) to 0%.

4) Autotune (motor stopped): In case of IFD motor control when slip compensation is inactive (**C039**=0%) no autotune is required. On the other hand, when slip compensation is active, it is recommended to compute stator resistance **C022**.

The steps to take to perform motor autotune are the following:
With the **ENABLE-A** and **ENABLE-B** commands open, access the AUTOTUNE MENU and set **I073** = [1: Motor Tune] and **I074** = [0: Motor Params]. Use the **ESC** key to accept changes.

Close the **ENABLE-A** and **ENABLE-B** commands and wait until tune is complete (Warning "**W32** Open Enable" is displayed). The drive has computed and saved the values for **C022** (stator resistance).

If alarm "**A097** Motor Wires KO" trips, check the motor wiring. If alarm "**A065** Autotune KO" trips, this means that the **ENABLE** command has opened before autotune was complete. In this case, reset the drive by sending a command from **RESET** terminal (**MDI3** as factory default), or pressing the **RESET** key in the display/keypad and perform the autotune procedure again.

5) Overload: Set parameters **C043**, **C044** and **C045** as the maximum desired overload current.

6) Startup: Activate the **ENABLE-A** input (terminal 15), **ENABLE-B** input (terminal S) and the **START** input (terminal 14) and send a speed reference: the **RUN** LED and **REF** LEDs will come on and the motor will start running. Make sure that the motor is rotating in the correct direction. If not, set parameter **C014** (Phase Rotation) to [1:Yes], or open the **ENABLE-A, ENABLE-B** and **START** inputs, remove voltage from the drive and, after waiting at least 20 minutes, swap two of the motor phases.

7) Possible failures:

If no failure occurred, go to step **8)**. Otherwise, check the drive connections paying particular attention to supply voltages, DC link and input reference. Also check if alarm messages are displayed. In the MEASURES MENU, check the reference speed (**M001**), the supply voltage to the control section (**M030**), the DC link voltage (**M029**), and the condition of control terminals (**M033**). Check to see if these readouts match with the measured values.

8) Additional parameter modifications:

When parameter **P003** = Standby Only (condition required for changing C parameters), you can change **Cxxx** parameters in the CONFIGURATION menu only when the drive is DISABLED or STOPPED, whereas if **P003** = Standby + Fluxing, you can change **Cxxx** parameters when the motor is stopped but the drive is enabled.

You can write down any custom parameters in the table provided on the last pages of this Programming Guide (CUSTOM PARAMETERS).

9) Reset:

If an alarm trips, find the cause responsible for the alarm and reset the drive by sending a command from **RESET** terminal (**MDI3** as factory default), or pressing the **RESET** key on the display/keypad.

NOTE

When the IFD control algorithm is used, only speed references can be set up.

NOTE

The **ENABLE-A** and **ENABLE-B** inputs are allocated to the STO function. If this safety function is to be adopted, the control mode and the control circuit of these signals must be accomplished as per the Safe Torque Off Function - Application Manual**.**
That manual also includes a detailed validation procedure of the control configuration of the STO function to be executed upon first start-up and also periodically at yearly intervals.

7.2. “VTC” Control Algorithm

1) Wiring: Follow the instructions stated in the “Caution Statements” and “Installation” sections in the Sinus Penta’s Installation Guide.

2) Power on: Power on the drive and do not close the link to the **ENABLE-A** and **ENABLE-B** inputs to prevent the motor from running. Check if the display/keypad turns on.

3) Parameter setting: The equipment startup is made easier by the START-UP MENU, which is a wizard for the setup of the main motor control parameters.

From the START-UP MENU, set the following:

1. The actual power supply voltage in **C008**. It is possible to select the rated mains voltage range or the power supply from a DC-bus stabilized by a Regenerative Penta;
2. The control algorithm as VTC (Vector Torque Control) in **C010**;
3. The motor ratings by way of:

- **C015** (fmot1) rated frequency
- **C016** (rpmnom1) rated rpm
- **C017** (Pmot1) rated power
- **C018** (Imot1) rated current
- **C019** (Vmot1) rated voltage
- **C029** (Speedmax1) max. allowable speed.

CAUTION: It is not advisable to set rated motor power and current lower than 50% of the drive size. This would adversely affect the motor control performance.

4) Setting no-load current C021 If the motor current is known, set **C021** (**I_0**) to the value of **I_0** expressed as a percentage of the rated motor current.
If the no-load current of the motor is not known but the motor can rotate freely without any connected load, start the motor in IFD mode at nominal rpm, read out the current value from the Motor Measures Menu and use that value as the first trial value for **I_0**. For example, if the rated motor current is **C018** = 133 A and **M026** = 36 A, set **C021** = 36/133 = 27%.

NOTE: If the motor must run at a higher speed than the rated speed (field weakening mode) read out the no-load current value at rated speed in any case.
Lastly, if the no-load current of the motor is not known and the motor cannot rotate under no-load conditions, you can use the first **I_0** trial value automatically computed by the Penta drive during the tuning procedure described in step **5)**.

NOTE: Each time the tuning procedure in step **5)** is carried out with no-load current parameter **C021** (**I_0**) = 0, the Penta drive will automatically enter a value based on the motor current ratings.

5) Autotune of motor parameters (motor stopped) With the **ENABLE-A** and **ENABLE-B** commands open, access the AUTOTUNE MENU and set **I073** = [1: Motor Tune] and **I074** = [0: Motor Params]. Press **ESC** to confirm the new values.
Close the **ENABLE-A** and **ENABLE-B** commands and wait until tune is complete (Warning “**W32** Open Enable” is displayed).

The drive has now computed and saved the following parameter values:

- **C022** (stator resistance) through motor measurements
- **C023** (leakage inductance) through motor measurements
- If **C021**=0, a first trial value for no-load current **C021** is computed based on the motor ratings
- **C024** (mutual inductance)
- If **C025**=0, a first trial value for rotor time constant **C025** is computed based on the motor ratings

If alarm “**A097** Motor Wires KO“ trips, check the motor wiring. If alarm “**A065** Autotune KO” trips, this means that the **ENABLE-A** and **ENABLE-B** commands have opened before autotune was

complete. In that case, reset the drive by sending a command from **RESET** terminal (**MDI3** as factory default), or pressing the **RESET** key in the display/keypad and perform the autotune procedure again.
If the motor can rotate with no connected load, carry out the autotune procedure for the rotor time constant and the current loop of the VTC regulator as detailed in step **6a)**, otherwise carry out the autotune procedure as detailed in step **6b)** (in both cases, the rotor time constant **C025** is computed based on the motor measurements).

6a) Autotune for rotor time constant and current loop (rotor free)

CAUTION: This type of tuning requires that the motor is free to rotate with no connected load. During autotune, current is first applied to the motor when the rotor is not running, then the motor is operated to run at approx. 90% of its rated speed.

If the motor can rotate with no connected load, with the **ENABLE-A** and **ENABLE-B** commands open, access the AUTOTUNE MENU and set **I073** = [1: Motor Tune] e **I074** = [2: Control YES rot]. Press **ESC** to confirm the new values.
Close the **ENABLE-A** and **ENABLE-B** commands and wait until tune is complete (Warning "**W32** Open Enable" is displayed).

The drive has now computed and saved the following parameter values:
- **C025** (rotor time constant) through motor measurements
- **P175t1** (proportional gain of the current control) and **P175u1** (integral time of the current control) through motor measurements.

If alarm "**A065** Autotune KO" trips, this means either that the **ENABLE-A** and **ENABLE-B** commands have opened before autotune was complete, or that the available timeout has elapsed. In either case, reset the drive sending a command from terminal MDI3, or press the **RESET** key on the display/keypad and perform the autotune procedure again.

NOTE: If autotune has not been interrupted by opening the **ENABLE-A** and **ENABLE-B** commands, decrease no-load current value **C021** by 5% before performing the autotune procedure again.

6b) Autotune for rotor time constant and current loop (motor stopped):

If the motor cannot rotate with any connected load, it is anyway possible to estimate the rotor time constant by way of the autotune procedure, therefore an autotune procedure similar to that of point **6a)** is carried out, but without turning the motor.

With the **ENABLE-A** and **ENABLE-B** commands open, access the AUTOTUNE MENU and set **I073** = [1: Motor Tune] and **I074** = [1: Control NO rot]. Press **ESC** to confirm the new changes. Close the **ENABLE-A** and **ENABLE-B** commands and wait until tune is complete (Warning "**W32** Open Enable" is displayed).

The drive has now computed and saved the following parameter values:
- **C025** (rotor time constant) through motor measurements
- **P175t1** (proportional gain of the current control) and **P175u1** (integral time of the current control) through motor measurements.

If alarm "**A065** Autotune KO" trips, this means that the **ENABLE-A** and **ENABLE-B** commands have opened before autotune was complete or the autotune algorithm has failed within the preset timeout. In that case, reset the drive by sending a command from **RESET** terminal (**MDI3** as factory default), or pressing the **RESET** key in the display/keypad and perform the autotune procedure again.

7) Overload:	Set parameters **C048** and **C049** in the LIMITS MENU based on the maximum torque that can be generated expressed as a percentage of the motor rated torque.
8) Start up:	Activate the **ENABLE-A** input (terminal 15), **ENABLE-B** (terminal S) and the **START** input (terminal 14) and send a speed reference. The **RUN** LED and **REF** LED will come on and the motor will start. Make sure that the motor is rotating in the correct direction. If not, set parameter **C014** (Phase Rotation) = [1:Yes], or open the **ENABLE-A**, **ENABLE-B** and **START** inputs, remove voltage from the drive and, after waiting at least 20 minutes, swap two of the motor phases.
9) Speed regulator adjustment:	If overshoot occurs when the speed setpoint is attained or if a system instability is detected (jerking), adjust the parameters relating to the speed loop (SPEED LOOP AND CURRENT BALANCING MENU). Set the two parameters relating to integral time (**P125, P126**) as [Disabled] and set low values for the parameters relating to proportional gain (**P128, P129**). Set equal values for **P128** and **P129** and increase them equally until overshoot takes place when the setpoint is attained. Decrease **P128** and **P129** by approx. 30%, then decrease the high values set for integral time in **P125** and **P126** (keep both values equal) until an acceptable setpoint response is obtained. Check to see if the motor runs smoothly at constant speed.
10) Possible failures:	If no failure occurred, go to step **11)**. Otherwise, check the drive connections paying particular attention to supply voltages, DC link and input reference. Also check if alarm messages are displayed. In the MEASURES MENU, check the reference speed (**M000**), the reference speed processed by the ramps (**M002**), the supply voltage of the control section (**M030**), the DC-link voltage (**M029**), the condition of the control terminals (**M033**). Check to see if these readouts match with the measured values.
11) Additional parameter modifications:	If the motor control is underperfoming, make sure that the following measurements are consistent with the expected motor operation: - estimated speed **M004** in respect to speed ramp **M002**, - output frequency **M006**, - generated torque **M012** in respect to torque demand **M011**, - output current **M026**, - output voltage **M027**. Proceed as follows:

Issue	What to do
Generation of weak torque or inaccurate torque delivery	Increase the flux boost at low frequency **P175h1** and adjust the frequency range for the boost to occur via parameters **P175i1** and **P175j1**. The magnetization current at low frequency with active current boost equals the no-load current value in **C021** increased by the value in **P175h1** (for example, if **C021**=27% and **P175h1**=30%, the magnetization current is 27%x1.3=35.1%). Up to the frequency value in **P175i1**, the magnetization current is **C021** x (1+**P175h1**); at a frequency higher than **P175j1**, the magnetization current is **C021**; at intermediate frequency values, the magnetization current follows a linear pattern. Too high magnetization current values may lead to saturation of the motor flux, lower efficiency due to greater no-load current, inaccurate torque adjustment or controller instability. It is suggested that **P175j1** be applied at its maximum value up to 50% of the rated frequency. Also, set **P175i1** in such a way so as to obtain a rather smooth pattern (for example, **P175i1** set to half the value in **P175j1**). In case **P175i1** and **P175j1** are not correctly adjusted, torque adjustment may be uneven or current variations may occur.
Generation of weak torque at high speed	If the motor is not capable of delivering high torque at high speed (close to rated torque or field weakening torque) or requires excessive current in respect to the expected current, adjust rotor time constant **C025** and increase no-load current **C021**.

Generation of weak torque at low speed or in regenerative mode	Change current distortion compensation parameters in VTC control **P175a**, **P175b**, **P175c**. Change current distortion compensation **P175b** first, then change positive and negative current split **P175c.** For high values in **P175b**, also increase the linear pattern threshold in **P175a**. If parameter **P175b** is set too high or **P175a** is set too low, rotor oscillations may occur, or it may happen that the rotor is not kept standstill even in no-load conditions. If this is the case, set lower values for the parameters above.
Low output voltage or weak torque in field weakening mode	Disable static field weakening by setting **C030** = Disable and enable automatic field weakening by setting **C030a** >0. In that way, the field weakening amplitude is automatically adjusted to ensure adjusting the required speed at the maximum allowable voltage fitting the rated motor voltage and the available DC voltage.
Generated torque (measure **M012**) different from torque demand (measure **M011**)	It is required for certain applications that the generated torque is as close as possible to the torque demand; this is due to the fact that the torque limitation (parameters **C047, C048** and **C049**) operates on the torque demand, thus it is important that the generated torque is limited correctly. To do so, it is necessary to: • Verify **M011** and **M012** in normal working conditions of the motor and, or in any case, at least at 75% of the rated speed with at least 75% of the rated load. If the motor must run at a higher speed than rated speed (weakening field mode) verify the parameters in this condition as well. • If **M011**>**M012**, gradually increase **C023** at a rate of around 10%. • If **M011**<**M012**, gradually decrease **C023** at a rate of around 10%. • In the event that, increasing **C023**, difficulties in the starting phase arise, gradually decrease **C024** at a rate of around 10% and find a new value for **C023** to make **M011** and **M012** equivalent.

When parameter **P003** = Standby Only (condition required for changing **Cxxx** parameters), you can change **Cxxx** parameters only when the drive is DISABLED or STOPPED, whereas if **P003** = Standby + Fluxing, you can change **Cxxx** parameters when the motor is stopped but the drive is enabled.

Before changing any parameters, remember that the correct code for parameter **P000** must be previously set up.

You can write down any custom parameters in the table provided on the last pages of this Programming Manual (CUSTOM PARAMETERS).

12) Reset: If an alarm trips, find the cause responsible for the alarm and reset the drive by sending a command from **RESET** terminal (**MDI3** as factory default), or pressing the **RESET** key on the display/keypad.

NOTE The **ENABLE-A** and **ENABLE-B** inputs are allocated to the STO function. If this safety function is to be adopted, the control mode and the control circuit of these signals must be accomplished as per the Safe Torque Off Function - Application Manual**.**
That manual also includes a detailed validation procedure of the control configuration of the STO function to be executed upon first start-up and also periodically at yearly intervals.

7.3. "FOC" Control Algorithm

1) Wiring:

Follow the instructions stated in the "Caution Statements" and "Installation" sections in the Installation Guide.

2) Power on:

Power on the drive and do not close the link to the **ENABLE-A** and **ENABLE-B** inputs to prevent the motor from running. Check to see if the display/keypad turns on.

3) Parameter setting:

The equipment startup is made easier by the START-UP MENU, which is a wizard for the set-up of the main motor control parameters.

From the START-UP MENU, set the following:

1. The actual power supply voltage in **C008**. It is possible to select the rated mains voltage range or the power supply from a DC-bus stabilized by a Regenerative Penta;
2. Control algorithm as FOC (Field Oriented Control) in **C010**;
3. The motor ratings by way of:

- **C015** (fmot1) rated frequency
- **C016** (rpmnom1) rated rpm
- **C017** (Pmot1) rated power
- **C018** (Imot1) rated current
- **C019** (Vmot1) rated voltage
- **C029** (Speedmax1) max. allowable speed.

CAUTION: It is not advisable to set rated motor power and current lower than 50% of the drive size. This would adversely affect the motor control performance.

4) Setting no-load current C021

If the no-load current of the motor is known, set **C021** ($\mathbf{I_0}$) with the $\mathbf{I_0}$ value expressed as a percentage of the rated motor current.
If the no-load current of the motor is not known but the motor can rotate freely without any connected load, start the motor in IFD mode at nominal rpm, read out the current value from the Motor Measures Menu (**M026**) and use it as a first trial value for $\mathbf{I_0}$. For example, if the rated current is **C018** = 133 A and **M026** = 36 A, set **C021** = 36/133 = 27%.

NOTE: If the motor must run at a higher speed than the rated speed (field weakening mode) read out the no-load current value at rated speed in any case.
Lastly, if the no-load current of the motor is not known and the motor cannot rotate under no-load condition, you can use the first $\mathbf{I_0}$ trial value automatically computed by the Penta drive during the tuning procedure described in step **6)**.

NOTE: Each time the tuning procedure in step **5)** is carried out with no-load current parameter **C021** ($\mathbf{I_0}$) = 0, the Penta drive will automatically enter a value based on the motor current ratings.

5) Encoder test:

The motor must run when testing the encoder.

Set the source of the encoder signal used as a speed feedback (Encoder A in terminal board, Encoder B from **ES836**, **ES913** or **ES861** optional board) in parameter **C189**; enter the number of pulse/rev (**C190** or **C191**).
Set the parameter relating to speed feedback from encoder: **C012** = Yes.
With the **ENABLE-A** and **ENABLE-B** commands open, access the AUTOTUNE MENU and set parameter **I073** = [2: Encoder Tune]. Use the **ESC** key to confirm changes. Close the **ENABLE-A** and **ENABLE-B** commands and wait until encoder tune is complete ("**W32** Open Enable" is displayed).
Once encoder tune is complete, the display will show one of the following messages:
"**W31** Encoder Ok"; the speed feedback is correct. If the speed detected by the encoder is opposite to the desired speed, the drive will automatically reverse the feedback sign (parameter **C199**).
"**A059** Encoder Fault"; the speed detected from the encoder is not consistent with the control speed. Possible causes:

- Wrong number of pls/rev of the encoder
- Wrong power supply of the Encoder (e.g. +5V instead of +24V): check the encoder ratings and the position of jumpers and DIP-switches for the encoder supply in the optional encoder board
- Wrong configuration of the DIP-switches for the encoder selection (push-pull or line-driver encoder) in the optional encoder board
- No connection to the encoder channel (check wiring)
- At least one Encoder channel is faulty (replace the encoder).

6) Motor tuning parameters (motor stopped)

With the **ENABLE-A** and **ENABLE-B** commands open, access the AUTOTUNE MENU and set **I073** = [1: Motor Tune] and **I074** = [0: Motor Params]. Press **ESC** to confirm the new values.
Close the **ENABLE-A** and **ENABLE-B** commands and wait until tune is complete (Warning "**W32** Open Enable" is displayed).

The drive has now computed and saved the following parameter values:

- **C022** (stator resistance) through motor measurements
- **C023** (leakage inductance) through motor measurements
- If **C021**=0, a first trial value for no-load current **C021** is computed based on the motor ratings
- **C024** (mutual inductance)
- If **C025**=0, a first trial value for rotor time constant **C025** is computed based on the motor ratings

If alarm "**A097** Motor Wires KO" trips, check the motor wiring. If alarm "**A065** Autotune KO" trips, this means that the **ENABLE-A** and **ENABLE-B** commands have opened before autotune was complete. In that case, reset the drive by sending a command from **RESET** terminal (**MDI3** as factory default), or pressing the **RESET** key in the display/keypad and perform the autotune procedure again.

If the motor can rotate with no connected load, carry out the autotune procedure for the rotor time constant and the current loop of the FOC regulator as detailed in step **7a)**, otherwise carry out the autotune procedure as detailed in step **7b)** (in both cases, the rotor time constant **C025** is computed based on the motor measurements).

7a) Autotune of the rotor time constant and current and flux loops (rotor free)

CAUTION: This type of tuning requires that the motor is free to rotate with no connected load. During autotune, current is first applied to the motor when the rotor is not running, then the motor is operated to run at approx. 90% of its rated speed.

If the motor can rotate with no connected load, with the **ENABLE-A** and **ENABLE-B** commands open, access the AUTOTUNE MENU and set **I073** = [1: Motor Tune] e **I074** = [2: Control YES rot]. Press **ESC** to confirm the new values.
Close the **ENABLE-A** and **ENABLE-B** commands and wait until tune is complete (Warning "**W32** Open Enable" is displayed).

The drive has now computed and saved the following parameter values:

- **C025** (rotor time constant) through motor measurements
- **P155** (proportional gain of the current control) and **P156** (integral time of the current control) through motor measurements.
- **P158** (proportional gain of the flux control) and **P159** (integral time of the flux control) based on the rotor time constant.

If alarm "**A065** Autotune KO" trips, this means that the **ENABLE-A** and **ENABLE-B** commands have opened before autotune was complete or the autotune algorithm has failed within the preset timeout. In that case, reset the drive by sending a command from **RESET** terminal (**MDI3** as factory default), or pressing the **RESET** key in the display/keypad and perform the autotune procedure again.

NOTE: If autotune has not been interrupted by opening the **ENABLE-A** and **ENABLE-B** commands, decrease no-load current value **C021** by 5% before performing the autotune procedure again.

7b) Autotune of the rotor time constant and current and flux loops (motor stopped)

If the motor cannot rotate with any connected load, it is anyway possible to estimate the rotor time constant by way of the autotune procedure, therefore an autotune procedure similar to that of point **7a)** is carried out, but without turning the motor.

With the **ENABLE-A** and **ENABLE-B** commands open, access the AUTOTUNE MENU and set **I073** = [1: Motor Tune] and **I074** = [1: Control NO rot]. Press **ESC** to confirm the new changes. Close the **ENABLE-A** and **ENABLE-B** commands and wait until tune is complete (Warning "**W32** Open Enable" is displayed).

The drive has now computed and saved the following parameter values:

- **C025** (rotor time constant) through motor measurements
- **P155** (proportional gain of the current control) and **P156** (integral time of the current control) through motor measurements.
- **P158** (proportional gain of the flux control) and **P159** (integral time of the flux control) based on the rotor time constant.

If alarm "**A065** Autotune KO" trips, this means that the **ENABLE-A** and **ENABLE-B** commands have opened before autotune was complete or the autotune algorithm has failed within the preset timeout. In that case, reset the drive by sending a command from **RESET** terminal (**MDI3** as factory default), or pressing the **RESET** key in the display/keypad and perform the autotune procedure again.

8) Overload:

Set parameters **C048** and **C049** in the LIMITS MENU based on the maximum torque that can be generated expressed as a percentage of the motor rated torque.

9) Start up:

Activate the **ENABLE-A** input (terminal 15), **ENABLE-B** (terminal S) and the **START** input (terminal 14) and send a speed reference. The **RUN** LED and **REF** LED will come on and the motor will start. Make sure that the motor is rotating in the correct direction. If not, set parameter **C014** (Phase Rotation) = [1:Yes], or open the **ENABLE-A**, **ENABLE-B** and **START** inputs, remove voltage from the drive and, after waiting at least 20 minutes, swap two of the motor phases.

10) Speed regulator adjustment:

If overshoot occurs when the speed setpoint is attained or if a system instability is detected (jerking), adjust the parameters relating to the speed loop (SPEED LOOP AND CURRENT BALANCING MENU). Set the two parameters relating to integral time (**P125, P126**) as [Disabled] and set low values for the parameters relating to proportional gain (**P128, P129**). Set equal values for **P128** and **P129** and increase them equally until overshoot takes place when the setpoint is attained. Decrease **P128** and **P129** by approx. 30%, then decrease the high values set for integral time in **P125** and **P126** (keep both values equal) until an acceptable setpoint response is obtained. Check to see if the motor runs smoothly at constant speed.

11) Possible failures:

If alarm "**A060** Fault No Curr." trips, this means that the current loop is not properly tuned. Follow the instructions given in step **6)** and decrease the value of **I_0** (parameter **C021** in the MOTOR CONFIGURATION MENU).

If the motor is noisy when starting, this means that the rotor time constant is not correct. Follow the instructions given in step **7a)** or **7b)** again, or manually change the value of the rotor time constant (parameter **C025**) for a smooth motor startup.
If no failure occurred, go to step **7)**. Otherwise, check the drive connections paying particular attention to supply voltages, DC link and input reference. Also check if alarm messages are displayed. In the Motor Measures Menu, check the speed reference (**M000**), the reference speed processed by the ramps (**M002**), the supply voltage of the control section (**M030**), the DC link voltage (**M029**), the condition of the control terminals (**M033**). Check to see if these readouts match with the measured values.

12) Additional parameter modifications:

For the optimization of the motor performance, adjust parameters **C021** (no-load current), **C024** (mutual inductance), **C025** (rotor time constant). Consider the following:

- **C021 Too high values** → Lower torque, especially at rated speed, because most part of the voltage imposed by the drive is used to magnetize the motor instead of generating a proper motor torque;
- **C021 Too low values** → Because of the motor flux weakening, higher current ratings are needed;
- **C024 Mutual inductance** → This is computed each time the no-load current level is changed. This is not binding for the motor control, but strongly affects the correct estimation of the output torque; in case of overestimation, decrease **C024**, and vice versa;
- **C025 Optimum value** → To obtain the optimum value of the rotor time constant, the best way consists in performing several attempts with a constant load but with different values of **C025**. The optimum value is the one ensuring to obtain the output torque with the lower current (see **M026**).

When parameter **P003** = Standby Only (condition required for changing C parameters), you can change **Cxxx** parameters in the CONFIGURATION menu only when the drive is DISABLED or STOPPED, whereas if **P003** = Standby + Fluxing, you can change **Cxxx** parameters when the motor is stopped but the drive is enabled.
You can write down any custom parameters in the table provided on the last pages of this Programming Guide (CUSTOM PARAMETERS).

13) Reset:

If an alarm trips, find the cause responsible for the alarm and reset the drive by sending a command from **RESET** terminal (**MDI3** as factory default), or pressing the **RESET** key on the display/keypad.

NOTE

The **ENABLE-A** and **ENABLE-B** inputs are allocated to the STO function. If this safety function is to be adopted, the control mode and the control circuit of these signals must be accomplished as per the Safe Torque Off Function - Application Manual**.**
That manual also includes a detailed validation procedure of the control configuration of the STO function to be executed upon first start-up and also periodically at yearly intervals.

8. MEASURES MENU

8.1. Overview

The Measures Menu contains the variables measured by the drive that can be used by the user.
In the display/keypad, measures are divided into subgroups.
The measure subgroups are the following:

Motor Measures Menu
This menu contains: the values of the speed reference at constant rpm, the values of the reference being used and the speed values of the connected motor expressed in rpm; the drive rated frequency;
the torque reference at constant rpm, the torque demand and the motor torque output, the torque limit reference at constant speed and the torque limit being used expressed both in Nm and as a percentage of the rated torque of the selected motor; the flux reference and the electrical variables measured by the drive mains side, the DC-bus and output; the measures of the incremental or absolute encoders being used.

PID Controller Menu
This menu contains the values relating to the PID controller of the Penta drive.

Digital Inputs Menu
This menu contains the state of the drive digital inputs and the indication of the functions programmed for the digital inputs of the Penta drive.

References Menu
This menu contains the following values: analog references, the encoder input and the frequency input references,
the speed/torque or reference/feedback values of the PID coming from serial link or fieldbus.

Outputs Menu
This menu contains the state of the drive digital outputs, analog outputs and frequency outputs.

Temperatures from PT100 Menu
This menu contains the temperature values detected in the first four analog channels of ES847 I/O expansion board (this menu is available only if ES847 is fitted).

Autodiagnostics Menu
This menu contains the temperature values, the operation time counter and the supply time counter, the active alarm and the drive status.

Data Logger Measures Menu
This menu contains the status of the type of connections (serial links, Ethernet and modem) supported by ES851 Data Logger board (this menu is available only if the Data Logger ES851 is fitted).

Digital Input Settings Menu
This menu contains the functions assigned to the digital inputs.

Fault List Menu
This menu contains the trip log of the last eight alarms tripped and the values of some measures being used when the alarm trip was stored.

PowerOff Log Menu
This menu contains the value of some measures being used at the drive power off.

8.2. Motor Measures Menu

This menu contains speed values, torque values and electrical variables measured by the drive on the mains side, DC bus and output.

M000 Speed Reference at Constant RPM

M000-1	**Range**	± 32000 (integer part) ± 99 (decimal part)	± 32000.99 rpm Note: The actual range depends on the selected motor, because it is defined by the value set in the parameters for the motor max. speed and min. speed. **C028**–**C029** Motor 1 **C071**–**C072** Motor 2 **C114**–**C115** Motor 3
	Active	Active only when a speed reference is used for the selected motor. Decimal part active for FOC control only.	
	Address	1650 (integer part) 1651 (decimal part)	
	Function	Value of the speed reference obtained when the motor rotates at constant speed, once the preset ramp time is over.	

M002 Speed Ramp Output

M002-3	**Range**	± 32000 (integer part) ± 99 (decimal part)	± 32000.99 rpm Note: The actual range depends on the selected motor, because it is defined by the value set in the parameters for the motor max. speed and min. speed. **C028**–**C029** Motor 1 **C071**–**C072** Motor 2 **C114**–**C115** Motor 3
	Active	Active only when a speed reference is used for the selected motor. Decimal part active for FOC control only.	
	Address	1652 (integer part) 1653 (decimal part)	
	Function	This is the measure of the speed value processed with respect to the ramp time.	

M004 Motor Speed

M004-5	**Range**	± 32000 (integer part) ± 99 (decimal part)	± 32000.99 rpm Note: it is possible to set a customized unit of measure and a customized scaling for measure **M004u**.
	Active	Always active. Decimal part active for FOC control only.	
	Address	1654 (integer part) 1655 (decimal part)	
	Function	Motor speed value.	

M006 Drive Output Frequency

M006	**Range**	± 10000	± 1000.0 Hz (see Table 70)
	Active	Always active.	
	Address	1656	
	Function	This is the measure of the voltage frequency output of the drive.	

M007 Torque Reference at Constant Speed (Nm)

M007	**Range**	± 32000	± 32000 Nm Note: The actual range depends on the torque limit values set for the selected motor. **C047–C048** Motor 1 **C090–C091** Motor 2 **C133–C134** Motor 3
	Active	Active only when a torque reference is used for the selected motor.	
	Address	1657	
	Function	This is the measure of the torque reference required at constant speed and expressed in Nm.	

M008 Torque Demand (Nm)

M008	**Range**	± 32000	± 32000 Nm Note: The actual range depends on the rated torque and the torque limit values set for the selected motor.	
			Limits with Torque control: **C047–C048** Motor 1 **C090–C091** Motor 2 **C133–C134** Motor 3	Limits with Speed control: **C048–C049** Motor 1 **C091–C092** Motor 2 **C134–C135** Motor 3
	Active	Active for VTC and FOC controls only.		
	Address	1658		
	Function	With Speed control: Torque demand of the speed regulator for the type of control used. With Torque control: Torque reference processed in respect to the preset torque ramp time.		

M009 Torque Generated by the Motor (Nm)

M009	**Range**	± 32000	± 32000 Nm Note: it is possible to set a customized unit of measure and a customized scaling for measure **M009u.**
	Active	Active for VTC and FOC controls only.	
	Address	1659	
	Function	Estimated value of the torque produced by the connected motor.	

M010 Torque Reference at Constant RPM (%)

M010	**Range**	± 500	± 500 % Note: The actual range depends on the torque limit values set for the selected motor. **C047–C048** Motor 1 **C090–C091** Motor 2 **C133–C134** Motor 3
	Active	Active only when a torque reference is used for the selected motor.	
	Address	1660	
	Function	This is the measure of the torque reference required at constant speed and expressed as a percentage of the motor rated torque.	

M011 Torque Demand (%)

M011	**Range**	± 500	± 500 % Note: The actual range depends on the torque limit values set for the selected motor.	
			Limits with Torque control: **C047–C048** Motor 1 **C090–C091** Motor 2 **C133–C134** Motor 3	Limits with Speed control: **C048–C049** Motor 1 **C091–C092** Motor 2 **C134–C135** Motor 3
	Active	Active for VTC and FOC controls only.		
	Address	1661		
	Function	With speed control: Torque demand of the speed regulator expressed as a percentage of the motor rated torque. With torque control: Torque reference processed with respect to the preset torque ramp time and expressed as a reference of the motor rated torque.		

M012 Torque Generated by the Motor (%)

M012	**Range**	± 500	± 500 %
	Active	Active for VTC and FOC controls only.	
	Address	1662	
	Function	Estimated value of the torque produced by the motor and expressed as a percentage of the rated torque of the selected motor.	

M013 Torque Limit Demand before Ramps (Nm)

M013	**Range**	± 32000	± 32000 Nm Note: The actual range depends on the preset torque limit values and the rated torque of the selected motor.	
			Limits with Torque control: **C047–C048** Motor 1 **C090–C091** Motor 2 **C133–C134** Motor 3	Limits with Speed control: **C048–C049** Motor 1 **C091–C092** Motor 2 **C134–C135** Motor 3
	Active	Active for VTC and FOC controls only.		
	Address	1663		
	Function	This is the limit value for the torque at constant speed. If an external torque limit is used, the value of this measure is the torque limit obtained at constant speed; on the other hand, if the torque limit is internal to the drive, this value is the actual torque limit expressed in Nm.		

M014 Torque Limit Demand after Ramps (Nm)

M014	**Range**	± 32000	± 32000 Nm Note: The actual range depends on the preset torque limit values and the rated torque of the selected motor.	
			Limits with Torque control: **C047–C048** Motor 1 **C090–C091** Motor 2 **C133–C134** Motor 3	Limits with Speed control: **C048–C049** Motor 1 **C091–C092** Motor 2 **C134–C135** Motor 3
	Active	Active for VTC and FOC controls only.		
	Address	1664		
	Function	This is the torque limit value being used, expressed in Nm.		

M013a Speed Limit before the Ramps

M013a	**Range**	± 32000	± 32000 rpm
	Active	Active for FOC only.	
	Address	1726	
	Function	Limit value at constant speed of the motor speed of rotation in “torque control with speed limit” mode (C011=2 for Motor 1; C054, C097 for Motors 2 and 3).	

M014a Speed Limits after the Ramps

M014a	**Range**	± 32000	± 32000 rpm
	Active	Active for FOC only.	
	Address	1727	
	Function	Current limit value of the motor speed of rotation in “torque control with speed limit” mode (**C011**=2 for Motor 1; **C054**, **C097** for Motors 2 and 3).	

M015 Torque Limit Reference before Ramps (%)

M015	**Range**	± 500	± 500 % Note: The actual range depends on the torque limit values set for the selected motor.	
			Limits with Torque control: **C047**–**C048** Motor 1 **C090**–**C091** Motor 2 **C133**–**C134** Motor 3	Limits with Speed control: **C048**–**C049** Motor 1 **C091**–**C092** Motor 2 **C134**–**C135** Motor 3
	Active	Active for VTC and FOC controls only.		
	Address	1665		
	Function	This is the limit value for the torque at constant speed expressed as a percentage of the rated torque of the selected motor. If an external torque limit is used, the value of this measure is the torque limit obtained at constant speed; on the other hand, if the torque limit is internal to the drive, this value is the actual torque limit.		

M016 Torque Limit Reference after Ramps (%)

M016	**Range**	± 500	± 500 % Note: The actual range depends on the torque limit values set for the selected motor.	
			Limits with Torque control: **C047**–**C048** Motor 1 **C090**–**C091** Motor 2 **C133**–**C134** Motor 3	Limits with Speed control: **C048**–**C049** Motor 1 **C091**–**C092** Motor 2 **C134**–**C135** Motor 3
	Active	Active for VTC and FOC controls only.		
	Address	1666		
	Function	This is the torque limit value being used expressed as a percentage of the motor rated torque.		

M017 Flux Reference

M017	**Range**	0 ÷ 500	0 ÷ 5.00 Wb
	Active	Active for VTC and FOC controls only.	
	Address	1667	
	Function	Flux reference required and expressed in Weber (Wb).	

M026 Output Current

M026	**Range**	0 ÷ 65535	0 ÷ 6553.5 A Note: The actual range depends on the drive model.
	Active	Always active.	
	Address	1676	
	Function	Measurement of the RMS of the output current.	

M026a Motor Thermal Capacity

M026a	**Range**	0 ÷ 1000	0.0 ÷ 100.0%
	Active	Always active.	
	Address	1728	
	Function	Heating of the connected motor. This parameter indicates the current level of the motor heating following I2t pattern set in the MOTOR THERMAL PROTECTION MENU. This value is expressed as a percentage of the allowable asymptotic value.	

M027 Output Voltage

M027	**Range**	0 ÷ 65535	0 ÷ 65535 V Note: The actual range depends on the drive voltage class.
	Active	Always active.	
	Address	1677	
	Function	Measure of the RMS of the output voltage.	

M027a Power Factor

M027a	**Range**	0 ÷ 1000	0.000 ÷ 1.000
	Active	Always active.	
	Address	1742	
	Function	This is the estimated value of the power factor (cosphi), such as the ratio between the active power and the apparent power at the drive output.	

M028 Output Power

M028	**Range**	–32768 ÷ +32767	–3276.8 ÷ +3276.7 kW Note: The actual range depends on the drive model.
	Active	Always active.	
	Address	1678	
	Function	Measure of the active power produced by the drive. A negative value indicates input power (the motor is regenerating energy).	

M028a Energy Consumption

M028a	**Range**	0 ÷ 1000000000	0 ÷ 10000000.00 kWh
	Active	Always active.	
	Address	1723-1724 (LSWord, MSWord)	
	Function	Counter of the drive energy consumption. This is a value expressed in 32 bits divided into two 16-bit words: the low part and the high part.	

M029 DC-Bus Voltage

M029	**Range**	0 ÷ 1400	0 ÷ 1400 V
	Active	Always active.	
	Address	1679	
	Function	Measure of the voltage in the drive DC-link.	

M030 Supply Voltage

M030	**Range**	0 ÷ 1000	0 ÷ 1000 V
	Active	Always active.	
	Address	1680	
	Function	Measure of the RMS value of the drive supply voltage.	

M004u Custom motor speed

M004u-5u	**Range**	± 32000 (integer part) ± 99 (decimal part)	± 32000.99 with the unit of measure defined by **P268s**
	Active	Always active. Decimal part active for FOC control only.	
	Address	1743 (integer part) 1744 (decimal part)	
	Function	This indicates the motor speed expressed in the unit of measure defined in **P268s** and scaled with the factor of scaling **P268t,** with respect to the motor speed **M004** expressed in rpm. Example: If **P268s** = SPM and **P268u** = 0.6%, when **M004** = 1000 rpm, **M004u** = 6 SPM.	

M009u Custom torque output

M009u	**Range**	± 32000	± 32000 with the unit of measure defined by **P268u**
	Active	Active for VTC and FOC controls only.	
	Address	1745	
	Function	It is the estimated torque generated by the motor, expressed in the unit of measure defined in **P268u** and scaled with the factor of scaling **P268v,** with respect to the torque of motor **M009** expressed in Nm. Example: If **P268u** = ftLb and **P268v** = 73.75%, when **M009** = 100 Nm, **M009u** = 73.75 ftLb.	

M106 Active Motor

M106	**Range**	1 ÷ 3	1: Mot1 2: Mot2 3: Mot3
	Active	Always active.	
	Address	1523	
	Function	This indicates the currently active motor.	

8.3. PID Regulator Menu

This menu contains the measures relating to the input and output values of the internal PID regulator.

M018 PID Reference at Constant RPM (%)

M018	**Range**	±10000	±100.00 % Note: The actual range depends on the max. value and the min. value of the PID reference set in parameters **P245–P246**.
	Active	Always active.	
	Address	1668	
	Function	This is the measure of the PID reference expressed as a percentage. Scaling is detailed in the PID PARAMETERS MENU and the PID CONFIGURATION MENU.	

M018a PID2 Reference at Constant RPM (%)

M018a	**Range**	±10000	±100.00 % Note: The actual range depends on the max. value and the min. value of the PID2 reference set in parameters **P445-P446**.
	Active	This measure is active if enabled from **C291a**	
	Address	1731	
	Function	This is the measure percent of the reference selected with **C286** for the PID2 or the 2-zone mode. Scaling is detailed in the PID2 PARAMETERS MENU and the PID CONFIGURATION MENU.	

M019 PID Reference after Ramps (%)

M019	**Range**	±10000	±100.00 % Note: The actual range depends on the max. value and the min. value of the PID reference set in parameters **P245–P246**.
	Active	Always active.	
	Address	1669	
	Function	This is the measure of the PID reference after the ramps expressed as a percentage. Scaling is detailed in the PID PARAMETERS MENU and the PID CONFIGURATION MENU.	

M019a PID2 Reference after Ramps (%)

M019a	**Range**	±10000	±100.00 % Note: The actual range depends on the max. value and the min. value of the PID2 reference set in parameters **P445-P446**.
	Active	This measure is active if enabled from **C291a**	
	Address	1732	
	Function	This is the measure percent of the current PID reference after the ramps selected with **C286** for the PID2 or the 2-zone mode. Scaling is detailed in the PID2 PARAMETERS MENU and the PID CONFIGURATION MENU.	

M020 PID Feedback (%)

M020	**Range**	±10000	±100.00 % Note: The actual range depends on the max. value and the min. value of the PID feedback set in parameters **P247–P248**.
	Active	Always active.	
	Address	1670	
	Function	This is the measure of the PID feedback expressed as a percentage. Scaling is detailed in the PID PARAMETERS MENU and the PID CONFIGURATION MENU.	

M020a PID2 Feedback (%)

M020a	**Range**	±10000	±100.00 % Note: The actual range depends on the max. value and the min. value of the PID2 feedback set in parameters **P447-P448**.
	Active	This measure is active if enabled from **C291a**	
	Address	1733	
	Function	This is the measure percent of the PID2 feedback selected with **C286** for the PID2 or the 2-zone mode. Scaling is detailed in the PID2 PARAMETERS MENU and the PID CONFIGURATION MENU.	

M021 PID Error (%)

M021	**Range**	±10000	±100.00 % Note: The actual range depends on the min. and max. saturation values of the reference and the feedback set in parameters **P245–P246** for the reference and in **P247–P248** for the feedback.
	Active	Always active.	
	Address	1671	
	Function	This is the measure of the PID input error expressed as a percentage. See also the PID PARAMETERS MENU and the PID CONFIGURATION MENU.	

M021a PID2 Error (%)

M021a	**Range**	±10000	±100.00 % Note: The actual range depends on the min. and max. saturation values of the reference and the feedback set in parameters **P445-P446** for the reference and in **P447–P448** for the feedback.
	Active	This measure is active if enabled from **C291a**	
	Address	1736	
	Function	This is the measure percent of the PID2 input error or the 2-zone mode input error (difference between the reference selected with **C286** and the feedback selected with **C289**). Please refer to the PID2 PARAMETERS MENU and the PID CONFIGURATION MENU.	

M022 PID Output (%)

M022	**Range**	±10000	±100.00 % Note: The actual range depends on the min. and max. saturation values of the PID output set in parameters **P236–P237**.
	Active	Always active.	
	Address	1672	
	Function	This is the measure of the output produced by the PID regulator and expressed as a percentage. Please refer to the PID PARAMETERS MENU and the PID CONFIGURATION MENU for the scaling of the PID output.	

M022a PID2 Output (%)

M022a	**Range**	±10000	±100.00 % Note: The actual range depends on the min. and max. saturation values of the PID output set in parameters **P436–P437**.
	Active	This measure is active if enabled from **C291a**	
	Address	1718	
	Function	This is the measure of the output produced by the PID2 regulator and expressed as a percentage. Scaling is detailed in the PID2 PARAMETERS MENU and the PID CONFIGURATION MENU.	

M023 PID Reference after Ramps

M023	**Range**	±32000	Note: The actual range depends on the max. value and the min. value of the PID reference set in parameters **P245–P246** and on the gain level set in **P257**.
	Active	Always active.	
	Address	1673	
	Function	This is the measure of the reference after the ramps being used for the PID regulator, as **M019** but multiplied by the gain level set in **P257** (see also the PID PARAMETERS MENU and the PID CONFIGURATION MENU). As for the display/keypad, the unit of measure can be programmed with parameters **P267**, **P267a** in the DISPLAY/KEYPAD menu.	

M023a PID2 Reference after Ramps

M023a	**Range**	±32000	Note: The actual range depends on the min. and max. values of the PID2 reference set in parameters **P445-P446** and on the gain level set in **P457**.
	Active	This measure is active if enabled from **C291a**	
	Address	1737	
	Function	This is the measure of the reference being used for the PID2 or the 2-zone mode, as **M019a** but multiplied by the gain level set in **P457** (see also the PID2 PARAMETERS MENU and the PID CONFIGURATION MENU). As for the display/keypad, the unit of measure can be programmed with parameters **P267b**, **P267c** in the DISPLAY/KEYPAD menu.	

M024 PID Feedback

M024	**Range**	±32000	Note: The actual range depends on the max. value and the min. value of the PID feedback set in parameters **P247–P248** and on the gain level set in **P257**.
	Active	Always active.	
	Address	1674	
	Function	This is the measure of the feedback being used for the PID regulator, as **M020** but multiplied by the gain level set in **P257** (see also the PID PARAMETERS MENU and the PID CONFIGURATION MENU). As for the display/keypad, the unit of measure can be programmed with parameters **P267**, **P267a** in the DISPLAY/KEYPAD menu.	

M024a PID2 Feedback

M024a	**Range**	±32000	Note: The actual range depends on the max. value and the min. value of the PID2 feedback set in parameters **P447–P448** and on the gain level set in **P457**.
	Active	This measure is active if enabled from **C291a**	
	Address	1738	
	Function	This is the measure of the feedback being used for the PID2 regulator or the 2-zone mode as **M020a** but multiplied by the gain level set in **P457** (see also the PID2 PARAMETERS MENU and the PID CONFIGURATION MENU). As for the display/keypad, the unit of measure can be programmed with parameters **P267b**, **P267c** in the DISPLAY/KEYPAD menu.	

8.4. Digital Inputs Menu

This menu allows checking the state of the command sources for the digital inputs (local terminals, serial link and fieldbus), the terminal board resulting from their combination and the terminals which are actually used for the drive control. The terminals which are actually used to control the drive also consider any timers applied to the digital inputs.

M031 Delayed Digital Inputs

M031			
	Range	Bit-controlled measure	See Table 1
	Active	Always active.	
	Address	1681	
	Function	Status of the control terminal board used by the drive. This is the terminal board resulting from the combination of the preset command sources (local terminal board, serial link and fieldbus), where: - Inputs **MDI1** to **MDI8** are the result of the OR between the different command sources. - The **ENABLE (E)** status is the result of the AND of inputs **MDI2&S** of the physical terminals and of **MDI2** inputs of all the other programmed command sources. - The **ENABLE SW (ESW)** is the result of the AND of the inputs programmed as **ENABLE SW** (**C152**) of all the programmed command sources. See also the CONTROL METHOD MENU and the TIMERS MENU. Refer to Figure 57 for the **ENABLE** and **ENABLE SW** status.	

M032 Instant Digital Inputs

M032			
	Range	Bit-controlled measure	See Table 1
	Active	Always active.	
	Address	1682	
	Function	Status of the virtual control terminal board upstream of the application of the timers to the digital inputs (if no timer is applied, it matches with **M031**). See the CONTROL METHOD MENU and the TIMERS MENU. Refer to Figure 56 for the **ENABLE** and **ENABLE SW** status.	

Table 1: Coding of Measures M031, M032

Bit n.	Digital Input	Bit n.	Digital Input
0	MDI1	5	MDI6/ECHA/FINA
1	MDI2	6	MDI7/ECHB
2	MDI3	7	MDI8/FINB
3	MDI4	8	ENABLE-SW
4	MDI5	9	ENABLE

M033 Local Control Terminal Board

M033			
	Range	Bit-controlled measure	See Table 3
	Active	Always active.	
	Address	1683	
	Function	Status of the digital inputs in the drive physical terminal board. The status of **MDI2&S (S)** input is the result of a logic AND between **ENABLE-A** and **ENABLE-B** physical signals.	

Table 2: Coding of Measure M033

Bit n.	Digital Input	Bit n.	Digital Input
0	MDI1(START)	4	MDI5
1	MDI2&S (S)	5	MDI6/ECHA/FINA
2	MDI3	6	MDI7/ECHB
3	MDI4	7	MDI8/FINB

M034 Control Terminals from Serial Link

M034	Range	Bit-controlled measure	See Table 3
	Active	Always active.	
	Address	1684	
	Function	Status of the digital inputs in the terminal board controlled via serial link.	

M035 Control Terminal Board from Fieldbus

M035	Range	Bit-controlled measure	See Table 3
	Active	Always active.	
	Address	1685	
	Function	State of the digital inputs in the terminal board controlled via fieldbus.	

Table 3: Coding of Measures M034, M035

Bit n.	Digital Input	Bit n.	Digital Input
0	MDI1	4	MDI5
1	MDI2	5	MDI6/ECHA/FINA
2	MDI3	6	MDI7/ECHB
3	MDI4	7	MDI8/FINB

M036 Auxiliary Digital Inputs in the Terminal Board

M036	Range	Bit-controlled measure	See Table 4
	Active	Always active.	
	Address	1686	
	Function	Status of the auxiliary digital inputs in ES847 or ES870 terminal board.	

M036a Auxiliary Digital Inputs via Serial Link

M036a	Range	Bit-controlled measure	See Table 4
	Active	Always active.	
	Address	1713	
	Function	Status of the auxiliary digital inputs via serial link.	

M036b Auxiliary Digital Inputs via Fieldbus

M036b	Range	Bit-controlled measure	See Table 4
	Active	Always active.	
	Address	1717	
	Function	Status of the auxiliary digital inputs via Fieldbus.	

Table 4: Coding of Measures M036, M036a, M036b

Bit n.	Digital Input	Bit n.	Digital Input
0	XMDI1	4	XMDI5
1	XMDI2	5	XMDI6
2	XMDI3	6	XMDI7
3	XMDI4	7	XMDI8

8.5. References Menu

This menu contains the measures of the possible reference sources for speed, torque or PID available in the terminal board (analog inputs, frequency inputs and encoder input) and sent via serial link or fieldbus.

M037 REF External Analog Reference

M037	**Range**	Function of the preset type of reference (voltage/current).	Function of the type of reference (voltage/current) set in **P050**. The numerical value always includes two decimal figures; the unit of measure is V or mA.
	Active	Always active.	
	Address	1687	
	Function	Measure of the voltage /current value detected by the drive in REF analog input.	

M038 AIN1 External Analog Reference

M038	**Range**	Function of the preset type of reference (voltage/current)	Function of the type of reference (voltage/current) set in **P055**. The numerical value always includes two decimal figures; the unit of measure is V or mA.
	Active	Always active.	
	Address	1688	
	Function	Measure of the voltage /current value detected by the drive in AIN1 analog input.	

M039 AIN2 External Analog Reference

M039	**Range**	Function of the preset type of reference (voltage/current).	Function of the type of reference (voltage/current) set in **P060**. The numerical value always includes two decimals; the unit of measure is V or mA.
	Active	Always active.	
	Address	1689	
	Function	Measure of the voltage /current value detected by the drive in AIN2 analog input.	

M039a XAIN4 External Analog Reference

M039a	**Range**	Function of the preset type of reference.	Function of the type of reference (voltage) set in **P390**. The numerical value always includes two decimals; the unit of measure is V.
	Active	Active if set via parameter **R023** only.	
	Address	1729	
	Function	Measure of the voltage value detected by the drive in XAIN4 analog input.	

M039b XAIN5 External Analog Reference

M039b	**Range**	Function of the preset type of reference.	Function of the type of reference (current) set in **P395**. The numerical value always includes two decimals; the unit of measure is mA.
	Active	Active if set via parameter **R023** only.	
	Address	1730	
	Function	Measure of the current value detected by the drive in the XAIN5 analog input.	

M040 Speed Reference from Serial Link

M040	**Range**	± 32000 (integer part) ± 99 (decimal part)	± 32000.99 rpm Note: The actual range depends on the selected motor, because it is defined by the value set in the parameters for the max. speed and min. speed of the selected motor. **C028–C029** Motor 1 **C072–C073** Motor 2 **C114–C115** Motor 3
	Active	Always active.	
	Address	1690 (integer part), 1691 (decimal part)	
	Function	This is the value of the speed reference set via serial link.	

M042 Speed Reference from Fieldbus

M042	**Range**	± 32000 (integer part) ± 99 (decimal part)	± 32000.99 rpm Note: The actual range depends on the selected motor, because it is defined by the value set in the parameters for the max. speed and min. speed of the selected motor. **C028–C029** Motor 1 **C072–C073** Motor 2 **C114–C115** Motor 3
	Active	Always active.	
	Address	1692 (integer part), 1693 (decimal part)	
	Function	This is the measure of the speed reference set by the fieldbus.	

M044 Torque Reference from Serial Link

M044	**Range**	± 5000	± 500.0 % Note: The actual range depends on the torque limit value set for the selected motor. **C047–C048** Motor 1 **C090–C091** Motor 2 **C133–C134** Motor 3
	Active	Always active.	
	Address	1694	
	Function	This is the measure of the torque reference set via serial link and expressed as a percentage of the rated torque of the selected motor.	

M045 Torque Reference from Fieldbus

M045	**Range**	± 5000	± 500.0 % Note: The actual range depends on the torque limit values set for the selected motor. **C047–C048** Motor 1 **C090–C091** Motor 2 **C133–C134** Motor 3
	Active	Always active.	
	Address	1695	
	Function	This is the measure of the torque reference set by the fieldbus and expressed as a percentage of the rated torque of the selected motor.	

M046 PID Reference from Serial Link

M046	**Range**	±10000	±100.00 % Note: The actual range depends on the min. value and the max. value of the PID reference set in parameters: **P245–P246**
	Active	Always active.	
	Address	1696	
	Function	This is the measure of the PID reference set via serial link and expressed as a percentage.	

M047 PID Reference from Fieldbus

M047	**Range**	±10000	±100.00 % Note: The actual range depends on the min. value and the max. value of the PID reference set in parameters: **P245–P246**
	Active	Always active.	
	Address	1697	
	Function	This is the measure of the PID reference set by the fieldbus and expressed as a percentage.	

M048 PID Feedback from Serial Link

M048	**Range**	±10000	±100.00 % Note: The actual range depends on the min. value and the max. value of the PID feedback set in parameters: **P247–P248**
	Active	Always active.	
	Address	1698	
	Function	This is the measure of the PID feedback set via serial link and expressed as a percentage.	

M049 PID Feedback from Fieldbus

M049	**Range**	±10000	±100.00 % Note: The actual range depends on the min. value and the max. value of the PID feedback set in parameters: **P247–P248**
	Active	Always active.	
	Address	1699	
	Function	This is the measure of the PID feedback set by the fieldbus and expressed as a percentage.	

M050 Encoder Reference

M050	**Range**	± 32000	± 32000 rpm.
	Active	Always active.	
	Address	1700	
	Function	Reading of the encoder set as a reference source (see the ENCODER/FREQUENCY INPUTS MENU and the CONTROL METHOD MENU).	

M051 Frequency Input Reference

M051	**Range**	1000 ÷ 10000	10000 ÷ 100000 Hz. Note: The actual range depends on the frequency min. value and max. value set in **P071**-**P072**.
	Active	This measure is active only if **C189** = 9/10/11/12/13 (frequency input **FINA** or **FINB** are selected).	
	Address	1701	
	Function	Frequency readout in the digital input set as a reference source (see the ENCODER/FREQUENCY INPUTS MENU and the CONTROL METHOD MENU).	

M051a RMS Input from AIN1 and AIN2

M051a	**Range**	0 ÷ 32000	0.00 ÷ 32.00 V
	Active	This measure is active only if one of parameters among **C288**, **C289** or **C290** = 13: Vout measured. Also, **P055**, **P060** = 0: ±10V.	
	Address	3374	
	Function	RMS voltage obtained from instantaneous values of **AIN1** and **AIN2** if they are two sinusoidal voltage values having equal amplitude and frequency phase displacement of 120˚.	

8.6. Outputs Menu

This menu allows checking the status of the digital outputs, the analog outputs and the frequency outputs located in the terminal board.

M056 Digital Outputs

M056			
	Range	Bit-controlled measure.	See Table 5
	Active	Always active.	
	Address	1706	
	Function	Status of digital outputs MDO1÷4 and status of the precharge contactor.	

Table 5: Coding of Measure M056

Bit n.	Digital Output
0	MDO1/FOUT
1	MDO2
2	MDO3
3	MDO4
6	Status of the precharge contactor

M056a Virtual Digital Outputs

M056a			
	Range	Bit-controlled measure.	See Table 6
	Active	Always active.	
	Address	1675	
	Function	Status of virtual digital outputs MPL1÷4.	

Table 6: Coding of Measure M056a

Bit n.	Digital Output
0	MPL1
1	MPL2
2	MPL3
3	MPL4

M056b Timed Flags

M056b			
	Range	Bit-controlled measure	See Table 7
	Active	Always active.	
	Address	1741	
	Function	Status of timed flags TFL1 ÷ 4.	

Table 7: Coding of Measure M056b

Bit n.	Timed Flag
0	TFL1
1	TFL2
2	TFL3
3	TFL4

M057 Frequency Output

M057	Range	10000÷100000	10000 ÷ 100000 Hz Note: The actual range depends on the min. value and the max. value of MDO1 digital output set as a frequency reference. Values are set in **P204** and **P205** (see ANALOG AND FREQUENCY OUTPUTS MENU).
	Active	Always active.	
	Address	1707	
	Function	This is the frequency measure produced by MDO1 digital output when set as a frequency output.	

M058 AO1 Analog Output

M058	Range	±100	±100 %
	Active	Always active.	
	Address	1708	
	Function	Value percent of analog output AO1, referred to the preset max. output value (maximum absolute value between **P182** and **P183**, see ANALOG AND FREQUENCY OUTPUTS MENU).	

M059 AO2 Analog Output

M059	Range	±100	±100 %
	Active	Always active.	
	Address	1709	
	Function	Value percent of AO2 analog output referred to the preset max. output value (maximum absolute value between **P190** and **P191**, see ANALOG AND FREQUENCY OUTPUTS MENU).	

M060 Analog Output AO3

M060	Range	±100	±100 %
	Active	Always active.	
	Address	1710	
	Function	Value percent of AO3 analog output referred to the preset max. output value (maximum absolute value between **P198** and **P199**, see ANALOG AND FREQUENCY OUTPUTS MENU).	

M061 Auxiliary Digital Outputs

M061	Range	Bit-controlled measure.	See Table 8
	Active	Always active.	
	Address	1711	
	Function	Status of the auxiliary digital outputs located on the expansion board.	

Table 8: Coding of Measure M061

Bit n.	Digital Output	Bit n.	Digital Output
0	XMDO1	3	XMDO4
1	XMDO2	4	XMDO5
2	XMDO3	5	XMDO6

8.7. Temperature Measures from PT100 Menu

This menu displays the temperatures detected in the first four analog channels of the expansion board.
Scaling complies with DIN EN 60751 for PT100: 100 ohm @ 0 °C and 0.385 ohm/°C.

ES847 Expansion Board must be fitted on the equipment.
See also the EXPANSION BOARD CONFIGURATION MENU

M069 PT100 Measure in Channel 1

M069	Range	–500 ÷2600	–50.0 ÷260.0 °C
	Active	This measure is active only if programmed from parameter **R023**.	
	Address	1719	
	Function	Temperature detected in analog channel 1.	

M070 PT100 Measure in Channel 2

M070	Range	–500 ÷2600	–50.0 ÷260.0 °C
	Active	This measure is active only if programmed from parameter **R023**.	
	Address	1720	
	Function	Temperature detected in analog channel 2.	

M071 PT100 Measure in Channel 3

M071	Range	–500 ÷2600	–50.0 ÷260.0 °C
	Active	This measure is active only if programmed from parameter **R023**.	
	Address	1721	
	Function	Temperature detected in analog channel 3.	

M072 PT100 Measure in Channel 4

M072	Range	–500 ÷2600	–50.0 ÷260.0 °C
	Active	This measure is active only if programmed from parameter **R023**.	
	Address	1722	
	Function	Temperature detected in analog channel 4.	

8.8. Autodiagnostics Menu

This menu allows the user to check the functioning times and the relevant counters (for maintenance purposes) of the Penta drive; it also allows reading out the analog channels used for temperature sensors and the relevant temperature values, as well as the drive status.

M052 / M054 Functioning Times

M052/ M054	**Range**	0 ÷ 2147483647 (0 ÷ 7FFFFFFFh)	0 ÷429496729.4 sec
	Address	Supply Time: 1704-1705 (LSWord, MSWord) Operation Time: 1702-1703 (LSWord, MSWord)	
	Function	This screen displays • the ST (supply time) and • the OT (operation time). The supply time is the time when the drive is powered on. The operation time is the time when the IGBTs are on (switching). Both values are expressed in 32 bits divided into two 16-bit words: the low part and the high part.	

Functioning Times:

```
Supply      Time
M054=    53:25:01
Operation   Time
M052=    29:35:51
```

M062 Ambient temperature Measure

M062	**Range**	± 32000	± 320.0 °C
	Active	Always active.	
	Address	1712	
	Function	Ambient temperature measured on the surface of the control board.	

M064 IGBT Heatsink Temperature Measure

M064	**Range**	± 32000	± 320.0 °C
	Active	Always active.	
	Address	1714	
	Function	Measure of the IGBT heatsink temperature. If the temperature readout is <–30.0 °C or >150.0 °C, warning **W50 NTC Fault** appears. Note: Not all models are provided with the NTC sensor (see Table 17 in the PRODUCT MENU). If this sensor is not provided, the measure is forced to 32,000, corresponding to +320.0 °C.	

M064a Thermal Image of IGBT Junction Temperature

M064a	**Range**	± 32000	± 320.0 °C
	Active	Always active.	
	Address	1748	
	Function	Estimation of the average temperature measurement of the IGBT junction. Note: This estimation function is available only for the drive models adopting the specific algorithm, otherwise this measure is exactly the same as **M064.** Note: Not all models are provided with the NTC sensor (see Table 17 in the PRODUCT MENU). If this sensor is not provided, the measure is forced to 32,000, corresponding to +320.0 °C.	

M065 Operation Time Counter

M065	**Range**	0 ÷ 65000	0 ÷ 65000 h
	Active	Always active.	
	Address	1715	
	Function	Time elapsed after resetting the operation time counter. The Operation Time is the activation time of the drive IGBTs. See the following parameters: **C275/276/277/278.**	

M066 Supply Time Counter

M066	**Range**	0 ÷ 65000	0 ÷ 65000 h
	Active	Always active.	
	Address	1716	
	Function	Time elapsed after resetting the supply time counter. See the following parameters: **C275/276/277/278.**	

M089 Drive Status

M089	**Range**	See Table 139
	Active	Always active.
	Address	1739
	Function	Describes the current condition of the Penta drive.

M090 Active Alarm

M090	**Range**	See Table 137
	Active	Always active.
	Address	1740
	Function	Alarm tripped at the moment.

8.9. Data Logger Measures Menu

This menu displays the status of the types of connections (serial links, Ethernet and modem) supported by ES851 Data Logger board.

This menu can be viewed only if the Data Logger board is fitted.
See also the DATA LOGGER MENU.

M100 Data Logger Status (Line 3)

M100 Line 3	**Range**	0 ÷ 2	0: NOT FITTED 1: OK not interlocked 2: OK interlocked
	Active	This measure is active only if programmed from parameter **R021 = 2:ES851**.	
	Address	1336	
	Function	**0: NOT FITTED**, ES851 is not installed on the Penta drive. **1: OK not interlocked**, ES851 is operating independently of the drive where it is installed. To program ES851, a connection to a computer via the RemoteDrive software is required, or a special preset set via display/keypad is required (see the DATA LOGGER MENU). **2: OK interlocked**, ES851 is ready to be configured even through the display/keypad of the drive where it is installed.	

M100 ES851 Fault (Line 4)

M100 Line 4	**Range**	0 ÷ 6, 99 ÷ 104	0: No alarm 1: Parameter save fault 2: Log write error 3: FBS configuration failure 4: RS232 Modbus configuration failure 5: RS485 Modbus configuration failure 6: TCP/IP stack configuration failure 99: Flash card lacking or inaccessible 100: Invalid stream access 101: TCP/IP socket fault 102: Dial out connection failure 103: Control board clock failure 104: Modem initialization failure
	Active	This measure is active only if programmed from parameter **R021 = 2:ES851**.	
	Address	1340	
	Function	This indicates a general alarm tripped for ES851. In case an alarm trips, please contact ENERTRONICA SANTERNO's CUSTOMER SERVICE and mention the alarm code and name.	

M101 Connection Status

M101	Range	Bit-controlled measure	See Table 9
	Active	This measure is active only if programmed from parameter **R021 = 2:ES851**.	
	Address	1338	
	Function	Status of the connections supported by ES851. Note that the COM1 serial link is RS232 by default, whereas COM 2 is RS485 by default. For more details, please refer to the Programming Guide manual for the Data Logger ES851.	

Table 9: Data Logger connection status

Bit n.	Connection	Description
0-7	Type of modem connection failure	0: None 1: Dial KO 2: Connect KO 3: Authentication KO 4: IPCP KO* 5: Modem not yet initialized 6: Modem init KO 7: Modem not configured 8: Modem not dial out 16: Connect end (echo time out) 32: Connect end (idle time out) 64: Connect end (term expired)
8-10	Status of the connection via modem	0: No conn. 1: Dialing 2: Connecting 4: Connected 5: Attempt finished
11	COM1	0: No data exchange 1: Data exchanged
12	COM2	0: No data exchange 1: Data exchanged
13	Ethernet	0: No connection 1: Connection
14-15	Reserved	

* In computer networking, the **Internet Protocol Control Protocol (IPCP)** is a network control protocol for establishing and configuring Internet Protocol over a Point-to-Point Protocol link. The IPCP configures, enables, and disables the IP protocol modules on both ends of the point-to-point link.

M102 and M103 IP Address

M102	Range	0.0.0.0 ÷ 255.255.255.255
	Active	Active only if set up from parameter **R021** = 2: ES851 or **R021** = 3 Bridge Mini.
	Address	1332 ÷ 1333
	Function	Indicates the IP address currently used. Please refer to the Programming Guide for the ES851 board or the Bridge Mini board.

M104 and M105 Subnet Mask

M104	**Range**	0.0.0.0 ÷ 255.255.255.255
	Active	Active only if set up from parameter **R021** = 2: ES851 or **R021** = 3 Bridge Mini.
	Address	1334 ÷ 1335
	Function	Indicates the subnet mask currently used. Please refer to the Programming Guide for the ES851 board or the Bridge Mini board.

M110 Current Time

M110	**Range**	0 ÷ 2147483647 (0 ÷ 7FFFFFFFh)	0 ÷ 429496729.4 sec
	Active	Active only if set up from parameter **R021** = 2: ES851 or **R021** = 3 Bridge Mini.	
	Address	1965-1966 (LSWord, MSWord)	
	Function	Current time format: HH:MM:SS.	

M113 Current Date

M113	**Range**	0 ÷ 2147483647 (0 ÷ 7FFFFFFFh)	0 ÷ 2147483647 days
	Active	Active only if set up from parameter **R021** = 2: ES851 or **R021** = 3 Bridge Mini.	
	Address	1967-1967 (LSWord, MSWord)	
	Function	Date: YYYY:MM:DD.	

8.10. Encoder Measures Menu

The Encoder Measures Menu displays the measures of the incremental position sensors (if any), as well as some useful info for managing those sensors.

M120 Encoder A Count Value

M120	**Range**	0 ÷ 65535	0 ÷ 65535 Note: The actual range of this measure is based on the type of encoder being used.
	Active	Always active	
	Address	1746	
	Function	This is the count value of encoder A (see ENCODER/FREQUENCY INPUTS MENU). When the inverter is powered on, the initial value is always 0.	

M121 Encoder B Count Value

M121	**Range**	0 ÷ 65535	0 ÷ 65535 Note: The actual range of this measure is based on the type of encoder being used.
	Active	Always active	
	Address	1747	
	Function	This is the count value of encoder B (see ENCODER/FREQUENCY INPUTS MENU). When the inverter is powered on, the initial value is always 0.	

8.11. Digital Input Settings Menu

This menu allows checking the functions assigned to the digital inputs.

Table 10: Coding of the functions assigned to the digital inputs

Displayed Items	Function Assigned to the Digital Inputs
STOP	Stop function
REVERSE	Startup with negative speed
EN-SW	ENABLE SW
DISABLE	Drive disable
Mspd0	Multispeed 0
Mspd1	Multispeed 1
Mspd2	Multispeed 2
Mspd3	Multispeed 3
CW/CCW	Reversal of the direction of rotation
DCB	DC braking
UP	Reference increase
DOWN	Reference decrease
UDReset	Reset of speed setpoint due to UP/DOWN command
Alarm 1	Auxiliary trip 1
Alarm 2	Auxiliary trip 2
Alarm 3	Auxiliary trip 3
MRmp0	Multiramp 0
MRmp1	Multiramp 1
JOG	Jog mode
SLAVE	Selection of Slave Mode
PID Dis	PID Disable
KpdLock	Display/keypad unit
Mot 2	Selection of Motor 2
Mot 3	Selection of Motor 3
Var 0	Reference Variation 0
Var 1	Reference Variation 1
Var 2	Reference Variation 2
PID UDR	PID Reference Reset due to UP/DOWN commands
LOCAL	Selection of Local mode
Brk Lock	Mechanical brake locking
FireM	Fire Mode enabled
Src. Sel	Reference/command source switch
nTlim	External torque limit disable
START_B	START function, terminals B
STOP_B	STOP function, terminals B
REVERSE_B	Startup with negative speed, terminals B
MRef0	PID Multireference 1
MRef1	PID Multireference 2
MRef2	PID Multireference 3
PID Csl	PID Control Selection
START	START function
ENABLE	ENABLE function
RESET	Alarm RESET
EncA	Encoder A Input
EncB	Encoder B Input
FinA	FINA Frequency input
FinB	FINB Frequency input
Multi	More than one function allocated to the same input

8.12. Fault List Menu

Scroll the **Fault List Menu** to display the codes of the last eight alarms tripped.
Press the **SAVE/ENTER** key to access the alarm submenu and navigate to each value measured by the drive when the alarm tripped.
The diagram below shows a navigation example for the **Fault List Menu** (relating to alarm n.1 in particular). Note that n.1 is the last alarm tripped and n.8 is the first alarm tripped.
The measures marked with **Mxxx** are the same measures covered in this section.
If the Data Logger ES851 is installed (even the ES851 RTC version only) and parameter **R021** Data Logger is set to 2: ES851, or if the Bridge Mini is installed and parameter **R021** is set to 3: Bridge Mini, the date and time when the alarm tripped are displayed instead of the Supply Time (ST) and the Operation Time (OT) respectively.

Navigation Example - Fault List Menu.

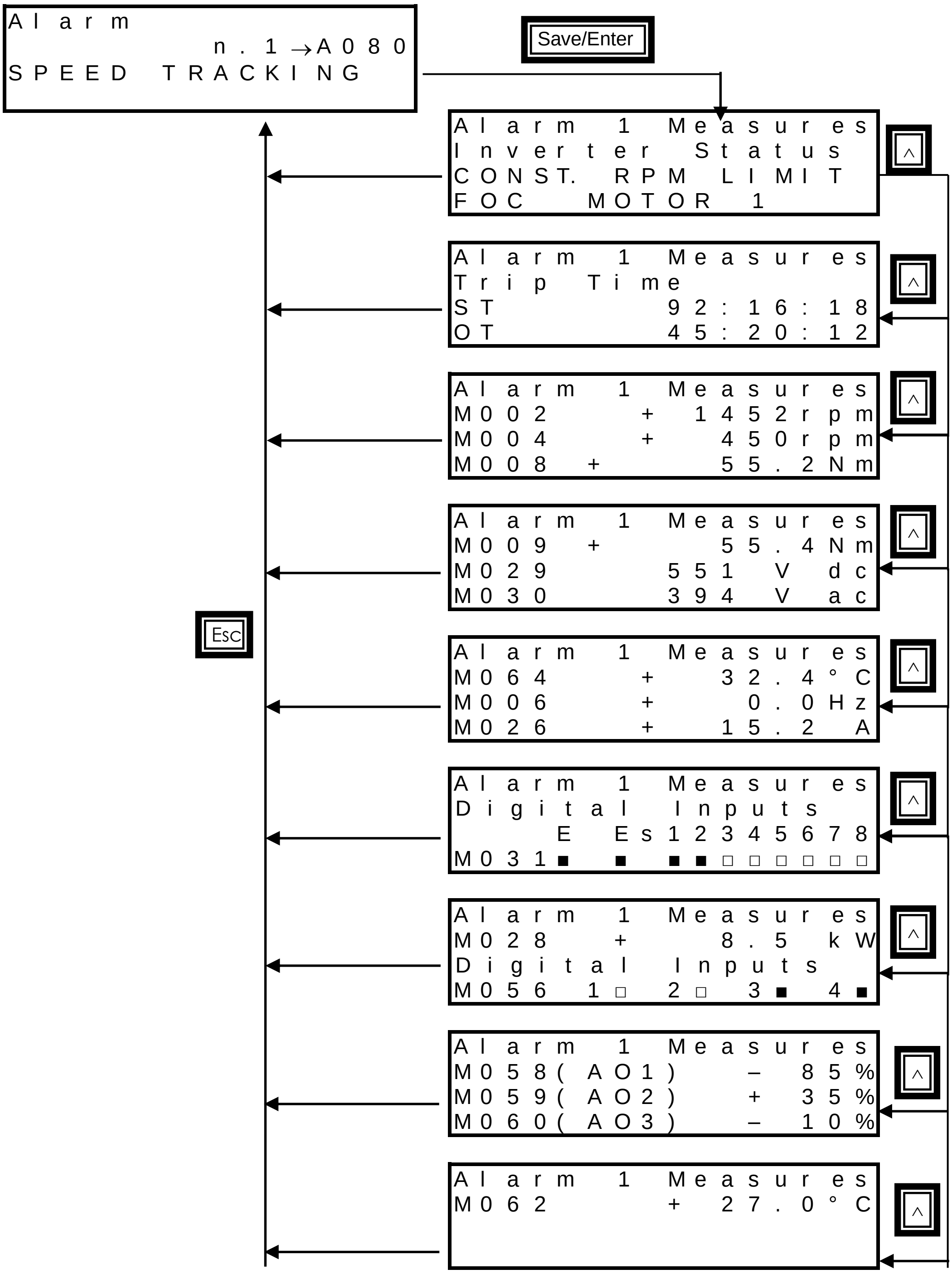


Table 11: Modbus base addresses in the Fault Lists

Fault List	Modbus Base Address
FL1	7712
FL2	7744
FL3	7776
FL4	7808
FL5	7840
FL6	7872
FL7	7904
FL8	7936

Table 12: List of the measures in the Fault Lists

Measure	Function	Range	Value	Modbus Offset Address
M090	Active Alarm	See Table 137	-	0
M052	Supply Time	See measure description	-	1: LSW 2: MSW
M054	Operation Time	See measure description	-	3: LSW 4: MSW
M089	Inverter Status	See Table 139	-	5
M026	Output Current	0 ÷ 65535	0 ÷ 6553.5 A	6
M004	Motor Speed	±32000	±32000 rpm	7
M002	Speed Reference after Ramps	±32000	±32000 rpm	8
M008	Torque Demand	±32000	±32000 Nm	9
M009	Torque Generated by the Motor	±32000	±32000 Nm	10
M029	DC-bus Voltage	0 ÷ 1400	0 ÷ 1400 V	11
M030	Grid Voltage	0 ÷ 1000	0 ÷ 1000 V	12
M064	IGBT Heatsink Temperature	±32000	± 320.0 °C	13
M006	Inverter Output Frequency	±10000	±1000.0 Hz	14
M031	Delayed Digital Inputs	See measure description	-	16
-	Selected Motor (high byte)	0 ÷ 2	0: Mot1 1: Mot2 2: Mot3	17
	Selected Control (low byte)	0 ÷ 2	0: IFD 1: VTC 2: FOC	
M028	Output Power	0 ÷ 65535	0 ÷ 6553.5 kW	19
M056	Digital Outputs	See measure description		20
M062	Ambient Temperature	±32000	± 320.0 °C	24
M064a	Thermal Image of IGBT Junction Temperature	±32000	± 320.0 °C	25

To get the Modbus address of a given measure in a Fault List, sum up the base address to the measure's offset.
Example:
The address of measure **M064a** in the Fault List **FL6** is as follows:
7872 + 25 = 7897

8.13. Power Off List Menu

This menu contains the measures of some characteristic variables detected at the drive power off, in conjunction with the alarm (if any) tripped at that moment.
Press the **SAVE/ENTER** key to access the submenu and navigate to the measures detected by the drive when the alarm tripped. Measures and codes are the same as the ones shown in the Fault List Menu**.**
If the Data Logger ES851 is installed (even the ES851 RTC version only) and parameter **R021** Data Logger is set to 2: ES851, or if the Bridge Mini is installed and parameter **R021** is set to 3: Bridge Mini, the date and time when the alarm has tripped are displayed instead of the Supply Time (ST) and the Operation Time (OT) respectively.
The diagram below shows a navigation example for the **Power Off List**.

Navigation Example – PowerOff List Menu

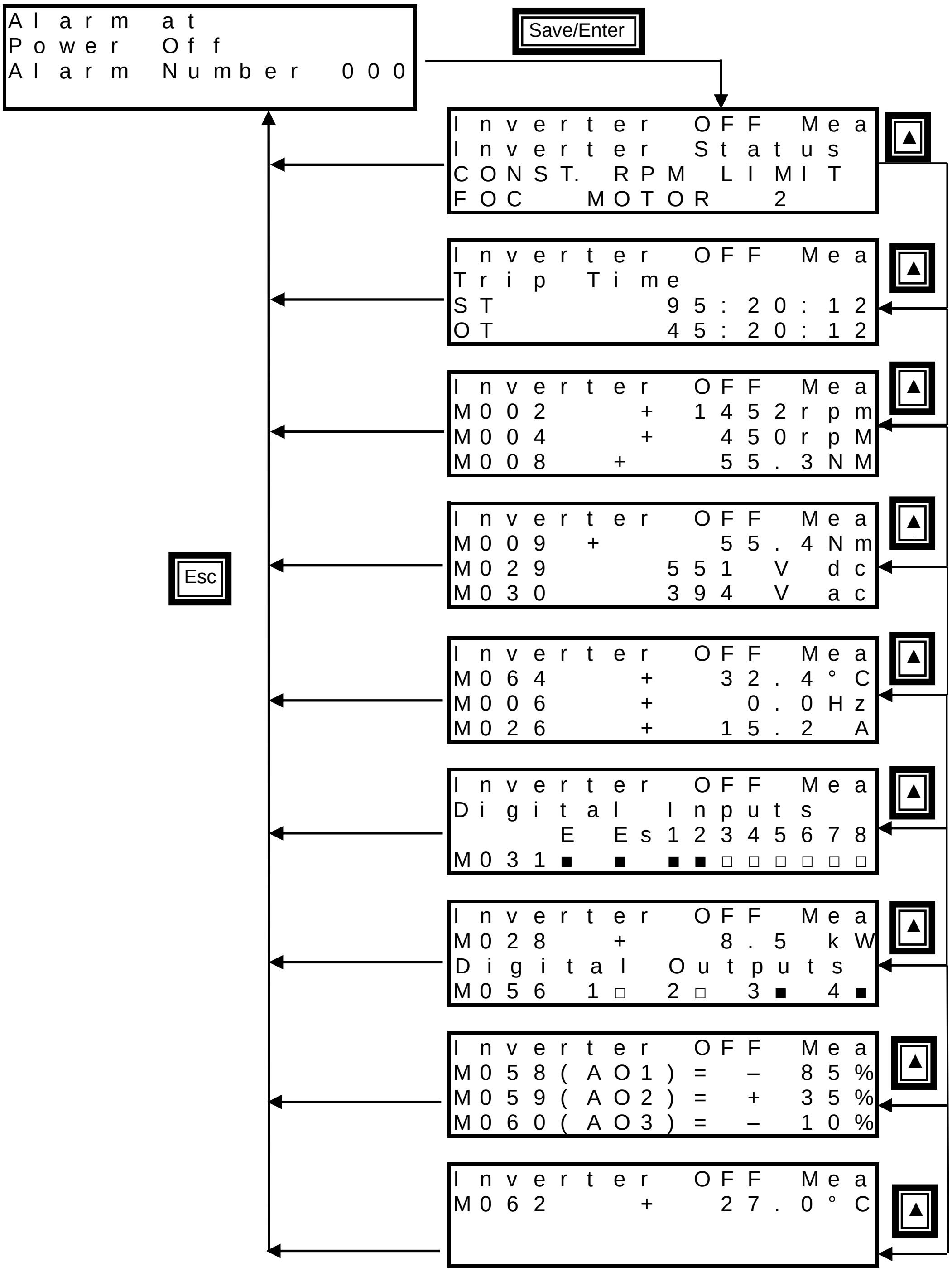


Table 13: List of the measures in the Power Off List

Measure	Function	Range	Value	Modbus Address
M090	Active Alarm	See Table 137	-	5044
M052	Supply Time	See measure description	-	5045: LSW 5046: MSW
M054	Operation Time	See measure description	-	5047: LSW 5048: MSW
M089	Inverter Status	See Table 139	-	5049
M026	Output Current	0 ÷ 65535	0 ÷ 6553.5 A	5050
M004	Motor Speed	±32000	±32000 rpm	5051
M002	Speed Reference after Ramps	±32000	±32000 rpm	5052
M008	Torque Demand	±32000	±32000 Nm	5053
M009	Torque Generated by the Motor	±32000	±32000 Nm	5054
M029	DC-bus Voltage	0 ÷ 1400	0 ÷ 1400 V	5055
M030	Grid Voltage	0 ÷ 1000	0 ÷ 1000 V	5056
M064	IGBT Heatsink Temperature	±32000	± 320.0 °C	5057
M006	Inverter Output Frequency	±10000	±1000.0 Hz	5058
M031	Delayed Digital Inputs	See measure description	-	5060
-	Selected Motor (high byte)	0 ÷ 2	0: Mot1 1: Mot2 2: Mot3	5061
	Selected Control (low byte)	0 ÷ 2	0: IFD 1: VTC 2: FOC	
M028	Output Power	0 ÷ 65535	0 ÷ 6553.5 kW	5063
M056	Digital Outputs	See measure description		5064
M062	Ambient Temperature	±32000	±320.0 °C	5068
M064a	Thermal Image of IGBT Junction Temperature	±32000	±320.0 °C	25

9. PRODUCT MENU

9.1. Overview

The Product Menu includes parameter **P263 Language**, allowing the user to select a dialog language; it also contains the Fire Mode enabling Password and the following information (read-only) about the product:

Product Name and Type
Implemented Software
SW Versions
Serial Number
Manufacturer

9.2. List of Parameter P263 and Fire Mode Enable Password

Table 14: List of Parameter P263 and Fire Mode Enable Password

Parameter	FUNCTION	User Level	DEFAULT VALUE	MODBUS Address
P263	Language	BASIC	1:ENGLISH	863
	Fire Mode Enable Password	BASIC	0	868

P263 Language

<table>
<tr><td rowspan="5">P263</td><td>Range</td><td>0 ÷ 4</td><td>0: ITALIANO
1: ENGLISH
2: ESPAÑOL
3: PORTUGUES
4: DEUTSCH
(F1 version – standard)</td><td>0: DANISH
1: ENGLISH
2: NORWEGIAN
3: FINNISH
4: SWEDISH
(F2 version – on demand)</td><td>0: RUSSIAN
1: ENGLISH
2: ESPAÑOL
3: PORTUGUES
4: DEUTSCH
(F3 version – on demand)</td><td>0: ITALIANO
1: ENGLISH
2: ESPAÑOL
3: PORTUGUES
4: FRANÇAIS
(F4 version – on demand)</td></tr>
<tr><td>Default</td><td>1</td><td colspan="4">1: ENGLISH</td></tr>
<tr><td>Level</td><td colspan="5">BASIC</td></tr>
<tr><td>Address</td><td colspan="5">863</td></tr>
<tr><td>Function</td><td colspan="5">The dialog language is factory set to English. Use parameter P263 to choose a different language.
The software implemented in the display/keypad is called MMI (man/machine interface); its version is displayed in the SW screen of the Product Menu.</td></tr>
</table>

CAUTION

The available language set is that of standard version F1.
Versions F2, F3 and F4 are to be explicitly requested at the time when ordering the drive.

Product Name and Type

Product Name and Type	Range	Fan control: bits 0 to 3 Voltage class: bits 4 to 7 Drive model: bits 8 to 15	0 ÷ 7 – see Table 18 0 ÷ 3 – see Table 16 0 ÷ 106 – see Table 15
	Address	1593	
	Function	This screen displays the name of the product (PENTA) and the type of product (see example below).	

```
P r o d u c t   N a m e
P E N T A
T y p e   0 0 2 0   4 T   _ _ _
```

The product name (PENTA) appears in the second line of the display/keypad. The third line shows the voltage class, the model of the drive and the type of fan control.
In the case shown in the example, the voltage class is 4T (400V), the model of the drive is 0020 and the fan operation is not controlled by the drive (character _).

The numbers corresponding to the different models of the Penta Drive are given in the table below:

Table 15: Indexes corresponding to the different models of the Penta Drive

Index	Model	Index	Model	Index	Model	Index	Model	Index	Model
0	**0003**	22	**0025**	44	**0076**	66	**0216**	88	**0599**
1	**0004**	23	**0030**	45	**0086**	67	**0217**	89	**0600**
2	**0005**	24	**0032**	46	**0087**	68	**0218**	90	**0748**
3	**0006**	25	**0033**	47	**0088**	69	**0250**	91	**0749**
4	**0007**	26	**0034**	48	**0112**	70	**0259**	92	**0750**
5	**0008**	27	**0035**	49	**0113**	71	**0260**	93	**---**
6	**0009**	28	**0036**	50	**0129**	72	**0290**	94	**0828**
7	**0010**	29	**0037**	51	**0130**	73	**0312**	95	**0831**
8	**0011**	30	**0038**	52	**0131**	74	**0313**	96	**0832**
9	**0012**	31	**0040**	53	**0150**	75	**0314**	97	**0850**
10	**0013**	32	**0041**	54	**0151**	76	**0366**	98	**0960**
11	**0014**	33	**0042**	55	**0162**	77	**0367**	99	**0964**
12	**0015**	34	**0049**	56	**0163**	78	**0368**	100	**0965**
13	**0016**	35	**0051**	57	**0164**	79	**0399**	101	**1128**
14	**0017**	36	**0060**	58	**---**	80	**0401**	102	**1129**
15	**0018**	37	**0061**	59	**0178**	81	**0402**	103	**1130**
16	**0019**	38	**0062**	60	**0179**	82	**0457**	104	**1296**
17	**0020**	39	**0067**	61	**0180**	83	**0459**	105	**1800**
18	**0021**	40	**0068**	62	**0181**	84	**0523**	106	**2076**
19	**0022**	41	**0069**	63	**0200**	85	**0524**	107	**---**
20	**0023**	42	**0074**	64	**0201**	86	**0526**	108	**---**
21	**0024**	43	**0075**	65	**0202**	87	**0598**	109	**---**

Table 16: Voltage classes of the Penta Drive

Index	Class
0	**2T**
1	**4T**
2	**5T**
3	**6T**

The type of fan control is marked by 3 characters:

Table 17: Fan control modes

Character	Description
F	The fan activation is controlled by the inverter.
S	The fan operation is correct: when a fan fault is detected, the relevant alarm trips.
N	A NTC sensor is fitted, that acquires the heatsink temperature. The fan activation threshold is set in parameter **C264**.

Table 18: Coding for fan activation

Code	Symbol	Fan control	Fan status	NTC
0	**---**	No	No	No
1	**-S-**	No	Yes	No
2	**F--**	Yes	No	No
3	**FS-**	Yes	Yes	No
4	**--N**	No	No	Yes
5	**-SN**	No	Yes	Yes
6	**F-N**	Yes	No	Yes
7	**FSN**	Yes	Yes	Yes

SW Application

SW Application		
	Function	This screen displays the type of software application which is implemented in the drive (e.g. Regenerative). For the application software downloading instructions see the RemoteDrive DRIVE REMOTE CONTROL - User Manual.

SW Versions

SW Versions			
	Range	0 ÷ 65535	0 ÷ 65.535
	Address	Texas: 475 MMI: 1489 Motorola: 1487	
	Function	This screen displays the SW versions implemented on the Penta drive: **Texas** → **SW version of the Texas DSP** **MMI** → **SW version of the display/keypad** **Motorola** → **SW version of Motorola microprocessor**	

Maximum Output Frequency

Maximum Output Frequency			
	Range	0 ÷ 999	0 ÷ 999 Hz
	Address	3327	
	Function	This screen displays the maximum allowable output frequency (Hz) for the drive.	

CAUTION

According to EU Regulation 428/2009, maximum output frequency is factory-set to 599Hz for any drive models, even those which can withstand higher output frequency values (see Maximum Programmable Speed Value).
If the factory-set output frequency is to be increased, when ordering the equipment it is necessary to declare that it will not go against what is stated by the regulation itself (in other words, that it will not be a dual-use device).

Serial Number

Serial Number	Range	0 ÷ 9999999	0 ÷ 9999999
	Address	1827-1828 (LSWord, MSWord)	
	Function	This is the serial number of the drive. The serial number is required when contacting ENERTRONICA SANTERNO's CUSTOMER SERVICE in order to activate the Fire Mode. This measure is expressed in 32 bits divided into two 16-bit words: the low part and the high part.	

Fire Mode Enable Password

Fire Mode Enable Password	Range	0 ÷ 9999	0 ÷ 9999
	Default	0	0
	Level	BASIC	
	Address	868	
	Function	To enable the Fire Mode, please contact ENERTRONICA SANTERNO's CUSTOMER SERVICE and give the Serial Number of the drive where the Fire Mode is to be activated. Enter the password given by the Customer Service.	

CAUTION The Fire Mode Enable Password is set to 0 when the Restore Default is performed.

Manufacturer

Manufacturer	Function	The name of Enertronica Santerno is displayed followed by Enertronica Santerno's website (santerno.com).

You can also send a Modbus query message to read the product ID.

Product ID

Product ID	Range	1 ÷ 65535	1 ÷ 65535
	Address	476	
	Function	You can read the product ID from address 476. The eight high bits give the first character of the ID, the eight low bits give the second character of the product ID. E.g. for PD (Penta Drive): MODBUS value read from address 476: 20548d → 0x5044H 50H → Character 'P' 44H → Character 'D'	

10. PASSWORD AND USER LEVEL MENU

10.1. Overview

The Password and User Level menu allows changing the programming parameters and sets their visibility.

- **P000** enables parameter modification
- **P001** sets the user level
- **P002** allows to change the password set in **P000**
- **P003** conditions required to change C parameters

10.2. List of Parameters P000 to P003

Table 19: List of Parameters P000 to P003

Parameter	FUNCTION	User Level	DEFAULT VALUES	MODBUS Address
P000	Write enable	BASIC	00001	513
P001	Programming level	BASIC	0:[Basic]	514
P002	Write enable password	ENGINEERING	00001	510
P003	Conditions required to change C parameters	ADVANCED	StandBy+Fluxing	509

P000 Write Enable

Factory setting is **P000 = 1** (parameter write is enabled). To access parameter **P000** allowing parameter write, access the Password and User Level Menu from the Parameters Menu.

P000			
	Range	00000÷32767	00000: [No] ÷32767
	Default	00001	00001
	Level	BASIC	
	Address	Cannot be accessed via serial link. Parameter write via serial link is always enabled.	
	Function	Set the correct value in **P000** to enable parameter write. The default password for **P000** is 00001. You can enter a custom password in **P002.**	

P001 User Level

P001	Range	0÷2	0: Basic 1: Advanced 2: Engineering
	Default	0	0 : Basic
	Level	BASIC	
	Address	514	
	Function	The inverter programming parameters are grouped by access levels based on their functions (more or less complex functions). Some menus, or some parts of menus, are not displayed when a given access level is selected. When the BASIC access level is selected once the inverter parameterization is correct, navigation is easier, as only frequently accessed parameters are displayed. The User Level is stated for each parameter.	

P002 Password for Write Enable

P002	Range	00001 ÷ 32767	00001 ÷ 32767
	Default	00001.	
	Level	ENGINEERING	
	Address	510	
	Function	Once write is enabled after entering the correct password in **P000**, you can use parameter P002 to enter a custom password.	

CAUTION **The new password allowing parameter write is the value entered in P002. Note it down and keep it handy!**

P003 Conditions for C Parameter Modifications

P003	Range	0 ÷ 1	0:[Stand-by only] ÷ 1:[StandBy+Fluxing]
	Default	1	1:[StandBy+Fluxing]
	Level	ADVANCED	
	Address	509	
	Function	Factory setting allows **C parameters** to be programmed even when the inverter is enabled. However, the motor must be stopped. If **P003=0: [Stand-by only]**, C parameters can be changed only when the inverter is disabled. This parameter also affects the behaviour of the digital inputs for **LOC/REM** and motor selection: when those inputs change, they produce their effect only when C parameters are allowed to be changed, according to the value in **P003**.	

CAUTION If **P003 = 1:[StandBy+Fluxing]** when changing a C parameter, the drive automatically disables (stops modulating) and the motor starts idling.

NOTE If **C010 = 0: IFD [Voltage/Frequency]**, C parameters may be set up when the **ENABLE-A** and **ENABLE-B** inputs are active and the motor is stopped independently of **P003**.

11. DISPLAY/KEYPAD MENU

11.1. Overview

NOTE It is recommended that the “Operating and Remoting the Keypad” section in the Motor Drives Accessories - User Manual be read as well.

The Display/Keypad Menu contains programming parameters to do the following:
Set the navigation mode within the drive menus;
Select the Root Page;
Select measures from the Root Page and the Keypad Page;
Select the type of Keypad Page displayed in Local mode;
Set custom PID units of measure;
Disable the **LOC/REM** or **FWD/REV** keys in the keypad.

The Root Page, the Keypad Page and Local mode are detailed in the following sections.

11.2. Root Page

```
 INVERTER  OK
→     +   1500.00rpm
→     +      0.00rpm
 MEA  PAR  CF[IDP]
```

The Root page is factory-set as the startup page to be displayed when the drive is turned on.

NOTE You can access the four main menus only from the root page:
MEA → Measures;
PAR → Programming parameters;
CF → Configuration parameters;
IDP → Product identification.

Line 1 on this page displays the drive operating status (see the description of parameter **M089**).

Lines 2 and 3 display two measures which may be selected with parameters P268, **P268a. These measures can be scaled through parameters P268y and P268z.**

Line 4 displays the four main menus of the drive. The selected menu is displayed in square brackets: use the ▲ and ▼ keys to select a different menu. Press the **SAVE/ENTER** key to access the selected menu.

11.3. Keypad Page and Local Mode

Keypad

```
→        +        0 . 0 H z
→          +        0 . 0 A
→      +        0 . 0 0 r p m
R e f  +   1 5 0 0 . 0 0 r p m
```

SAVE/
ENTER

Keypad Help

```
→M 0 0 6   M o t . F r e q .
→M 0 2 6   I ( R M S )   O u t
→M 0 0 4   M o t o r   S p d
R e f  +   1 5 0 0 . 0 0 r p m
```

To access the Keypad pages, press the **MENU key** from the Root Page or press the **LOC/REM key** after selecting the Local mode.
The measures displayed on the Keypad page can be set up through parameters **P268b** to **P268e**. From the Keypad page, press the **SAVE/ENTER** key to display the Keypad Help page, describing the measures displayed on the Keypad page. The Keypad Help page is displayed for a few seconds.

NOTE If parameter **P264b** (Navigation mode via **MENU key)** is set to Operator, navigation is locked once the Keypad Page is displayed. Press the **ESC** key for a few seconds to resume navigation.

The following Keypad Pages are available:
Measures only → four lines displaying measures only
Speed → line 4 shows the speed reference, that can be changed with the ▲ and ▼ keys.
Torque → line 4 shows the torque reference, that can be changed with the ▲ and ▼ keys.
Limit Torque → line 4 shows the limit torque reference, that can be changed with the ▲ and ▼ keys.
PID → line 4 shows the PID reference, that can be changed with the ▲ and ▼ keys.

If the Local Mode is NOT selected, pressing the MENU key allows viewing only the pages containing the references sent via keypad (see the CONTROL METHOD MENU and the PID CONFIGURATION MENU).

LOCAL MODE

In **LOCAL** mode (the L-CMD and L-REF LEDs come on when the Local mode is active), only the commands and references sent via keypad are enabled, while any other command source or reference source is disabled (see the CONTROL METHOD MENU, the DIGITAL INPUTS MENU and the INPUTS FOR REFERENCES MENU). The keypad page displayed when the **LOC/REM** key is pressed depends on the setting of parameter **P266** (Type of Keypad Page in Local Mode):
P266 = Measures Only → Page containing 4 preset measures; no reference can be changed.

P266 = Ref.Activated → Line 4 in the Keypad Page enables changing the drive reference: the speed reference if a speed control is activated ("Ref" displayed), the torque reference if a torque control is activated ("TRef" displayed). If the drive reference is the PID output (**C294** PID Action = 1:[Reference]), the PID reference is given ("PRef" displayed).
Use the ▲ and ▼ keys to change the reference displayed in line 4 on the Keypad Page.

P266 = Ref.Activated+Spd → To be used only when the drive reference depends on the PID output when a speed control is used (**C294** PID Action = 1:[Reference]). When the **LOC/REM** key is pressed for the first time, "PRef" is displayed in line 4 and the PID reference may be adjusted; when the **LOC/REM** key is pressed twice, the PID is disabled and the speed reference can be changed ("Ref" displayed).
Use the▲ and ▼ keys to change the reference shown in line 4 on the Keypad Page.

11.4. List of Parameters P264 to P269b

Table 20: List of Parameters P264 to P269b

Parameter	FUNCTION	User Level	DEFAULT SETTING	MODBUS Address
P264	Navigation mode	ADVANCED	0 :[BY MENU]	864
P264a	Circular navigation	ADVANCED	1: [YES]	865
P264b	Navigation mode with the **MENU** key	ADVANCED	0:[STANDARD]	512
P265	Root page	ADVANCED	3: [Start Up]	866
P266	Type of Keypad page in Local Mode	ADVANCED	1:[Ref.Activated]	511
P267	Preset PID units of measure	ENGINEERING	0:[Disable]	867
P267a	Custom PID units of measure	ENGINEERING	[%]	1851
P267b	Preset PID2 units of measure	ENGINEERING	0:[Disable]	861
P267c	Custom PID2 units of measure	ENGINEERING	[%]	1865
P268	Measure n.1 on Root page	ADVANCED	**M004** Motor Spd	cannot be accessed
P268y	Scaling of Measure n.1 on Root page	ADVANCED	100.00%	515
P268a	Measure n.2 on Root page	ADVANCED	**M000** Speed Ref.	cannot be accessed
P268z	Scaling of Measure n.2 on Root page	ADVANCED	100.00%	516
P268b	Measure n.1 on Keypad page	ADVANCED	**M006** Mot.Freq.	cannot be accessed
P268c	Measure n.2 on Keypad page	ADVANCED	**M026** Motor Current	cannot be accessed
P268d	Measure n.3 on Keypad page	ADVANCED	**M004** Motor Spd	cannot be accessed
P268e	Measure n.4 on Keypad page	ADVANCED	**M000** Speed Ref.	cannot be accessed
P268s	Custom Motor Speed unit of measure	ENGINEERING	rpm	722
P268t	Scaling of Custom Motor Speed	ENGINEERING	100.00%	517
P268u	Custom Torque unit of measure	ENGINEERING	Nm	723
P268v	Scaling of Custom Torque	ENGINEERING	100.00%	518
P269	Disable **LOC/REM FWD/REV** keys	ENGINEERING	[NO NO]	869
P269b	**ESC** key to restore previous value	ENGINEERING	[NO]	1051

P264 Navigation Mode

P264	**Range**	0 ÷ 2	0: By Menu 1: Changed Pars Only 2: Linear
	Default	0	0: By Menu
	Level	ADVANCED	
	Address	864	
	Function	Navigation by menu is factory-set and is activated whenever the Penta drive is powered on. Set **P264**=1:[Changed Pars Only] to navigate only through the parameters whose default values have been changed. In that case, linear navigation becomes active: only the parameters that have been changed are displayed in sequence. Press the ▲ and ▼ keys to go to a different parameter. Navigation is slower if only few parameters have been changed. Set **P264**=2:[Linear] to display parameters in sequence using the ▲ and ▼ keys. If Linear navigation is selected, parameters are no longer divided into menus and submenus.	

NOTE This parameter cannot be saved. Navigation by menu is restored whenever the drive is powered on.

P264a Circular Navigation

P264a			
	Range	0 ÷ 1	0: [NO] 1: [YES]
	Default	1	1: [YES]
	Level	ADVANCED	
	Address	865	
	Function	Parameter **P264a** is factory set to 1:[YES]. This means that "wrap" navigation is activated: navigation starts from the first page of the selected menu. Press ▲ to go to the next page. When the last page is displayed, press ▲ again to return to the first page of the selected menu. From the first page of the selected menu, press ▼ to go to the last page of the active menu. If **P264a**=0: [NO], when the last page of the active menu is displayed, the ▲ key is disabled; you can only view the previous pages—up to the first page of the active menu—by pressing the ▼ key.	

P264b Navigation Mode with the MENU Key

P264b			
	Range	0 ÷ 1	0: [STANDARD] 1: [OPERATOR]
	Default	0	0: [STANDARD]
	Level	ADVANCED	
	Address	512	
	Function	Press the **MENU** key from any parameter to go to the access page of the menu containing that parameter; press the **MENU** key again to go to the Root page; press the MENU key again to go to the Keypad page. If factory setting is active (**P264b**=0: [STANDARD]) press the **MENU** key from the Keypad page to go to the Root page, then to the starting parameter. If **P264b**=1: [OPERATOR], navigation is locked once the Keypad Page is displayed. Hold down the **ESC** key for a few seconds to resume navigation. This prevents inexpert users from navigating through the parameters stored to the keypad. If the Keypad page is preset as the startup page (**P265**=1: [Measures]) and **P264b**=1 :[OPERATOR], navigation is always locked.	

P265 Startup Page

P265			
	Range	0 ÷ 3	0: [Root] 1: [Measures] 2: [Keypad] 3: [Start-Up]
	Default	3	3: [Start-Up]
	Level	ADVANCED	
	Address	866	
	Function	**P265** sets the page to be displayed when the drive is turned on. **P265** = 0: the Root page is the startup page. **P265** = 1: the Keypad Page displaying 4 measures only is the startup page. **P265** = 2: The Keypad page displaying a reference in line 4 is the startup page. **P265** = 3: the START-UP MENU is the startup page.	

P266 Type of Keypad Page in Local Mode

P266	**Range**	0 ÷ 2	0: [Measures Only] 1: [Ref.Activated] 2: [Ref.Activated+Speed]
	Default	1	1: [Ref.Activated]
	Level	ADVANCED	
	Address	511	
	Function	**P266** sets the type of keypad page to be displayed in Local mode. If **P266 = 0: [Measures Only]** in Local mode, the reference cannot be changed. If **P266 = 1: [Ref.Activated]** in Local mode, the Keypad page containing the activated reference is displayed; for example, if a torque control is active, the Keypad page displayed in Local mode shows the torque reference in line 4. Use the ▲ and ▼ keys to change the torque reference. If a speed control is active and the drive reference is the PID output (**C294** PID Action = 1: [Reference]), when in Local mode, you should disable the PID regulator and send a speed reference from keypad (to do so, set **P266 = 2: [Ref.Activated+Speed]**). When pressing the **LOC/REM** key to enter the Local mode, the Keypad page containing the PID reference is displayed. Use the ▲ and ▼ keys to change the PID reference. Press the **LOC/REM** key once again (when the drive is disabled) to disable the PID control. The Keypad page containing the speed reference is displayed. Use the ▲ and ▼ keys to change the speed reference.	

P267/P267b Preset PID/PID2 Units of Measure

P267/P267b	**Range**	0 ÷ 39	See Table 21
	Default	0	0: [Disable]
	Level	ENGINEERING	
	Address	867/861	
	Function	The PID/PID2 reference and PID/PID2 feedback are expressed as a percentage in measures **M019, M020, M019a, M020a**. Parameters **P257/P457** allow setting a gain value to “scale” the PID reference and PID feedback and to obtain the following measures: **M023** = **P257** * **M019; M024** = **P257** * **M020**; **M023a** = **P457** * **M019a; M024a** = **P457** * **M020a** which are properly scaled. Parameters **P267/P267b** (see coding of **P267/P267b**) sets the unit of measure for the measures above; the unit of measure can also be entered in parameter **P267a/P267c** (only if **P267/P267b** = 0: [Disable]). Example: the PID reference is 100%; **M020** = 100%; if **P257** = 0.04 and **P267** = 1: [bar], the scaled measure for the PID reference is → **M023** = 4.00 bar.	

Table 21: Preset units of measure

Unit of Measure	P267/P267b P267s/P267u	Item Displayed	Unit of measure	P267/P267b P267s/P267u	Item Displayed
Customized	0: Disabled	----(see **P267a/c**)	m/s	20: m/s	m/s
bar	1: bar	bar	ft/s	21: ft/s	ft/s
mbar	2: mbar	mbar	rpm	22: rpm	rpm
atm	3:atm	atm	gal/s	23: GPS	GPS
Pa	4: Pa	Pa	gal/min	24: GPM	GPM
kPa	5: kPa	kPa	gal/h	25: GPH	GPH
PSI	6: PSI	PSI	ft^3/s	26: CFS	CFS
m^3/s	7: m3/s	m3/s	ft^3/min	27: CFM	CFM
m^3/min	8: m3/m	m3/m	ft^3/h	28: CFH	CFH
m^3/h	9: m3/h	m3/h	A	29: A	A
l/s	10: l/s	l/s	V	30: V	V
l/min	11: l/m	l/m	W	31: W	W
l/h	12: l/h	l/h	kW	32: kW	kW
°	13: °	°	HP	33: HP	HP
°C	14: °C	°C	CV	34: CV	CV
°F	15: °F	°F	kVA	35: kVA	kVA
Nm	16: Nm	Nm	ft-lbs	36: ftLb	ftLb
kgm	17: kgm	kgm	Polished Rod Speed	37: PRS	PRS
m	18: m	m	Polished Rod Torque	38: PRT	PRT
ft	19: ft	ft	stroke/min	39: SPM	SPM

<u>P267a/P267c Custom PID/PID2 Units of Measure</u>

P267a/P267c	**Range**	0x20 ÷ 0x8A (every byte)	ASCII 0x20 = blank ASCII 0x8A = □
	Default	0x015D255B	ASCII 0x5D = [ASCII 0x25 = % ASCII 0x5B =] ⇒ [%]
	Level	ENGINEERING	
	Address	1851/1865	(This is a 32-bit data item) Characters are 8-bit ASCII encoded; there are three 8-bit characters starting from the least significant bit. Bit 24 must always be set to 1.
	Function	Parameter **P267a/P267c** is active only if **P267/P267b** = 0: [Disable] and it relates to the unit of measure actually displayed in **M023**, **M024, M023a**, **M024a**. This parameter allows setting a 3-character string to display the units of measures for the PID Measures: **M023**, **M024, M023a**, **M024a**. Press the **SAVE/ENTER** key to edit each character: when a flashing cursor appears on the left of each character, press ▲ and ▼ to scroll all the characters displayed. Press the **ESC** key to go to the next character. Press **SAVE/ENTER** to store the new parameter value.	

NOTE See also parameter **P257/P457** in the PID PARAMETERS MENU.

P268 (P268a) Measure n.1 (n.2) on Root Page

P268 / P268a		
	Range	**M000** ÷ **M027a** (see Table 23)
	Default	**P268** → **M004** Motor Spd **P268a** → **M000** Speed Ref.
	Level	ADVANCED
	Address	Cannot be accessed via serial link.
	Function	These two parameters allow selecting two measures to be displayed on the Root Page.

P268y (P268z) Scaling of Measure n.1 (n.2) on Root Page

P268y / P268z			
	Range	0 ÷ 10000	0 ÷ 100.00%
	Default	10000	100.00%
	Level	ADVANCED	
	Address	515 / 516	
	Function	These parameters allow scaling the read-out of the measures on the Root page which have been selected with parameters **P268** and **P268a**.	

P268b (P268c, P268d, P268e) Measure n.1 (n.2, n.3, n.4) on Keypad Pages

P268b, P268c, P268d, P268e		
	Range	**M000** ÷ **M027a** (see Table 23)
	Default	**P268b** → **M006** Mot.Freq. **P268c** → **M026** Motor Current **P268d** → **M004** Motor Spd **P268e** → **M000** Speed Ref.
	Level	ADVANCED
	Address	Cannot be accessed via serial link.
	Function	These four parameters allow selecting four measures to be displayed on the Keypad Pages.

NOTE

Measure n. 4 is available in the measure Keypad page only. In the remaining Keypad pages st is substituted by the References / Feedback / Limits active in that page.

Table 22: List of the programmable measures for P268, P268a, P268b, P268c, P268d, P268e

M000 Speed Ref	M048 SerPID Fbk
M002 Ramp Out	M049 FbusPID Fbk
M004 Motor Speed	M050 Encoder Ref
M006 Mot.Freq.	M051 Freq.In Ref
M007 Torq.Ref	M056 Digital Out
M008 Torq.Demand	M057 Freq.Out
M009 Torq.Out	M058 Analog Out AO1
M010 Torq.Ref %	M059 Analog Out AO2
M011 Torq.Dem.%	M060 Analog Out AO3
M012 Torq.Out %	M061 Aux. Dig.OUT
M013 T.Lim.Ref	M062 Amb.Temp.
M014 T.Lim.RmpOut	M036a Aux.Ser. Dig.IN
M015 T.Lim.Ref %	M064 Hts.Temp.
M016 T.Lim.RmpOut %	M065 OT Counter
M017 Flux Ref	M066 ST Counter
M018 PID Ref %	M036b Aux.FBus. Dig.IN
M019 PID RmpOut %	M022a PID2 Out %
M020 PID Fbk %	M069 PT100 Temp.1
M021 PID Err %	M070 PT100 Temp.2
M022 PID Out %	M071 PT100 Temp.3
M023 PID Ref	M072 PT100 Temp.4
M024 PID Fbk	M028a Energy (low)
M056a Virtual Dig.Out	M013a Speed Lim Ref
M026 Mot.Current	M014a Speed Lim Out
M027 Out Volt	M026a I2t %
M028 Power Out	M039a Analog In XAIN4
M029 Vbus-DC	M039b Analog In XAIN5
M030 V Mains	M018a PID2 Ref %
M031 Delay.Dig.IN	M019a PID2 RmpOut %
M032 Istant.Dig.IN	M020a PID2 Fbk %
M033 Term. Dig.IN	M021a PID2 Err %
M034 Ser. Dig.IN	M023a PID2 Ref
M035 Fbus. Dig.IN	M024a PID2 Fbk
M036 Aux. Dig.IN	M090 Alarm
M037 Analog In REF	M056b Timed Flags TFL
M038 Analog In AIN1	M027a Power Factor
M039 Analog In AIN2	M004u Custom Mot. Speed
M040 Ser.SpdRef	M009u Custom Torq.Out
M042 Fbus.SpdRef	M120 Enc. A Pulses
M044 Ser.TrqLimRef	M121 Enc. B Pulses
M045 Fbus.TrqLimRef	
M046 SerPID Ref	
M047 FbusPID Ref	

P268s Custom Motor Speed unit of measure

P268s			
	Range	0 ÷ 39	See Table 21
	Default	0	0: [Disable]
	Level	ENGINEERING	
	Address	722	
	Function	It is the unit of measure used to display the speed of custom motor **M004u**.	

P268t Scaling of Custom Motor Speed

P268t			
	Range	0 ÷ 65535	0.00 ÷ 655.35 %
	Default	10000	100.00 %
	Level	ENGINEERING	
	Address	517	
	Function	It is the gain for scaling of the speed of custom motor **M004u**, with respect to the speed of motor **M004** expressed in rpm. Example: If **P268s** = SPM and **P268u** = 0.6%, when **M004** = 1000 rpm, **M004u** = 6 SPM.	

P268u Custom Torque unit of measure

P268u			
	Range	0 ÷ 39	See Table 21
	Default	0	0: [Disable]
	Level	ENGINEERING	
	Address	723	
	Function	It is the unit of measure used to display the torque of custom motor **M009u**.	

P268v Scaling of Custom Torque

P268t			
	Range	0 ÷ 65535	0.00 ÷ 655.35 %
	Default	10000	100.00 %
	Level	ENGINEERING	
	Address	518	
	Function	It is the gain for scaling of the torque of custom motor **M009u,** with respect to the speed of motor **M009** expressed in Nm. Example: If **P268u** = ftLb and **P268v** = 73.75%, when **M009** = 100 Nm, **M009u** = 73.75 ftLb.	

P269 Disable LOC/REM FWD/REV Keys

P269			
	Range	0 ÷ 3	0:[No No] - 3:[YES YES]
	Default	0	0:[No No]
	Level	ENGINEERING	
	Address	869	
	Function	This parameter allows disabling the **LOC/REM** and/or the **FWD/REV** key. This is a bit-controlled parameter: bit 0 relates to **LOC/REM**, while bit 1 relates to **FWD/REV**. Set 0 to select [NO], set 1 to select [Yes]. **P269** = 0 → both keys are enabled. **P269** = 1 → the **LOC/REM** key is disabled. **P269** = 2 → the **FWD/REV** key is disabled. **P269** = 3 → both keys are disabled.	

P269b ESC Key to Restore Previous Value

P269b			
	Range	0 ÷ 1	0:[No] - 1:[YES]
	Default	0	0:[No]
	Level	ENGINEERING	
	Address	1051	
	Function	Effect of pressing the **ESC** key when changing a parameter after pressing **SAVE/ENTER:** **P269b** = **0:[No]** → press **ESC** to confirm the parameter value, which is not stored non-volatile memory (the previous value will be restored when the drive is next powered on). **P269b** = **1**:**[YES]** → press **ESC** to restore the previous value. In both cases, press **SAVE/ENTER** to confirm the new parameter value and store it to non-volatile memory (the new value is still effective when the drive is next powered on).	

12. RAMPS MENU

12.1. Overview

An acceleration/deceleration ramp is a function allowing linear variations of the motor speed.
The ramp time is the time the motor takes to reach its max. speed when it starts from zero speed (or the time the motor takes to reach 0 speed when decelerating).
Four pairs of programmable values are available. Each pair defines the motor acceleration time and deceleration time. The unit of measure of the basic time period is assigned to each pair of values.
In the Ramps menu, you can set the acceleration and deceleration times for the four speed ramps available for ordinary operation, for the torque ramp and the speed/torque ramp in JOG mode.
Using two special parameters, you can also set the start rounding off and the end rounding off for the acceleration ramps, while two different parameters allow setting the start rounding off and the end rounding off for the deceleration ramps. A fifth parameter allows selecting the ramps for the preset rounding off.

12.1.1. Description of the Speed Ramps

For the four speed ramps that can be selected through a combination of the digital inputs set in **C167** and **C168**, you can set the following: acceleration time, deceleration time and their units of measure, allowing increasing the programmable time range.

P009 Ramp Up Time 1
P010 Ramp Down Time 1
P012 Ramp Up Time 2
P013 Ramp Down Time 2
P014 Unit of Measure for Ramp Times 1 and 2

P015 Ramp Up Time 3
P016 Ramp Down Time 3
P018 Ramp Up Time 4
P019 Ramp Down Time 4
P020 Unit of Measure for Ramp Times 3 and 4

The Ramp Time corresponds to the time taken by the speed reference (starting from 0 rpm) to reach the maximum, as absolute value, between min. speed and max. speed of the selected motor (**C028** and **C029** for motor 1, and so on). The time unit of measure may have the following values:

0 → 0.01 s
1 → 0.1 s
2 → 1 s
3 → 10 s

The programmable range may be 0 s – 327000 s.

Example of a speed ramp:

Table 23: Example of a Speed Ramp

P014		Range P009 – P010	
Value	Unit of measure	Min	Max
0	0.01 s	0	327.00 s
1	0.1 s	0	3270.0 s
2	1 s	0	32700 s
3	10 s	0	327000 s

The factory setting of the unit of measure is 0.1 s; the ramp time is 10 sec.

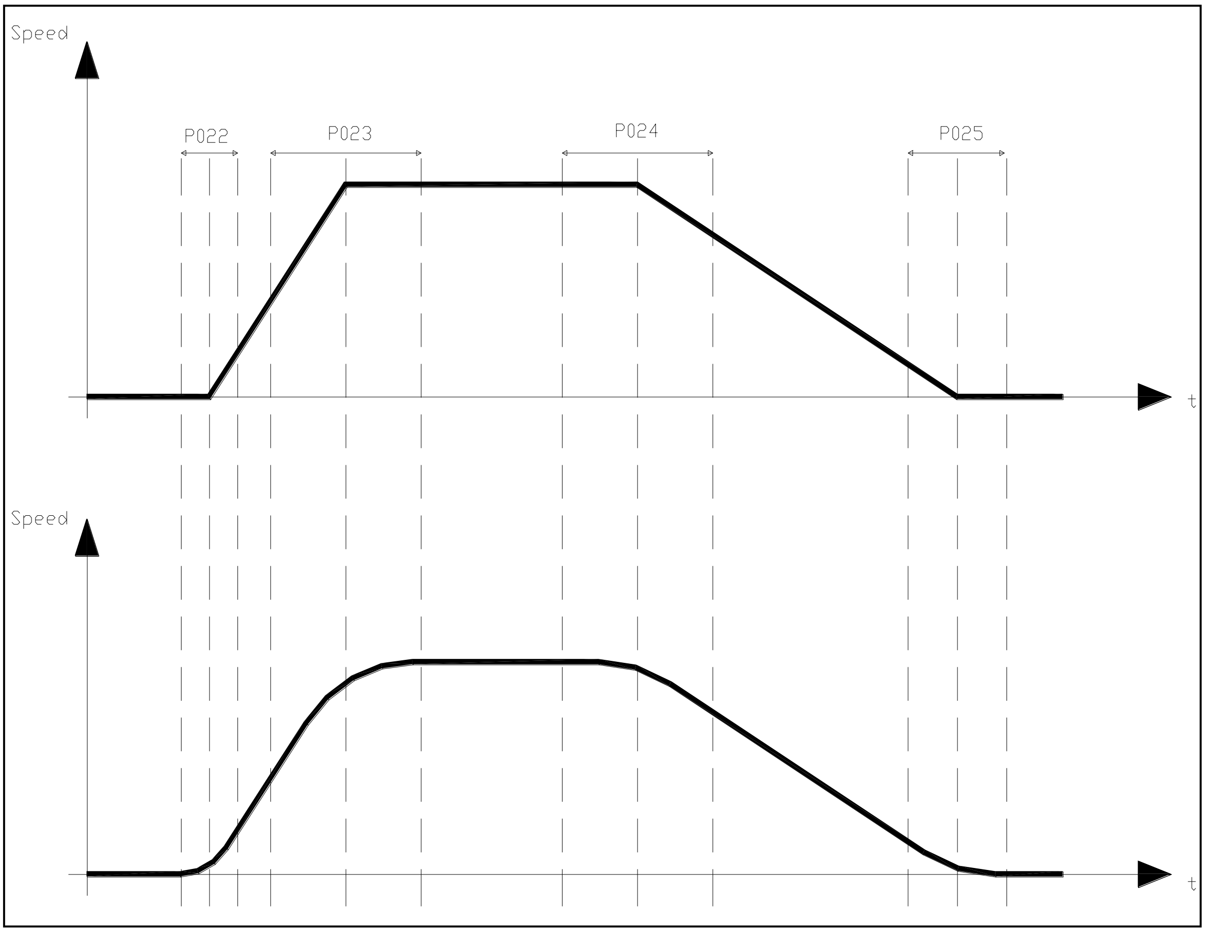


Figure 4: Example of S ramps

You can also select the rounding off and the rounding off percentage for the 4 stages of starting ramp up and the starting ramp down, and for the end ramp up and the end ramp down (S ramps). The limited jerk S-curve (jerk is the derivative of acceleration and a measure of impact) can be represented by a second-order polynomial in velocity. Limited Jerk S-curves are used to eliminate discontinuities in acceleration that are detrimental to mechanical gear.

The rounding off is expressed as a percentage of the ramp time it relates to; if used, it allows increasing the preset ramp time by half the sum value of the two rounding off values. Its effect is shown in the figures below.

Example: **P009** = 10sec ; **P021** = 1111 binary (rounding off selected for all four ramps); **P022** = 50%; **P023** = 50%
The resulting ramp up time is as follows:
P009 + ((**P009*** (**P022**+**P023**)/2)/100) = 10 + ((10* (50+50)/2)/100) = 15 sec

The effect of this rounding off can be seen in the figures below:

The figure shows two patterns for the ramp reference. The first pattern is not rounded off; the second pattern has the same ramp times, but different rounding off values are applied to the start/end ramp up/down time.

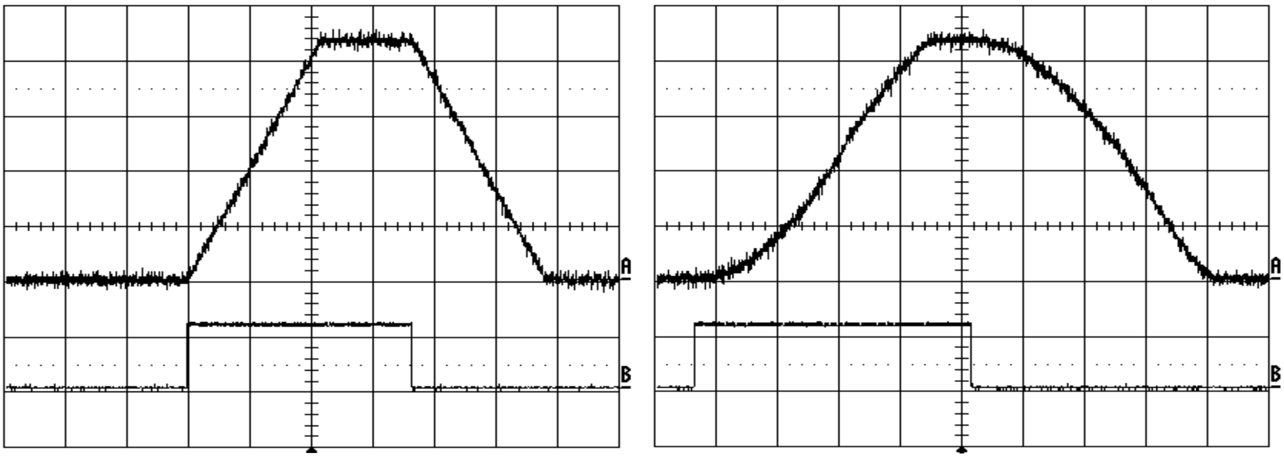


Figure 5: Speed profile without Rounding Off and with Rounding Off 2 (example)

In the figures above, the run command is represented by the high level of the second signal. Note that the time the reference takes to reach constant rpm depends not only on the ramp times, but also on the rounding off values you have defined.

Acceleration RESET function
This parameter has effect only if S ramps are used. Parameter **P031** enables to reset acceleration when reference trends change.
Whenever a speed reference trend changes, the motor acceleration is instantly set to zero and the ramp output reference will be computed considering the preset rounding off (see
Figure 6). The figure shows the instant when deceleration begins; the rounding off value assigned to the speed reference when the gradient changes is the value set for the deceleration starting stage.
If parameter **P031** is set to [No], acceleration is brought to zero before the speed reference starts decreasing, then deceleration begins with the preset pattern.

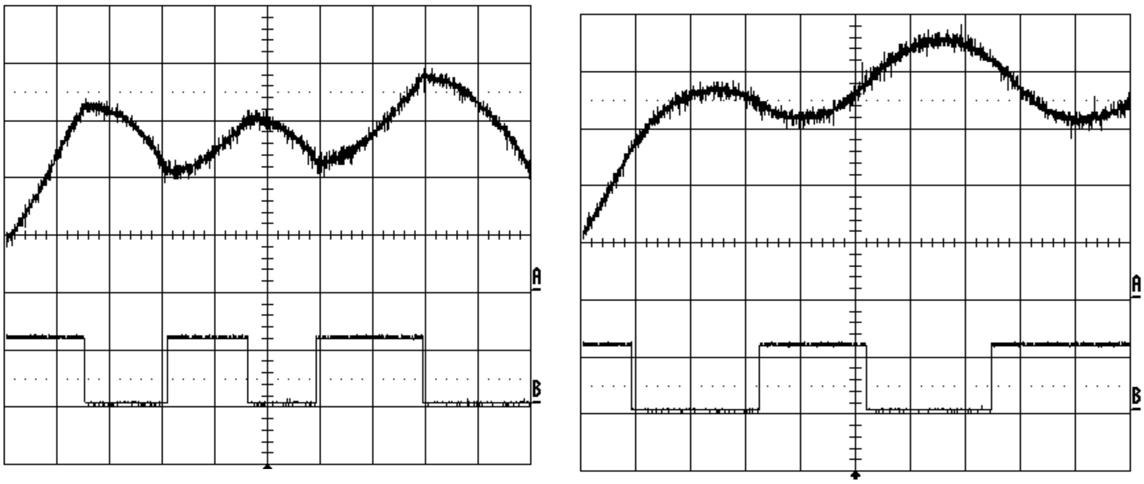


Figure 6: Speed profile with Acceleration Reset - Yes to No (Example)

12.1.2. Description of the Torque Ramps

If the control algorithm is VTC or FOC and if it is controlled by setting “Torque” (**C011** for motor 1, **C054** for motor 2, and **C097** for motor 3 respectively), the reference is “ramped“ based on the values set in parameter **P026** (torque increase ramp time), **P027** (torque decrease ramp time), and **P028** (unit of measure for the ramp times). The ramp up time setting is the time the output torque reference takes to go from 0 to the max. value (as an absolute value) between Torque min. and Torque max. of the selected motor (**C047**, **C048** for motor 1 and so on).

12.1.3. Anti-sway Function

This function allows suppressing overhead load swaying from applications such as bridge cranes.
A fully open-loop algorithm is used, which does not require any additional sensors or boards.

The Anti-sway function is enabled through parameter **P034**. Parameter **P036** allows setting the maximum rope length in metres. Additional settings can be made through parameter **P035** (Damping/Friction Coefficient).

NOTE A fully open-loop algorithm is used, which is affected by external factors such as wind, impacts, previous residual sway and similar.
Make sure that the Anti-sway function is used indoor only.

NOTE For optimum performance, make sure that all S ramps are disabled when using the Anti-sway function.

CAUTION The anti-sway function will be automatically disabled if Sinus Penta drive enters the current limitation mode and will remain disabled until the next opening and closing of the **ENABLE-A** and **ENABLE-B** inputs.

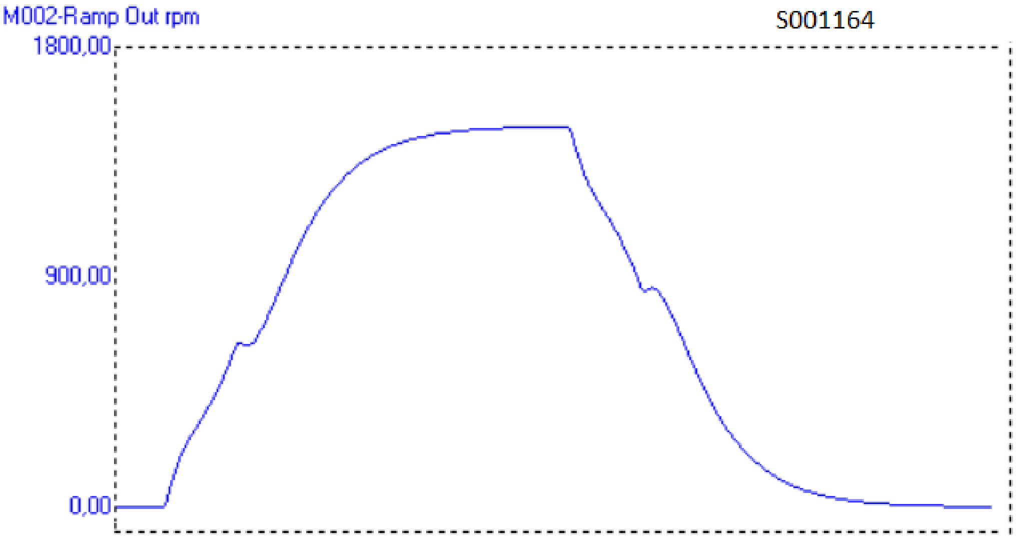


Figure 7: Example of a speed profile when the Anti-sway function is enabled

12.2. List of Parameters P009 to P036

Table 24: List of Parameters P009 to P033

Parameter	FUNCTION	User Level	Default Values	MODBUS Address
P009	Speed ramp 1: acceleration time	BASIC	See Table 82 and Table 86	609
P010	Speed ramp 1: deceleration time	BASIC	See Table 82 and Table 86	610
P012	Speed ramp 2: acceleration time	ADVANCED	See Table 82 and Table 86	612
P013	Speed ramp 2: deceleration time	ADVANCED	See Table 82 and Table 86	613
P014	Speed ramps 1 and 2: time unit of measure	ADVANCED	See Table 82 and Table 86	614
P015	Speed ramp 3: acceleration time	ADVANCED	See Table 82 and Table 86	615
P016	Speed ramp 3: deceleration time	ADVANCED	See Table 82 and Table 86	616
P018	Speed ramp 4: acceleration time	ADVANCED	See Table 82 and Table 86	618
P019	Speed ramp 4: deceleration time	ADVANCED	See Table 82 and Table 86	619
P020	Speed ramps 3 and 4: time unit of measure	ADVANCED	See Table 82 and Table 86	620
P021	Selection for S ramp rounding off	ADVANCED	1111b (all S ramps)	621
P022	Acceleration S ramp: start rounding off time	ADVANCED	See Table 82 and Table 86	622
P023	Acceleration S ramp: end rounding off time	ADVANCED	See Table 82 and Table 86	623
P024	Deceleration S ramp: start rounding off time	ADVANCED	See Table 82 and Table 86	624
P025	Deceleration S ramp: end rounding off time	ADVANCED	See Table 82 and Table 86	625
P026	Torque ramp time: up	ADVANCED	5 s	626
P027	Torque ramp time: down	ADVANCED	5 s	627
P028	Unit of measure for torque ramp time	ADVANCED	0.1 s	628
P029	Jog ramp acceleration time	ADVANCED	1 s	629
P030	Jog ramp deceleration time	ADVANCED	1 s	629
P031	Gradient variation acceleration reset	ADVANCED	1: [YES]	630
P032	Fire Mode Ramp: acceleration time	ENGINEERING	See Table 82 and Table 86	632
P033	Fire Mode Ramp: deceleration time	ENGINEERING	See Table 82 and Table 86	633
P034	Anti-sway Enable	ENGINEERING	0:[Off]	617
P035	Damping/Friction Coefficient	ENGINEERING	0.100	757
P036	Maximum Rope Length	ENGINEERING	0.000 m	760

P009 Speed Ramp 1: Acceleration Time

P009	**Range**	0 ÷ 32700	0 ÷327.00 s if **P014**=0 → 0.01 s 0 ÷3270.0 s if **P014**=1 → 0.1 s 0 ÷32700 s if **P014**=2→ 1 s 0 ÷327000 s if **P014**=3 → 10 s
	Default	See Table 82 and Table 86	
	Level	BASIC	
	Address	609	
	Function	Determines the time the reference takes to go from 0 rpm to the max. preset speed (considering the max. value between absolute values for max. speed and min. speed set for the selected motor). If S ramps are used, the actual time the reference takes to reach constant rpm exceeds the time set in **P009** for a percentage equal to (**P022**+**P023**)/2.	

P010 Speed Ramp 1: Deceleration Time

P010	**Range**	0 ÷ 32700	0 ÷327.00 s if **P014**=0 → 0.01 s 0 ÷3270.0 s if **P014**=0 → 0.1 s 0 ÷32700 s if **P014**=0 → 1 s 0 ÷327000 s if **P014**=0 → 10 s
	Default	See Table 82 and Table 86	
	Level	BASIC	
	Address	610	
	Function	Determines the time the reference takes to go from the max. preset speed (considering the max. value between absolute values for max. speed and min. speed set for the selected motor) to zero rpm. If S ramps are used, the actual time the reference takes to reach 0 speed exceeds the time set in **P010** for a percentage equal to (**P024**+**P025**)/2.	

P012 Speed Ramp 2: Acceleration Time

P012	**Range**	0 ÷ 32700	0 ÷327.00 s if **P014**=0 → 0.01 s 0 ÷3270.0 s if **P014**=0 → 0.1 s 0 ÷32700 s if **P014**=0 → 1 s 0 ÷327000 s if **P014**=0 → 10 s
	Default	See Table 82 and Table 86	
	Level	ADVANCED	
	Address	612	
	Function	Same as ramp 1 (see **P009**).	

NOTE Values for ramp 2 can be applied to the reference provided that multiramp digital inputs are set up and that ramp 2 is selected (see the DIGITAL INPUTS MENU).

P013 Speed Ramp 2: Deceleration Time

P013	**Range**	0 ÷ 32700	0 ÷327.00 s if **P014**=0 → 0.01 s 0 ÷3270.0 s if **P014**=0 → 0.1 s 0 ÷32700 s if **P014**=0 → 1 s 0 ÷327000 s if **P014**=0 → 10 s
	Default	See Table 82 and Table 86	
	Level	ADVANCED	
	Address	613	
	Function	Same as ramp 1 (see **P010**).	

NOTE Values for ramp 2 can be applied to the reference provided that multiramp digital inputs are set up and that ramp 2 is selected (see the DIGITAL INPUTS MENU).

P014 Speed Ramps 1 and 2: Time Unit of Measure

P014	**Range**	0 ÷ 3	0 → 0.01 s 1→ 0.1 s 2→ 1 s 3→ 10 s
	Default	See Table 82 and Table 86	
	Level	ADVANCED	
	Address	614	
	Function	Defines the unit of measure for the time periods for speed ramp 1 (**P009** and **P010**), for speed ramp 2 (**P012** and **P013**), and for ramps in Fire Mode (**P032** and **P033**). The allowable programmable range may be extended from 0 s to 327000s. E.g. **P014**=1 then **P009**=100; this means **P009** = 100 x 0.1 s = 10 s **P014**=0 then **P009**=100; this means **P009** = 100 x 0.01 s = 1 s **P014**=3 then **P009**=100; this means **P009** = 100 x 10 s = 1000 s	

P015 Speed Ramp 3: Acceleration Time

P015	**Range**	0 ÷ 32700	0 ÷327.00 s if **P020**=0 → 0.01 s 0 ÷3270.0 s if **P020**=0 → 0.1 s 0 ÷32700 s if **P020**=0 → 1 s 0 ÷327000 s if **P020**=0 → 10 s
	Default	See Table 82 and Table 86	
	Level	ADVANCED	
	Address	615	
	Function	Same as ramp 1 (see **P009**).	

NOTE Values for ramp 3 can be applied to the reference provided that multiramp digital inputs are set up and that ramp 3 is selected (see the DIGITAL INPUTS MENU).

P016 Speed Ramp 3: Deceleration Time

P016	**Range**	0 ÷ 32700	0 ÷327.00 s if **P020**=0 → 0.01 s 0 ÷3270.0 s if **P020**=0 → 0.1 s 0 ÷32700 s if **P020**=0 → 1 s 0 ÷327000 s if **P020**=0 → 10 s
	Default	See Table 82 and Table 86	
	Level	ADVANCED	
	Address	616	
	Function	Same as ramp 1 (see **P010**).	

NOTE Values for ramp 3 can be applied to the reference provided that multiramp digital inputs are set up and that ramp 3 is selected (see the DIGITAL INPUTS MENU).

P018 Speed Ramp 4: Acceleration Time

P018	**Range**	0 ÷ 32700	0 ÷327.00 s if **P020**=0 → 0.01 s 0 ÷3270.0 s if **P020**=0 → 0.1 s 0 ÷32700 s if **P020**=0 → 1 s 0 ÷327000 s if **P020**=0 → 10 s
	Default	See Table 82 and Table 86	
	Level	ADVANCED	
	Address	618	
	Function	Same as ramp 1 (see **P009**).	

NOTE Values for ramp 4 can be applied to the reference provided that multiramp digital inputs are set up and that ramp 4 is selected (see the DIGITAL INPUTS MENU).

P019 Speed Ramp 4: Deceleration Time

P019	**Range**	0 ÷ 32700	0 ÷327.00 s if **P020**=0 → 0.01 s 0 ÷3270.0 s if **P020**=0 → 0.1 s 0 ÷32700 s if **P020**=0 → 1 s 0 ÷327000 s if **P020**=0 → 10 s
	Default	See Table 82 and Table 86	
	Level	ADVANCED	
	Address	619	
	Function	Same as ramp 1 (see **P010**).	

NOTE Values for ramp 4 can be applied to the reference provided that multiramp digital inputs are set up and that ramp 4 is selected (see the DIGITAL INPUTS MENU).

P020 Speed Ramps 3 and 4: Time Unit of Measure

P020	**Range**	0 ÷ 3	0 → 0.01 s 1→ 0.1 s 2→ 1 s 3→ 10 s
	Default	See Table 82 and Table 86	
	Level	ADVANCED	
	Address	620	
	Function	Defines the unit of measure for the times for speed ramp 3, **P015** and **P016,** and speed ramp 4, **P020** and **P018**. The allowable programmable range may be extended from 0 s to 327000s.	

P021 Selection for Ramp Rounding Off

P021	**Range**	0000b ÷ 1111b binary 0x0000 ÷ 0x000F hexadecimal 0 ÷ 15	0000b (no S ramps) 1111b (all S ramps)
	Default	1111b (all S ramps)	
	Level	ADVANCED	
	Address	621	
	Function	In this parameter, you can select the bit corresponding to the ramp to be rounded off. Example: **P021** = 0011b = 3 decimal → ramps 1 and 2 are rounded off. The ramp rounding off allows reaching the reference end value with a zero tangent, both while accelerating and while decelerating, thus suppressing torque peaks that could damage mechanical couplings.	

P022 Acceleration Ramp: Start Rounding Off Time

P022	**Range**	0 ÷ 100	0 ÷ 100 %
	Default	See Table 82 and Table 86	
	Level	ADVANCED	
	Address	622	
	Function	Sets the rounding off time period for the first stage of the acceleration ramp. This parameter is expressed as a percentage of the acceleration ramp time of the active ramp. Example: the second ramp is active with an acceleration ramp time of 5 secs, P022 = 50%. Therefore, reference acceleration is limited for the first 2.5 secs of the ramp time.	

NOTE When using parameter **P022**, the preset acceleration ramp time is increased by: (**P022**%)/2.

P023 Acceleration Ramp: End Rounding Off Time

P023	**Range**	0 ÷ 100	0 ÷ 100 %
	Default	See Table 82 and Table 86	
	Level	ADVANCED	
	Address	623	
	Function	Sets the rounding off time period for the end stage of the acceleration ramp. This parameter is expressed as a percentage of the acceleration ramp time of the active ramp.	

NOTE When using parameter **P023**, the preset acceleration ramp time is increased by: (**P023**%)/2.

P024 Deceleration Ramp: Start Rounding Off Time

P024			
	Range	0 ÷ 100	0 ÷ 100 %
	Default	See Table 82 and Table 86	
	Level	ADVANCED	
	Address	624	
	Function	See the function for **P022**. The only difference is that this rounding off function is applied to the first stage of a deceleration ramp.	

NOTE When using parameter **P024**, the preset deceleration ramp time is increased by: (**P024**%)/2.

P025 Deceleration Ramp: End Rounding Off Time

P025			
	Range	0 ÷ 100	0 ÷ 100 %
	Default	See Table 82 and Table 86	
	Level	ADVANCED	
	Address	625	
	Function	See the function for **P023**. The only difference is that this rounding off function is applied to the last stage of a deceleration ramp.	

NOTE When using parameter **P025**, the preset deceleration ramp time is increased by: (**P025**%)/2.

P026 Torque Ramp Time: Up

P026			
	Range	0 ÷ 32700	Function of **P028**
	Default	500	50 sec
	Level	ADVANCED	
	Address	626	
	Function	Defines the time taken by the torque reference of the selected motor to go to zero from max. value (as an absolute value between Torque min. and Torque max.); (**C047**–**C048** for motor 1 and so on).	

P027 Torque Ramp Time: Down

P027			
	Range	0 ÷ 32700	Function of **P028**
	Default	500	50 sec
	Level	ADVANCED	
	Address	627	
	Function	Defines the time taken by the torque reference of the selected motor to go from max. value to zero (as an absolute value between Torque min. and Torque max.); (**C047**–**C048** for motor 1 and so on).	

P028 Unit of Measure for Torque Ramp Time

P028	**Range**	0 ÷ 3	0 → 0.01 s 1 → 0.1 s 2 → 1 s 3 → 10 s
	Default	1	1 → 0.1 s
	Level	ADVANCED	
	Address	628	
	Function	Defines the unit of measure for the torque ramp times. See the unit of measure for ramp 1 (par. **P014**).	

P029 Jog Ramp Acceleration Time

P029	**Range**	0 ÷ 6500	0 ÷ 6500 sec
	Default	1	1sec
	Level	ADVANCED	
	Address	629	
	Function	The preset time corresponds to the time the “ramped” speed/torque reference takes to go from zero to the JOG speed/torque value (**P070**).	

P030 Jog Ramp Deceleration Time

P030	**Range**	0 ÷ 6500	0 ÷ 6500 sec
	Default	1	1sec
	Level	ADVANCED	
	Address	630	
	Function	The preset time corresponds to the time the “ramped” speed/torque reference takes to go from the JOG speed/torque value (**P070**) to zero.	

P031 Gradient Variation Acceleration Reset

P031	**Range**	0 ÷ 1	0: [No] ; 1: [Yes]
	Default	1	1: [Yes]
	Level	ADVANCED	
	Address	631	
	Function	Defines whether acceleration is reset or not when switching from acceleration to deceleration and vice versa (reference gradient). For more details, see the description of the speed ramps at the beginning of this section.	

NOTE Parameter **P031** is interlocked with parameter **C210** (Automatic extension of down ramp) so that **P031** = 0:No cannot be programmed in conjunction with **C210** ≠ **[With resistor].**

P032 Fire Mode Acceleration Ramp

P032	**Range**	0 ÷ 32700	0 ÷ 327.00 s if **P014**=0 → 0.01 s 0 ÷ 3270.0 s if **P014**=1 → 0.1 s 0 ÷ 32700 s if **P014**=2 → 1 s 0 ÷ 327000 s if **P014**=3 → 10 s
	Default	See Table 82 and Table 86	
	Level	ENGINEERING	
	Address	632	
	Function	This ramp is used to accelerate the motor when in Fire Mode.	

P033 Fire Mode Deceleration Ramp

P033	**Range**	0 ÷ 32700	0 ÷ 327.00 s if **P014**=0 → 0.01 s 0 ÷ 3270.0 s if **P014**=1 → 0.1 s 0 ÷ 32700 s if **P014**=2 → 1 s 0 ÷ 327000 s if **P014**=3 → 10 s
	Default	See Table 82 and Table 86	
	Level	ENGINEERING	
	Address	633	
	Function	This ramp is used to decelerate the motor when in Fire Mode.	

P034 Anti-sway Enable

P034	**Range**	0 ÷ 1	0: [Off]; 1: [On]
	Default	0	Off
	Level	ENGINEERING	
	Address	617	
	Function	This parameter enables the Anti-sway function.	

P035 Damping/Friction Coefficient

P035	**Range**	0 ÷ 32700	0 ÷ 32.700
	Default	100	0.100
	Level	ENGINEERING	
	Address	757	
	Function	This parameter reduces load sway to a minimum.	

P036 Maximum Rope Length

P036	**Range**	0 ÷ 32700	0 ÷ 32.700 m
	Default	0	0.000 m
	Level	ENGINEERING	
	Address	760	
	Function	This parameter sets the maximum length of the rope.	

13. INPUTS FOR REFERENCES MENU

13.1. Processing Speed/Torque References

The “**main reference**” is the value, at constant rpm, for the controlled physical variable (speed or torque) (**M000**, **M007**) “required” for the drive.
This reference is acquired by the drive only if the **START** command is active and the drive is **RUNNING**, otherwise it is ignored.
The **main reference** is the reference at constant rpm: when the drive is **RUNNING**, it will increment the speed or torque **set–point** which will reach the main reference with a timed ramp (see the RAMPS MENU).
The drive operating mode is factory-set to **MASTER** with a **speed** reference. In **SLAVE** mode, a **torque** reference is used; this operating mode may be configured for **VTC** control (Vector Torque Control) and **FOC** control (Field Oriented Control) only.
The **control algorithm** and the **MASTER/SLAVE mode** can be set for each of the 3 programmable motors, depending on which motor is active at that moment (motor 1, motor 2 or motor 3).
To enable the **SLAVE** mode, set the following parameters to **1** or **2**:
C011 (motor 1)
C054 (motor 2)
C097 (motor 3)
The SLAVE mode may also be selected through a digital input (see the DIGITAL INPUTS MENU).
When the main reference is acquired by the drive (**RUNNING** on), it becomes the reference for the time ramps generating the current speed/torque set–point for the connected motor.
The setup of the main reference is based on a number of parameters included in several menus:

Table 25: Parameters used for the Inputs for References Menu

Parameters	Menu	Contents
P050 ÷ P074	**References**	Scaling parameters for references sent from analog inputs REF, AIN1, AIN2. Scaling parameters for references sent from encoder and frequency input. Parameters for changes made using the UP and DOWN keys. Parameter for JOG reference setting. Parameter for drive disabling in case of reference at min. value.
P390 ÷ P399	**References from optional board**	Scaling parameters for references sent from analog inputs XAIN4, XAIN5.
P080 ÷ P098	**Multispeed**	Parameters setting preset multispeed values to be selected through digital inputs.
P105 ÷ P108	**Prohibit Speed**	Parameters setting prohibit speed values.
P115 ÷ P121	**Reference Variation Percent**	Parameters setting slowing down values percent to be selected through digital inputs.
C143 ÷ C146	**Control Method**	Parameters setting the reference source.
C011, C028, C029	**Configuration of Motor 1**	Parameter setting the Master (speed) mode or the Slave (torque) mode. Parameters setting the min. speed or the max. speed.
C054, C071, C072	**Configuration of Motor 2**	
C097, C114, C115	**Configuration of Motor 3**	
C047, C048	**Limit for Motor 1**	Parameters setting the min. torque and the max. torque.
C090, C091	**Limit for Motor 2**	
C133, C134	**Limit for Motor 3**	

The following pages contain block diagrams illustrating speed reference processing (Figure 8) and torque reference processing (Figure 9). Menus and parameters used are also stated.

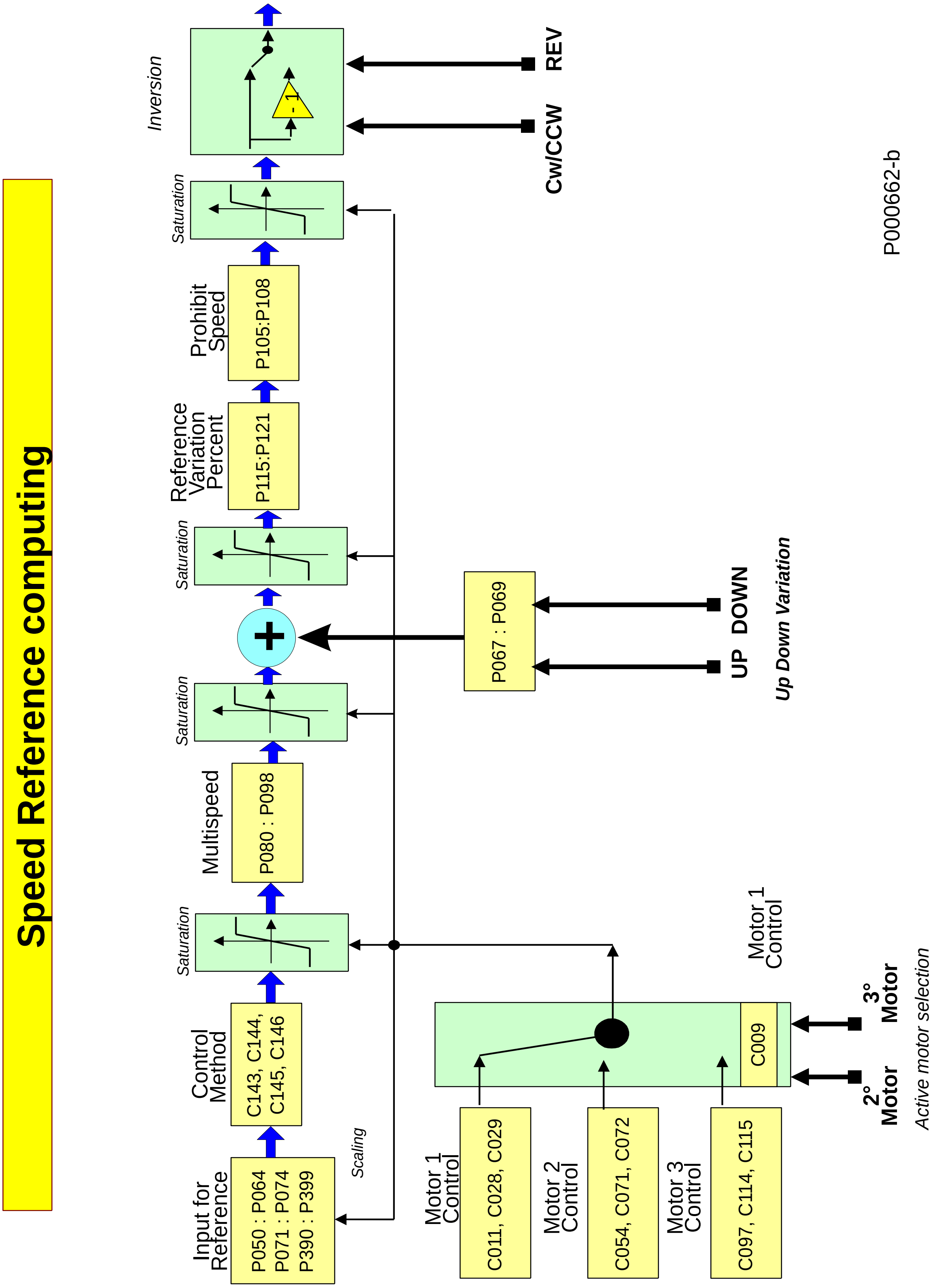


Figure 8: Speed Reference computing

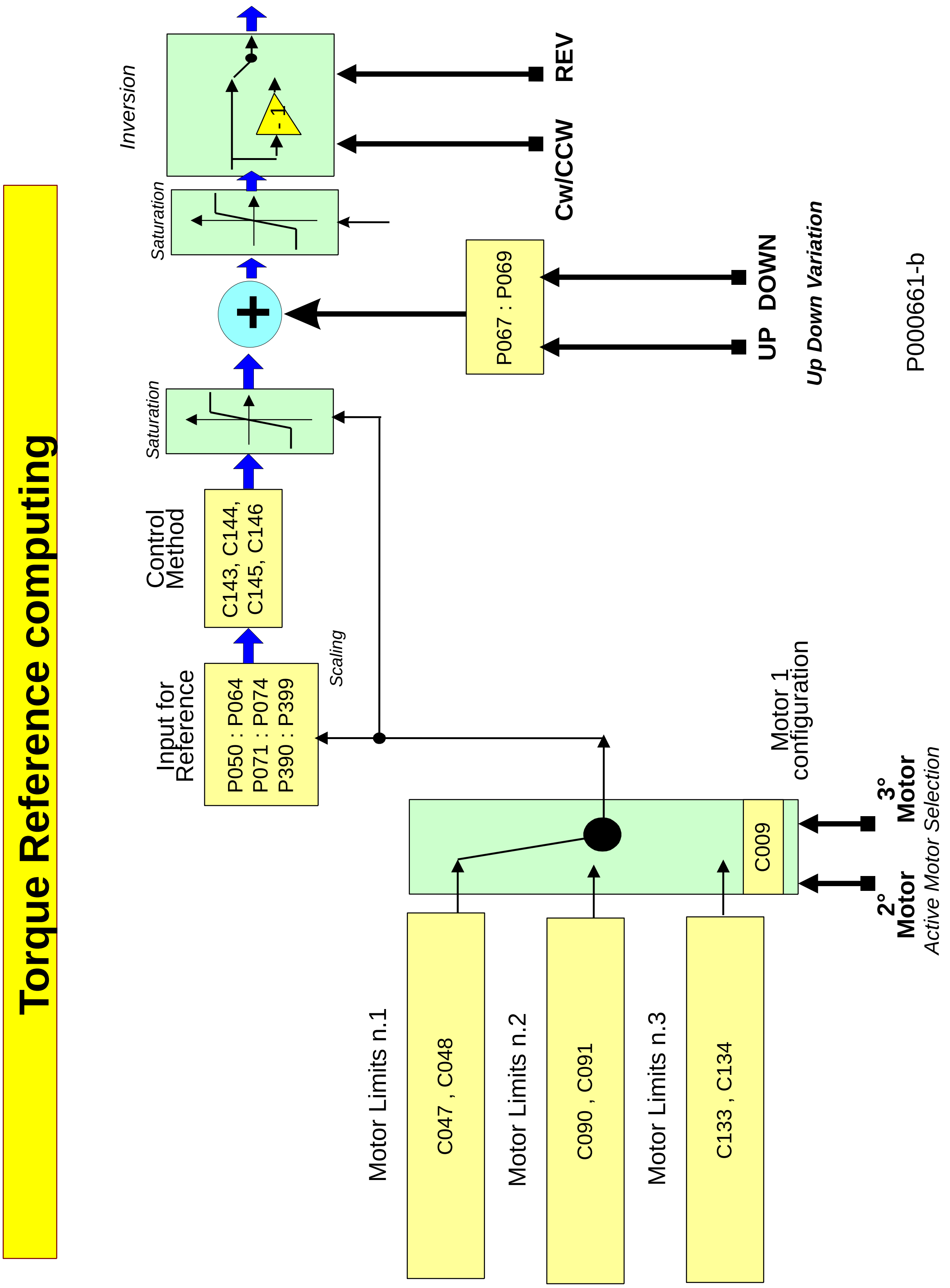


Figure 9: Torque Reference computing

13.2. Scaling Analog Inputs REF, AIN1, AIN2

NOTE Please refer to the Sinus Penta's Installation Guide for hardware details about analog inputs.

Three analog inputs are available: **REF**, **AIN1**, **AIN2**.
They can be voltage inputs or current inputs (switching is made possible through hardware DIP–Switch **SW1** and software parameters) and are bipolar analog inputs (–10V ÷ +10V or –20mA ÷ +20mA).
REF input is single-ended; **AIN1** and **AIN2** inputs are differential inputs.
Factory setting is as follows: the **main speed reference** is given by **REF** analog input, **0V ÷ +10V** mode; only motor 1 is active. Its max. speed and min. speed parameters are **C088**=**1500** rpm and **C029**=**0** rpm respectively.
For the 3 analog inputs, parameters **P050** ÷ **P064** allow setting the type of signal to be acquired, offset compensation (if any), scaling to obtain a speed reference or a torque reference, the signal filtering time constant.
Parameter **P053** sets the offset of the input analog signal (if **P053**=0 offset is zero), while parameter **P054** defines the filtering time constant (factory setting: **P054** = 5ms).
Type of input: for each analog input, DIP–Switch **SW1** allows setting the acquisition method of the input signal: voltage signal or current signal.
The voltage signal can be bipolar (–**10V** ÷ **+10V**) or unipolar (**0V** ÷ **+10V**).
The current signal can be bipolar (**–20mA** ÷ **+20mA**), unipolar (**0mA** ÷ **+20mA**) or can have a minimum offset (**4mA** ÷ **20mA**).
The user will set each analog input mode in parameters **P050**, **P055**, **P060**.

Table 26: Analog Input Hardware Mode

Type / Terminals	Name	Type	DIP–Switch	Parameter
Single-ended input/ 1,2	REF	±10V Input	SW1–1 off	**P050**
		0–20mA Input	SW1–1 on	
Differential input / 5,6	AIN1	±10V Input	SW1–2 off	**P055**
		0–20mA Input	SW1–2 on	
Differential input / 7,8	AIN2	±10V Input	SW1–3 off, SW1–4 5 off	**P060**
		0–20mA Input	SW1–3 on, SW1–4 5 off	
		PTC Input	SW1–3 off, SW1–4 5 on	See note

NOTE If AIN2 input is configured as PTC, refer to the MOTOR THERMAL PROTECTION MENU to select the proper parameters. Its measures are no longer valid.

NOTE Configurations different from the ones stated in the table above are not allowed.

CAUTION For each analog input (REF, AIN1, AIN2), make sure that the "mode" parameter setting (**P050**, **P055**, **P060**) matches with the setting of the relevant SW1 DIP–Switches.

Scaling is obtained by setting the parameters relating to the **linear function for the conversion** from the value read by the analog input to the corresponding speed/torque reference value.
The **conversion function** is a **straight line** passing through **2 points** in **Cartesian coordinates** having the values read by the analog input in the X-axis, and the speed/torque reference values multiplied by the reference percentage parameters in the Y-axis.

Each point is detected through its **two coordinates**.

The ordinates of the two points are the following:
the value of **Speed_Min** (or **Trq_Min** for the torque reference) multiplied by the percentage set through **P051a/P056a/P061a/P071a/P073a** for the **first point**; the value of **Speed_Max** (or **Trq_Max** for the torque reference) multiplied by the percentage set through **P052a/P057a/P062a/P072a/P074a** for the **second point**.

Speed_Min depends on the selected motor: see parameter **C028** (motor 1), **C071** (motor 2), or **C114** (motor 3).
Trq_Min depends on the selected motor: see parameter **C047** (motor 1), **C090** (motor 2) or **C133** (motor 3).

Speed_Max depends on the selected motor: see parameter **C029** (motor 1), **C072** (motor 2) or **C115** (motor 3).
Trq_Max depends on the selected motor: see parameter **C048** (motor 1), **C091** (motor 2), or **C134** (motor 3).

The X-axis values of the two points depend on the analog input:
REF Input:
Parameter **P051** is the X-axis value of the **first point;** parameter **P052** is the X-axis value of the **second point.**
AIN1 Input:
Parameter **P056** is the X-axis value of the **first point;** parameter **P057** is the X-axis value of the **second point.**
Input **AIN2**:
Parameter **P061** is the X-axis value of the **first point;** parameter **P062** is the X-axis value of the **second point.**

The figure below illustrates how parameters set computing the signals for speed (or torque) analog reference.

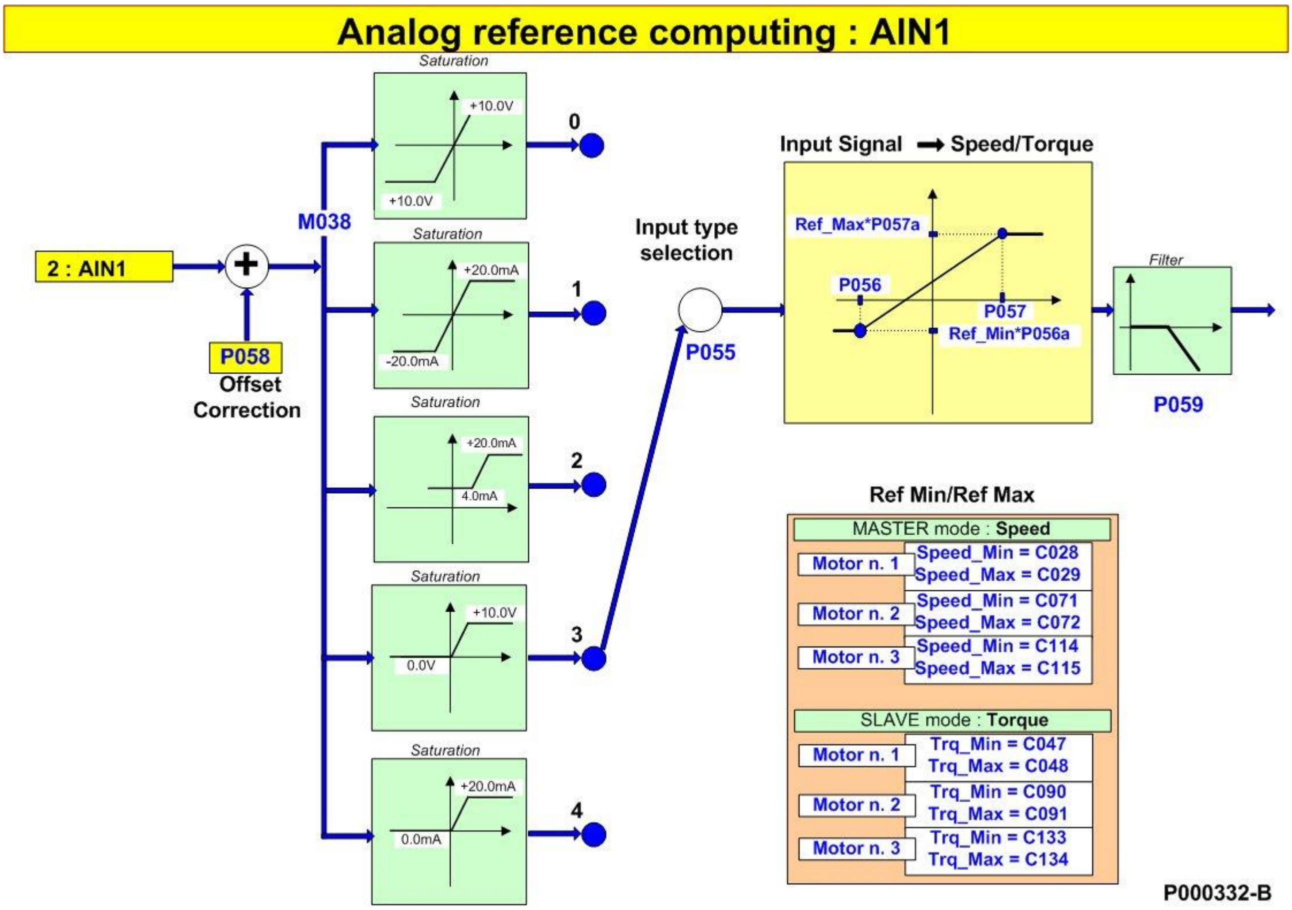


Figure 10: Computing Speed Analog Reference from terminal board: AIN1

The figures below illustrate programming examples for REF analog input, if motor 1 is selected and in MASTER mode: speed reference.

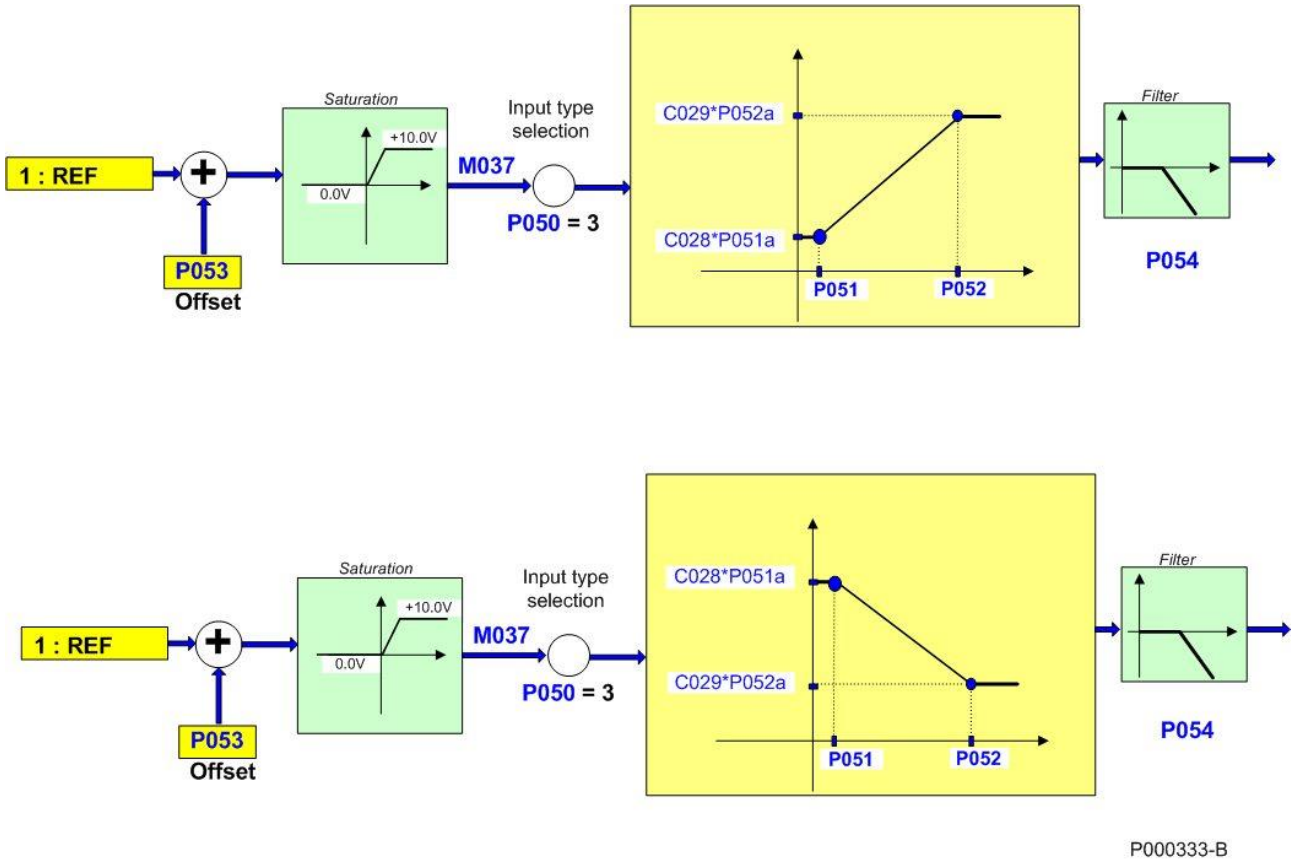


Figure 11: Computing Inputs REF (1) and (2) (examples)

The setup in the first part of the figure is as follows:
P050 = 3
P051 = 1V; **P051a** = 100%; **P052** = 10V; **P052a** = 100%
Speed_Min = **C028** = 100 rpm; **Speed_Max** = **C029** = 1100 rpm

The setup in the second part of the figure is as follows:
P050 = 3
P051 = 1V; **P051a** = 100%; **P052** = 10V; **P052a** = 100%
Speed_Min = **C028** = 1200 rpm; **Speed_Max** = **C029** = 400 rpm

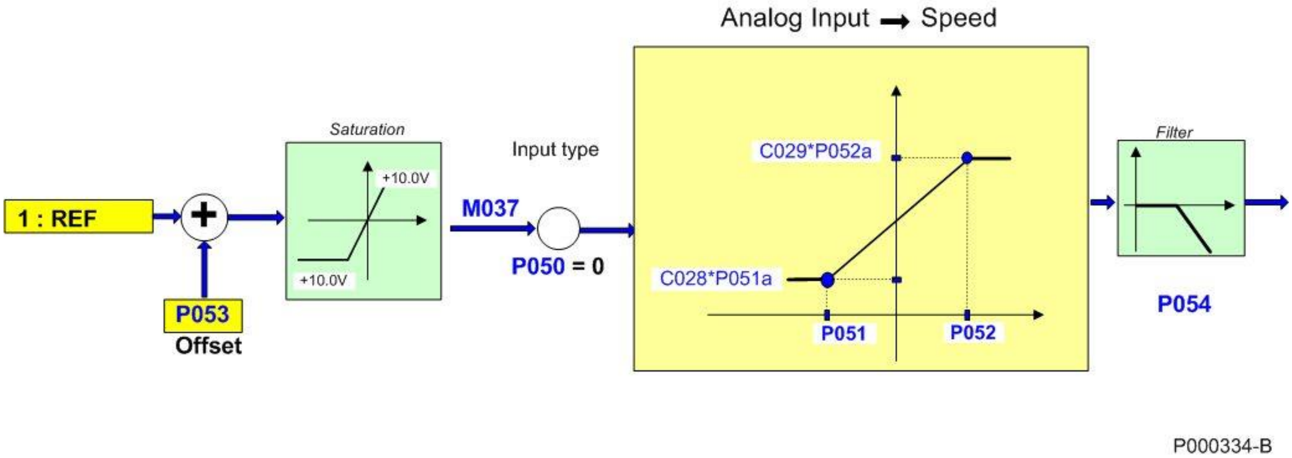


Figure 12: Computing REF Input (Example 3)

The Setup in Figure 12 is as follows:
P050 = 0
P051 = –5V; **P051a** = 100%; **P052** = +8V; **P052a** = 100%
Speed_Min = **C028** = 300 rpm; **Speed_Max** = **C029** =1450 rpm

13.3. List of Parameters P050 to P074a

Table 27: List of Parameters P050 to P074a

Parameter	FUNCTION	User Level	DEFAULT VALUE	MODBUS Address
P050	Type of signal over **REF** input	ADVANCED	3: 0÷10V	650
P051	Value of **REF** input producing min. reference (X-axis)	ADVANCED	0.0V	651
P051a	Percentage of Speed_Min/Trq_Min producing min. reference (Y-axis related to **P051**)	ADVANCED	100.0%	675
P052	Value of **REF** input producing max. reference (X-axis)	ADVANCED	10.0V	652
P052a	Percentage of Speed_Max/Trq_Max producing max. reference (Y-axis related to **P052**)	ADVANCED	100.0%	676
P053	Offset over **REF** input	ADVANCED	0V	653
P054	Filtering time over **REF** input	ADVANCED	5 ms	654
P055	Type of signal over **AIN1** input	ADVANCED	2: 4÷20mA	655
P056	Value of **AIN1** input producing min. reference (X-axis)	ADVANCED	4.0mA	656
P056a	Percentage of Speed_Min/Trq_Min producing min. reference (Y-axis related to **P056**)	ADVANCED	100.0%	677
P057	Value of **AIN1** input producing max. reference (X-axis)	ADVANCED	20.0mA	657
P057a	Percentage of Speed_Max/Trq_Max producing max. reference (Y-axis related to **P057**)	ADVANCED	100.0%	678
P058	Offset over **AIN1** input	ADVANCED	0mA	658
P059	Filtering time over **AIN1** input	ADVANCED	5 ms	659
P060	Type of signal over **AIN2** input	ADVANCED	2: 4÷20mA	660
P061	Value of **AIN2** input producing min. reference (X-axis)	ADVANCED	4.0mA	661
P061a	Percentage of Speed_Min/Trq_Min producing min. reference (Y-axis related to **P061**)	ADVANCED	100.0%	679
P062	Value of **AIN2** input producing max. reference (X-axis)	ADVANCED	20.0mA	662
P062a	Percentage of Speed_Max/Trq_Max producing max. reference (Y-axis related to **P062**)	ADVANCED	100.0%	701
P063	Offset over **AIN2** input	ADVANCED	0mA	663
P064	Filtering time over **AIN2** input	ADVANCED	5 ms	664
P065	Minimum reference and **START** disabling threshold	ADVANCED	0	665
P066	**START** disable delay at **P065** threshold	ADVANCED	0s	666
P067	Keypad and terminal board UP/DOWN ramp	ADVANCED	Quadratic	667
P068	Storage of UP/DOWN values at Power Off	ADVANCED	YES	668
P068a	Reset UP/DOWN speed/torque at Stop	ADVANCED	0:[NO]	940
P068b	Reset UP/DOWN PID at Stop	ADVANCED	0:[NO]	941
P068c	Reset UP/DOWN speed/torque at Source Changeover	ADVANCED	0:[NO]	942
P068d	Reset UP/DOWN PID at Source Changeover	ADVANCED	0:[NO]	943
P069	Range of UP/DOWN reference	ADVANCED	1: Unipolar	669
P070	Jog reference (speed/torque)	ADVANCED	0%	670
P071	Value of **FIN** producing min. reference (X-axis)	ADVANCED	10 kHz	671
P071a	Percentage of Speed_Min/Trq_Min producing min. reference (Y-axis related to **P071**)	ADVANCED	100.0%	713
P072	Value of **FIN** producing max. reference (X-axis)	ADVANCED	100 kHz	672
P072a	Percentage of Speed_Max/Trq_Max producing max. reference (Y-axis related to **P072**)	ADVANCED	100.0%	714
P073	Value of **ECH** producing min. reference (X-axis)	ADVANCED	0 rpm	673
P073a	Percentage of Speed_Min/Trq_Min producing min. reference (Y-axis related to **P073**)	ADVANCED	100.0%	702
P074	Value of **ECH** producing max. reference (X-axis)	ADVANCED	+1500 rpm	674
P074a	Percentage of Speed_Max/Trq_Max producing max. reference (Y-axis related to **P074**)	ADVANCED	100.0%	703

P050 Type of Signal over REF Input

P050	**Range**	0 ÷ 6	0: ± 10 V 1: ± 20 mA 2: 4 ÷ 20 mA 3: 0 ÷ 10 V 4: 0 ÷ 20 mA 5: ABS ± 10 V 6: ABS ± 20 mA
	Default	3	3: 0 ÷ 10 V
	Level	ADVANCED	
	Address	650	
	Function	This parameter selects the type of single–ended, analog signal over the REF terminal in the terminal board. The signal can be a voltage signal, a current signal, a unipolar signal, or a bipolar signal. **0:** ± 10 V Bipolar voltage input between –10V and +10V. The detected signal is saturated between these two values. **1**: ± 20 mA Bipolar current input between –20mA and +20mA. The detected signal is saturated between these two values. **2**: 4 ÷ 20 mA Unipolar current input with min. threshold, between +4 mA and +20mA. The detected signal is saturated between these two values. Before being saturated, if the detected signal is lower than 4 mA or greater than 20 mA, alarms **A066** or **A102** trip. **3**: 0 ÷ 10 V Unipolar voltage input between 0V and +10V. The detected signal is saturated between these two values. **4**: 0 ÷ 20 mA Unipolar current input between +0 mA and +20mA. The detected signal is saturated between these two values. **5**: ABS ± 10 V as **0:** ± 10 V, but negative voltages are considered as positive voltages. **6**: ABS ± 20 mA as **1**: ± 20 mA, but negative voltages are considered as positive voltages.	

NOTE The value set in parameter **P050** must match with the status of **SW1–1** switch allowing selecting the proper electric circuit for the analog signal processing (voltage signal or current signal).

P051 Value of REF Input Producing Min. Reference (X-axis)

P051	**Range**	–100 ÷ 100, –200 ÷ 200, +40 ÷ 200, 0 ÷ 100, 0 ÷ 200, –100 ÷ 100, –200 ÷ 200,	if **P050** = 0 if **P050** = 1 if **P050** = 2 if **P050** = 3 if **P050** = 4 if **P050** = 5 if **P050** = 6	–10.0 V ÷ 10.0 V, if –20.0 mA ÷ 20.0 mA, +4.0 mA ÷ 20.0 mA, 0.0 V ÷ 10.0 V, 0.0 mA ÷ 20.0 mA, –10.0 V ÷ 10.0 V, –20.0 mA ÷ 20.0 mA,	if **P050 =** 0: ± 10 V if **P050** = 1: ± 20 mA if **P050** = 2: 4 ÷ 20 mA if **P050** = 3: 0 ÷ 10 V if **P050** = 4: 0 ÷ 20 mA if **P050** = ABS ± 10 V if **P050** = ABS ± 20 mA
	Default	0	0 V		
	Level	ADVANCED			
	Address	651			
	Function	This parameter selects the value for REF input signal for minimum reference, or better the reference set in **C028xP051a** (Master mode) or in **C047xP051a** (Slave mode). If motor 2 is active, **C071** and **C090** will be used instead of **C028** and **C047**; if motor 3 is active, the values set in **C114** and **C133** will be used.			

P051a Percentage of Speed_Min/Trq_Min Producing Min. Reference (Y-axis related to P051)

P051a			
	Range	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	675	
	Function	This parameter represents the min. speed percentage (or the min. torque percentage for a torque reference) to be used for the minimum reference set with **P051.**	

P052 Value of REF Input Producing Max. Reference (X-axis)

P052			
	Range	–100 ÷ 100, if **P050** = 0 –200 ÷ 200, if **P050** = 1 +40 ÷ 200, if **P050** = 2 0 ÷ 100, if **P050** = 3 0 ÷ 200, if **P050** = 4 –100 ÷ 100, if **P050** = 5 –200 ÷ 200, if **P050** = 6	–10.0 V ÷ 10.0 V, if **P050 =** 0: ± 10 V –20.0 mA ÷ 20.0 mA, if **P050** = 1: ± 20 mA +4.0mA ÷ 20.0 mA, if **P050** = 2: 4 ÷ 20 mA 0.0 V ÷ 10.0V, if **P050** = 3: 0 ÷ 10 V 0.0 mA ÷ 20.0 mA, if **P050** = 4: 0 ÷ 20 mA –10.0 V ÷ 10.0 V, if **P050** = ABS ± 10 V –20.0 mA ÷ 20.0 mA, if **P050** = ABS ± 20 mA
	Default	100	10.0 V
	Level	ADVANCED	
	Address	652	
	Function	This parameter selects the value for REF input signal for maximum reference, or better the reference set in **C029xP052a** (Master mode) or in **C048xP052a** (Slave mode). If motor 2 is active, **C072** and C091 will be used instead of **C029** and **C048**; if motor 3 is active, the values set in **C115** and C1**3**4 will be used.	

P052a Percentage of Speed_Max/Trq_Max Producing Max. Reference (Y-axis related to P052)

P052a			
	Range	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	676	
	Function	This parameter represents the max. speed percentage (or the max. torque percentage for a torque reference) to be used for the maximum reference set with **P052.**	

P053 Offset over REF Input

P053			
	Range	–2000 ÷ 2000	–2.000 V ÷ +2.000 V, if **P050 =** 0,3,5 –20.00 mA ÷ +20.00 mA, if **P050** = 1,2,4,6
	Default	0	0 V
	Level	ADVANCED	
	Address	653	
	Function	This parameter selects the offset correction value of the REF analog signal that has been measured. The value set is added to the signal measured before saturation or conversion; its unit of measure is the same as the one of the signal selected for REF analog input.	

P054 Filtering Time over REF Input

P054	**Range**	0 ÷ +65000	0 ÷ +65000ms
	Default	5	5 ms
	Level	ADVANCED	
	Address	654	
	Function	This parameter selects the value of the filter time constant of the first command applied to the REF input signal when the signal saturation and conversion is over.	

P055 Type of Signal over AIN1 Input

P055	**Range**	0 ÷ 6	0: ± 10 V 1: ± 20 mA 2: 4 ÷ 20 mA 3: 0 ÷ 10 V 4: 0 ÷ 20 mA 5: ABS ± 10 V 6: ABS ± 20 mA
	Default	2	2: 4 ÷ 20 mA
	Level	ADVANCED	
	Address	655	
	Function	This parameter selects the type of differential analog signal over terminals **AIN1+** and **AIN1–** in the terminal board. The signal can be a voltage signal, a current signal, a unipolar signal, or a bipolar signal. **0:** ± 10 V Bipolar voltage input between –10V and +10V. The detected signal is saturated between these two values. **1**: ± 20 mA Bipolar current input between –20mA and +20mA. The detected signal is saturated between these two values. **2**: 4 ÷ 20 mA Unipolar current input with min. threshold, between +4 mA and +20mA. The detected signal is saturated between these two values. Before being saturated, if the detected signal is lower than 4 mA or greater than 20 mA, alarms **A067** or **A103** trip. **3**: 0 ÷ 10 V Unipolar voltage input between 0V and +10V. The detected signal is saturated between these two values. **4**: 0 ÷ 20 mA Unipolar current input between +0 mA and +20mA. The detected signal is saturated between these two values. **5**: ABS ± 10 V as **0:** ± 10 V, but negative voltages are considered as positive voltages. **6**: ABS ± 20 mA as **1**: ± 20 mA, but negative voltages are considered as positive voltages.	

NOTE The value set in parameter **P055** must match with the status of switch **SW1–2** allowing selecting the proper electric circuit for the analog signal processing (voltage signal or current signal).

P056 Value of AIN1 Input Producing Min. Reference (X-axis)

P056	**Range**	–100 ÷ 100, if **P055** = 0 –200 ÷ 200, if **P055** = 1 +40 ÷ 200, if **P055** = 2 0 ÷ 100, if **P055** = 3 0 ÷ 200, if **P055**= 4 –100 ÷ 100, if **P055** = 5 –200 ÷ 200, if **P055** = 6	–10.0 V ÷ 10.0 V, if **P055=** 0: ± 10 V –20.0 mA ÷ 20.0 mA, if **P055** = 1: ± 20 mA +4.0mA ÷ 20.0 mA, if **P055** = 2: 4 ÷ 20 mA 0.0 V ÷ 10.0V, if **P055** = 3: 0 ÷ 10 V 0.0 mA ÷ 20.0 mA, if **P055** = 4: 0 ÷ 20 mA –10.0 V ÷ 10.0 V, if **P055** = ABS ± 10 V –20.0 mA ÷ 20.0 mA, if **P055** = ABS ± 20 mA
	Default	40	+4.0mA
	Level	ADVANCED	
	Address	656	
	Function	This parameter selects the value for AIN1 input signal for minimum reference, or better the reference set in **C028xP056a** (Master mode) or in **C047xP056a** (Slave mode). If motor 2 is active, **C071** and **C090** will be used instead of **C028** and **C047**; if motor 3 is active, the values set in **C114** and **C133** will be used.	

P056a Percentage of Speed_Min/Trq_Min Producing Min. Reference (Y-axis related to P056)

P056a	**Range**	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	677	
	Function	This parameter represents the min. speed percentage (or the min. torque percentage for a torque reference) to be used for the minimum reference set with **P056.**	

P057 Value of AIN1 Input Producing Max. Reference (X-axis)

P057	**Range**	–100 ÷ 100, if **P055** = 0 –200 ÷ 200, if **P055** = 1 +40 ÷ 200, if **P055** = 2 0 ÷ 100, if **P055** = 3 0 ÷ 200, if **P055** = 4 –100 ÷ 100, if **P055** = 5 –200 ÷ 200, if **P055** = 6	–10.0 V ÷ 10.0 V, if **P055=** 0: ± 10 V –20.0 mA ÷ 20.0 mA, if **P055** = 1: ± 20 mA +4.0mA ÷ 20.0 mA, if **P055** = 2: 4 ÷ 20 mA 0.0 V ÷ 10.0V, if **P055** = 3: 0 ÷ 10 V 0.0 mA ÷ 20.0 mA, if **P055** = 4: 0 ÷ 20 mA –10.0 V ÷ 10.0 V, if **P055** = ABS ± 10 V –20.0 mA ÷ 20.0 mA, if **P055** = ABS ± 20 mA
	Default	200	+20.0mA
	Level	ADVANCED	
	Address	657	
	Function	This parameter selects the value for AIN1 input signal for maximum reference, or better the reference set in **C029xP057a** (Master mode) or in **C048xP057a** (Slave mode). If motor 2 is active, **C072** and **C091** will be used instead of **C029** and **C048**; if motor 3 is active, the values set in **C115** and **C134** will be used.	

P057a Percentage of Speed_Max/Trq_Max Producing Max. Reference (Y-axis related to P057)

P057a	**Range**	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	678	
	Function	This parameter represents the min. speed percentage (or the min. torque percentage for a torque reference) to be used for the minimum reference set with **P057.**	

P058 Offset over AIN1 Input

P058	**Range**	–2000 ÷ 2000	–2.000 V ÷ +2.000 V, if **P055 =** 0,3,5 – 20.00 mA ÷ +20.00 mA, if **P055** = 1,2,4,6
	Default	0	0 V
	Level	ADVANCED	
	Address	658	
	Function	This parameter selects the offset correction value of AIN1 analog signal that has been measured. The value set is added to the signal measured before saturation or conversion; its unit of measure is the same as the one of the signal selected for AIN1 analog input.	

P059 Filtering Time over AIN1 Input

P059	**Range**	0 ÷ +65000	0 ÷ +65000ms
	Default	5	5 ms
	Level	ADVANCED	
	Address	659	
	Function	This parameter selects the value of the filter time constant of the first command applied to AIN1 input signal when the signal saturation and conversion is over.	

P060 Type of Signal over AIN2 Input

P060	**Range**	0 ÷ 6	0: ± 10 V 1: ± 20 mA 2: 4 ÷ 20 mA 3: 0 ÷ 10 V 4: 0 ÷ 20 mA 5: ABS ± 10 V 6: ABS ± 20 mA
	Default	2	2: 4 ÷ 20 mA
	Level	ADVANCED	
	Address	660	
	Function	This parameter selects the type of differential analog signal over terminals **AIN2+** and **AIN2–** in the terminal board. The signal can be a voltage signal, a current signal, a unipolar signal, or a bipolar signal. **0:** ± 10 V Bipolar voltage input between –10V and +10V. The detected signal is saturated between these two values. **1**: ± 20 mA Bipolar current input between –20mA and +20mA. The detected signal is saturated between these two values. **2**: 4 ÷ 20 mA Unipolar current input with min. threshold, between +4 mA and +20mA. The detected signal is saturated between these two values. Before being saturated, if the detected signal is lower than 4 mA or greater than 20 mA, alarms **A068** or **A104** trip. **3**: 0 ÷ 10 V Unipolar voltage input between 0V and +10V. The detected signal is saturated between these two values. **4**: 0 ÷ 20 mA Unipolar current input between +0 mA and +20mA. The detected signal is saturated between these two values. **5**: ABS ± 10 V as **0:** ± 10 V, but negative voltages are considered as positive voltages. **6**: ABS ± 20 mA as **1**: ± 20 mA, but negative voltages are considered as positive voltages	

NOTE The value set in parameter **P060** must match with the status of switches **SW1–3, SW1-4** and **SW1-5** allowing selecting the proper electric circuit for the analog signal processing (voltage signal or current signal).

NOTE If the PTC thermal protection (**C274**) is enabled, the reference from **AIN2** is automatically managed as a 0 ÷10V input. The only parameter enabled for the control of AIN2 is **P064**; **P060, P061, P061a, P062, P062a** and **P063** cannot be viewed and are not considered for calculations.

P061 Value of AIN2 Input Producing Min. Reference (X-axis)

P061	**Range**	–100 ÷ 100, if **P060** = 0 –200 ÷ 200, if **P060** = 1 +40 ÷ 200, if **P060** = 2 0 ÷ 100, if **P060** = 3 0 ÷ 200, if **P060**= 4 –100 ÷ 100, if **P060** = 5 –200 ÷ 200, if **P060** = 6	–10.0 V ÷ 10.0 V, if **P060=** 0: ± 10 V –20.0 mA ÷ 20.0 mA, if **P060** = 1: ± 20 mA +4.0mA ÷ 20.0 mA, if **P060** = 2: 4 ÷ 20 mA 0.0 V ÷ 10.0V, if **P060** = 3: 0 ÷ 10 V 0.0 mA ÷ 20.0 mA , if **P060** = 4: 0 ÷ 20 mA –10.0 V ÷ 10.0 V, if **P060** = ABS ± 10 V –20.0 mA ÷ 20.0 mA, if **P060** = ABS ± 20 mA
	Default	40	4.0mA
	Level	ADVANCED	
	Address	661	
	Function	This parameter selects the value for AIN2 input signal for minimum reference, or better the reference set in **C028xP061a** (Master mode) or in **C047xP061a** (Slave mode). If motor 2 is active, **C071** and **C090** will be used instead of **C028** and **C047**; if motor 3 is active, the values set in **C114** and **C133** will be used.	

P061a Percentage of Speed_Min/Trq_Min Producing Min. Reference (Y-axis related to P061)

P061a	**Range**	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	679	
	Function	This parameter represents the min. speed percentage (or the min. torque percentage for a torque reference) to be used for the minimum reference set with **P061.**	

P062 Value of AIN2 Input Producing Max. Reference (X-axis)

P062	**Range**	–100 ÷ 100, if **P060** = 0 –200 ÷ 200, if **P060** = 1 +40 ÷ 200, if **P060** = 2 0 ÷ 100, if **P060** = 3 0 ÷ 200, if **P060**= 4 –100 ÷ 100, if **P060** = 5 –200 ÷ 200, if **P060** = 6	–10.0 V ÷ 10.0 V, if **P060=** 0: ± 10 V –20.0 mA ÷ 20.0 mA, if **P060** = 1: ± 20 mA +4.0mA ÷ 20.0 mA, if **P060** = 2: 4 ÷ 20 mA 0.0 V ÷ 10.0V, if **P060** = 3: 0 ÷ 10 V 0.0 mA ÷ 20.0 mA, if **P060** = 4: 0 ÷ 20 mA –10.0 V ÷ 10.0 V, if **P060** = ABS ± 10 V –20.0 mA ÷ 20.0 mA, if **P060** = ABS ± 20 mA
	Default	200	+20.0 mA
	Level	ADVANCED	
	Address	662	
	Function	This parameter selects the value for **AIN2** input signal for maximum reference, or better the reference set in **C029xP062a** (Master mode) or in **C048xP062a** (Slave mode). If motor 2 is active, **C072** and **C091** will be used instead of **C029** and **C048**; if motor 3 is active, the values set in **C115** and **C134** will be used.	

P062a Percentage of Speed Min/Trq Min Producing Max. Reference (Y-axis related to P062)

P062a	**Range**	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	701	
	Function	This parameter represents the max. speed percentage (or the min. torque percentage for a torque reference) to be used for the maximum reference set with **P062.**	

P063 Offset over AIN2 Input

P063	**Range**	–2000 ÷ 2000	–2.000 V ÷ +2.000 V, if **P060 =** 0,3,5 – 20.00 mA ÷ +20,00 mA , if **P060** = 1,2,4,6
	Default	0	0 V
	Level	ADVANCED	
	Address	663	
	Function	This parameter selects the offset correction value of AIN2 analog signal that has been measured. The value set is added to the signal measured before saturation or conversion; its unit of measure is the same as the one of the signal selected for AIN2 analog input.	

P064 Filtering Time over AIN2 Input

P064	**Range**	0 ÷ +65000	0 ÷ +65000ms
	Default	5	5 ms
	Level	ADVANCED	
	Address	664	
	Function	This parameter selects the value of the filter time constant of the first command applied to AIN2 input signal when the signal saturation and conversion is over.	

P065 Minimum Reference and START Disabling Threshold

P065	**Range**	0 ÷ +32000	0 ÷ +32000 rpm
	Default	0	0rpm
	Level	ADVANCED	
	Address	665	
	Function	If this parameter is other than zero, the current speed reference computed when processing of all active source references is over, **it is saturated as an absolute value of this parameter's value**. Saturation implies an absolute value, i.e. this parameter determines a "prohibit range" of the reference approx. zero. Example: **P065** = 100 rpm and current speed reference is 500 rpm; if reference drops below 100 rpm, for example down to +50rpm, the value of the active reference is saturated to 100 rpm until reference exceeds 100 rpm again or is lower than -100 rpm; in that case, the preset value will be assigned to the reference. If also parameter **P066** is other than zero, the **drive disabling function is enabled**: if the absolute value of the current speed reference is kept in the "prohibit range" for a time longer than the time set in **P066**, reference is set to zero and the motor speed decreases following the active ramp up to zero rpm; when the motor speed is equal to zero, the drive will automatically deactivate. With **ENABLE-A** and **ENABLE-B** inputs closed, **the drive will automatically reactivate** if the reference exceeds the value set in parameter **P065** as an absolute value.	

NOTE Parameter **P065** is active only when the speed reference is a direct speed reference not sent from PID with **C294** PID Action = 1:[Reference]).

NOTE Parameter **P065** is active only when the Speed Search and Power Down functions are disabled: **C245=0 and C225=0** or **C225=3.**

P066 START Disable delay at P065 Threshold

P066			
	Range	0 ÷ 250	0 ÷ 250 sec
	Default	0	0: Disabled
	Level	ADVANCED	
	Address	666	
	Function	If this parameter is other than zero and if also parameter **P065** is other than zero, the **drive disabling function is enabled**: if the absolute value of the current speed reference is kept in the “prohibit range” for a time longer than the time set in **P066**, reference is set to zero and the motor speed decreases following the active ramp up to zero rpm; when the motor speed is equal to zero, the drive will automatically deactivate. See also the description of parameter **P065**.	

P067 Keypad and Terminal Board UP/DOWN Ramp

P067			
	Range	0 ÷ 6501	0 sec ÷ 6500s Quadratic
	Default	6501	Quadratic
	Level	ADVANCED	
	Address	667	
	Function	Reference may be increased or decreased with input digital signals **UP** and **DOWN**, or using the ▲ and ▼ keys from the keypad (local mode). Reference increment or decrement is obtained by adding to the current reference a quantity which will be increased or decreased with a time ramp. Parameter **P067** indicates the ramp time to increase the reference from zero to the preset speed (or torque) maximum absolute value, i.e. the max. value between absolute values Spd_Min and Spd_Max (or Trq_Min and Trq_Max). If motor 1 is active, Spd_Min=**C028**, Spd_Max=**C029**, Trq_Min=**C047**, Trq_Max=**C048**.	

P068 Storage of UP/DOWN Values at Power Off

P068			
	Range	0 ÷ 1	0: Disabled, 1: Enabled
	Default	1	1: Enabled
	Level	ADVANCED	
	Address	668	
	Function	If **P068**=1, the Speed/Torque or PID references added through input digital signals **UP** and **DOWN** or with the **INC** and **DEC** keys (local mode), are stored at the drive power off and are added to the start reference when the drive is restarted. This function allows storing he reference value obtained with **UP** and **DOWN** signals.	

P068a Reset UP/DOWN Speed/Torque at Stop

P068a			
	Range	0 ÷ 1	0: NO, 1: YES
	Default	0	0: NO
	Level	ADVANCED	
	Address	940	
	Function	If **P068a** =1: [Yes], the Speed/Torque reference sent via the **UP**/**DOWN** digital signals or with the ▲ and ▼ keys in the keypad is reset whenever the START command for the drive is disabled and the deceleration ramp is finished.	

P068b Reset UP/DOWN PID at Stop

P068b			
	Range	0 ÷ 1	0: NO, 1: YES
	Default	0	0: NO
	Level	ADVANCED	
	Address	941	
	Function	If **P068b** =1: [Yes], the PID reference sent via the **UP**/**DOWN** digital signals or via the ▲ and ▼ keys in the keypad) is reset whenever the START command for the drive is disabled and the deceleration ramp is finished.	

P068c Reset UP/DOWN Speed/Torque at Source Changeover

P068c			
	Range	0 ÷ 1	0: NO, 1: YES
	Default	0	0: NO
	Level	ADVANCED	
	Address	942	
	Function	If **P068c** =1:[Yes], the Speed/Torque reference sent via the **UP/DOWN** digital signals or with the ▲ and ▼ keys in the keypad is reset whenever switching from the Remote mode to the Local mode and vice versa (using the **LOC/REM** key or the LOC/REM digital input, or when a command source switches to the other using the digital input programmed in **C179** or **C179a** - MDI for source selection, see the DIGITAL INPUTS MENU).	

P068d Reset UP/DOWN PID at Source Changeover

P068d			
	Range	0 ÷ 1	0: NO, 1: YES
	Default	0	0: NO
	Level	ADVANCED	
	Address	943	
	Function	If **P068d** =1: [Yes], the PID reference sent via the **UP/DOWN** digital signals or with the ▲ and ▼ keys in the keypad is reset whenever switching from the Remote mode to the Local mode and vice versa (using the **LOC/REM** key or the LOC/REM digital input, or when a command source switches to the other using the digital input programmed in **C179** - MDI for source selection, see the DIGITAL INPUTS MENU).	

P069 Range of UP/DOWN Reference

P069			
	Range	0 ÷ 1	0: Bipolar, 1: Unipolar
	Default	1	1: Unipolar
	Level	ADVANCED	
	Address	669	
	Function	If **P069**=1, the quantity added via the **UP/DOWN** digital signals or with the ▲ and ▼ keys (Local mode) is unipolar, i.e. it is positive only and has a min. value equal to zero. For bipolar quantities, the added quantity may be negative.	

P070 JOG reference (Speed/Torque)

P070			
	Range	± 100	± 100 %
	Default	0	0 %
	Level	ADVANCED	
	Address	670	
	Function	Value of the JOG reference. For speed control, the percentage of the jog reference relates to the maximum speed value of the selected motor (max. value as an absolute value between min. and max. speed parameters); in case of torque control, the percentage of the jog reference relates to the max. torque value of the selected motor (max. value as an absolute value between min. and max. torque limit).	

P071 Value of FIN Producing Min. Reference (X-axis)

P071			
	Range	1000 ÷ 10000	10 kHz ÷ 100 kHz
	Default	1000	10 kHz
	Level	ADVANCED	
	Address	671	
	Function	This parameter selects the value of the **frequency input** signal for minimum reference, or better the reference set in **C028xP071a** (Master mode) or in **C047xP071a** (Slave mode). If motor 2 is active, **C071** and **C090** will be used instead of **C028** and **C047**; if motor 3 is active, the values set in **C114** and **C133** will be used.	

P071a Percentage of Speed_Min/Trq_Min Producing Min. Reference (Y-axis related to P071)

P071a			
	Range	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	713	
	Function	This parameter represents the min. speed percentage (or the min. torque percentage for a torque reference) to be used for the minimum reference set with **P071.**	

P072 Value of FIN Producing Max. Reference (X-axis)

P072	**Range**	1000 ÷ 10000	10 kHz ÷ 100 kHz
	Default	10000	100 kHz
	Level	ADVANCED	
	Address	672	
	Function	This parameter selects the value of the **frequency input** signal for maximum reference, or better the reference set in **C029xP072a** (Master mode) or in **C048xP072a** (Slave mode). If motor 2 is active, **C072** and **C091** will be used instead of **C029** and **C048**; if motor 3 is active, the values set in **C115** and **C134** will be used.	

P072a Percentage of Speed_Max/Trq_Max Producing Max. Reference (Y-axis related to P072)

P072a	**Range**	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	714	
	Function	This parameter represents the max. speed percentage (or the max. torque percentage for a torque reference) to be used for the maximum reference set with **P072.**	

P073 Value of ECH Producing Min. Reference (X-axis)

P073	**Range**	–32000 ÷ 32000	± 32000 rpm
	Default	0	0 rpm
	Level	ADVANCED	
	Address	673	
	Function	This parameter selects the value of the **Encoder input** for minimum reference, or better the reference set in **C028xP073a** (Master mode) or in **C047xP073a** (Slave mode). If motor 2 is active, the values set in **C071** and **C090** will be used instead of **C028** and **C047**; if motor 3 is active, the values set in **C114** and **C133** will be used.	

P073a Percentage of Speed_Min/Trq_Min Producing Min. Reference (Y-axis related to P073)

P073a	**Range**	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	702	
	Function	This parameter represents the max. speed percentage (or the min. torque percentage for a torque reference) to be used for the maximum reference set with **P073.**	

P074 Value of ECH Producing Max. Reference (X-axis)

P074			
	Range	–32000 ÷ 32000	± 32000 rpm
	Default	+1500	+1500 rpm
	Level	ADVANCED	
	Address	674	
	Function	This parameter selects the value of the **Encoder input** for maximum reference, or better the reference set in **C029xP074a** (Master mode) or in **C048xP074a** (Slave mode). If motor 2 is active, **C072** and **C091** will be used instead of **C029** and **C048**; if motor 3 is active, the values set in **C115** and **C134** will be used.	

P074a Percentage of Speed_Max/Trq_Max Producing Max. Reference (Y-axis related to P074)

P074a			
	Range	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	703	
	Function	This parameter represents the max. speed percentage (or the max. torque percentage for a torque reference) to be used for the maximum reference set with **P074.**	

14. MULTISPEED MENU

14.1. Overview

NOTE See also the INPUTS FOR REFERENCES MENU and the DIGITAL INPUTS MENU.

The Multispeed menu allows defining the values for 15 **preset speed** (or **multispeed**) references set in parameters **P081** to **P098**. Their application method is set in **P080**.
The desired speed is selected through the digital inputs described in the previous section, relating to the **Digital Inputs Menu**.
The following reference ranges that can be programmed with the parameters above:
± 32000 rpm if multispeed unit of measure is → **P100** = 1.00 rpm
± 3200.0 rpm if multispeed unit of measure is → **P100** = 0.10 rpm
± 320.00 rpm if multispeed unit of measure is → **P100** = 0.01 rpm

Use parameters **C155**, **C156**, **C157** and **C158** to set the digital inputs in multispeed mode.
Parameter **P080** defines the functionality of the references set in the preset speed function: PRESET SPEED, SUM SPEED, EXCLUSIVE PRESET SPEED.
If **P080** = **PRESET SPEED**, the speed reference is the value set in the preset speed which is active at that moment. If digital inputs set as **multispeed** are all open (inactive), the speed reference is the reference coming from the sources selected in the **Control Method Menu** (**C143** to **C146**).
If **P080** = **EXCLUSIVE PRESET SPEED**, the speed reference is the value set in the multispeed which is active at that moment. If digital inputs set as **multispeed** are all open (inactive), no other reference source is considered; the speed reference is zero.
If **P080** = **SUM SPEED**, the speed reference value assigned to the **preset speed** which is active at that moment is summed up to the total amount of the speed references.

The reference obtained is always saturated by the parameters relating to the min. speed and the max. speed of the selected motor.

14.2. List of Parameters P080 to P100

Table 28: List of Parameters P080 to P100

Parameter	FUNCTION	User Level	DEFAULT VALUES	MODBUS Address
P080	Multispeed function	BASIC	0:Preset Speed	680
P081	Output speed Mspd1	BASIC	0.00 rpm	681
P083	Output speed Mspd2	BASIC	0.00 rpm	683
P085	Output speed Mspd3	BASIC	0.00 rpm	685
P087	Output speed Mspd4	ADVANCED	0.00 rpm	687
P088	Output speed Mspd5	ADVANCED	0.00 rpm	688
P089	Output speed Mspd6	ADVANCED	0.00 rpm	689
P090	Output speed Mspd7	ADVANCED	0.00 rpm	690
P091	Output speed Mspd8	ADVANCED	0.00 rpm	691
P092	Output speed Mspd9	ADVANCED	0.00 rpm	692
P093	Output speed Mspd10	ADVANCED	0.00 rpm	693
P094	Output speed Mspd 11	ADVANCED	0.00 rpm	694
P095	Output speed Mspd 12	ADVANCED	0.00 rpm	695
P096	Output speed Mspd 13	ADVANCED	0.00 rpm	696
P097	Output speed Mspd 14	ADVANCED	0.00 rpm	697
P098	Output speed Mspd 15	ADVANCED	0.00 rpm	698
P099	Fire Mode speed	ENGINEERING	750 rpm	699
P100	Multispeed unit of measure	ADVANCED	2: 1.0 rpm	700

P080 Multispeed Function

P080	**Range**	0 ÷ 2	0: Preset Speed, 1: Sum Speed, 2: Exclusive Preset Speed
	Default	0	0: Preset Speed
	Level	BASIC	
	Address	680	
	Function	Defines the functionality of the multispeed values for the global speed reference. Three functions are available: • 0: [Preset Speed] → the selected **multispeed** is the actual rpm value (upon limit due to min. and max. speed parameters for the selected motor) of the motor speed reference. If no **multispeed** is selected (*no digital input programmed for multispeed selection is activated, or all digital inputs programmed for multispeed selection are deactivated*), the speed reference is the reference for the sources set in the CONTROL METHOD MENU. • 1: [Sum Speed] → the reference relating to the selected multispeed is considered as the sum of the references for the other reference sources selected in the CONTROL METHOD MENU. • 2: [Exclusive Preset Speed] → the selected multispeed is the actual rpm value (upon saturation due to min. and max. speed parameters for the selected motor) of the motor speed reference. Unlike function 0 [Preset Speed], if no multispeed is selected (*no digital input programmed for multispeed selection is activated, or all digital inputs programmed for multispeed selection are deactivated*) **the speed reference is zero**.	

P081 to P098 Output Speed Mspd n.1 (/15)

P081÷P098	**Range**	–32000 ÷ 32000	±32000 rpm
	Default	0	0.00 rpm
	Level	From **P081** to **P085:** BASIC From **P087** to **P098:** ADVANCED	
	Address	681÷698	
	Function	This parameter sets the multispeed output speed selected through the relevant digital inputs (Table 101). The multispeed value is scaled based on the unit of measure set in **P100**. The reference resulting from the multispeed selected through the relevant digital inputs will be computed based on the setting of parameter **P080**.	

P099 Fire Mode Speed

P099			
	Range	–32000 ÷ 32000	±32000 rpm
	Default	750	750.00 rpm
	Level	ENGINEERING	
	Address	699	
	Function	Determines the value of the output speed in Fire Mode. The Fire Mode speed depends on the unit of measure programmed in **P100**.	

P100 Multispeed Unit of Measure

P100			
	Range	0 ÷ 2	0: [0.01 rpm] ÷ 2: [1.0 rpm]
	Default	2	2: [1.0 rpm]
	Level	ADVANCED	
	Address	700	
	Function	Determines the unit of measure considered for the 15 allowable multispeed values and the Fire Mode speed in **P099**.	

CAUTION When changing the unit of measure of the multispeed values in **P100**, the preset speed values for the multispeed and Fire Mode values will be RECOMPUTED.

15. PID MULTIREFERENCES MENU

15.1. Overview

This menu includes the parameters for the utilisation and allocation of PID Multireferences from digital inputs.
The reference sources are based on the setup in parameters **C285** to **C287** (see the PID CONFIGURATION MENU). The overall reference also depends on the multireferences that are already set (if any) or on the reduction percent of the reference itself (see the REFERENCE VARIATION PERCENT MENU).

Configuration example:

PID Configuration Menu

C285 Source of PID reference 1 = 2: AIN1
C286 Source of PID reference 2 = 0: Disable
C287 Source of PID reference 3 = 0: Disable

Digital Inputs Menu

C188a Input for PID Multireference 1 = 7: MDI7
C188b Input for PID Multireference 2 = 8: MDI8
C188c Input for PID Multireference 3 = 0: Disable

PID Multireferences Menu

P081a PID Reference 1 (Mref 1) = 1.0 bars
P082a PID Reference 2 (Mref 2) = 1.5 bars
P083a PID Reference 3 (Mref 3) = 2.5 bars

PID Parameters Menu

P257 Gain for PID scaling = 0.1

When AIN1 analog input is set to 100%, the pressure reference is 10 bars
(100%***P257** =10.0).

Supposing that AIN1 is set to 43%, the references below are obtained based on the combination of the digital inputs configured as multireferences, and based on the function allocated to parameter **P080a**.

P080a = 0: Preset Ref. If both digital inputs configured as Multireferences are not activated, the overall reference is given from AIN1 analog input selected as the first PID reference (**C285**):

P080a	Multireference Function = Preset Ref.	
MDI8	**MDI7**	**Overall reference**
0	0	4.3 bars
0	1	1.0 bars
1	0	1.5 bars
1	1	2.5 bars

P80a = 1: Sum Ref. If both digital inputs configured as Multireference are inactive, the overall reference is given from AIN1 analog input selected as the first PID reference (**C285**). For the combinations where at least one of the digital inputs configured as multireference is active, the resulting reference is the sum of the value for AIN1 plus the value for the selected multireference.

P080a	Multireference Function = Exclusive Preset Ref.	
MDI8	**MDI7**	**Overall reference**
0	0	4.3 bars
0	1	5.3 bars
1	0	5.8 bars
1	1	6.8 bars

P80a= 2: Exclusive Preset Ref. If no Multireference is activated, the overall reference is null.

P080a	**Multireference Function = 2: Exclusive Preset Ref.**	
MDI8	**MDI7**	**Overall Reference**
0	**0**	**0.0 bars**
0	**1**	**1.0 bars**
1	**0**	**1.5 bars**
1	**1**	**2.5 bars**

15.2. List of Parameters P080a to P099a

Table 29: List of Parameters P080a to P099a

Parameter	FUNCTION	User Level	DEFAULT VALUE	MODBUS Address
P080a	PID Multireference function	ENGINEERING	0	944
P081a	PID Multireference 1 (Mref1)	ENGINEERING	0	945
P082a	PID Multireference 2 (Mref2)	ENGINEERING	0	946
P083a	PID Multireference 3 (Mref3)	ENGINEERING	0	947
P084a	PID Multireference 4 (Mref4)	ENGINEERING	0	948
P085a	PID Multireference 5 (Mref5)	ENGINEERING	0	949
P086a	PID Multireference 6 (Mref6)	ENGINEERING	0	986
P087a	PID Multireference 7 (Mref7)	ENGINEERING	0	987
P099a	PID Reference in Fire Mode	ENGINEERING	50%	988

P080a Multireference

P080a	**Range**	0 ÷ 2	0: Preset Ref 1: Sum Ref 2: Exclusive Preset Ref.
	Default	0	0: [Preset Ref]
	Level	ENGINEERING	
	Address	944	
	Function	This parameter sets if the PID reference resulting from the selection of a digital multireference is to be considered either as the unique active reference or as summed up to the other configured PID reference sources (see example above).	

P081a÷P087a PID Multireference 1÷7

P081a÷P087a	**Range**	–1000 ÷ +1000	±1000
	Default	0	0
	Level	ENGINEERING	
	Address	945÷949, 986÷987	
	Function	This is the value of the PID reference selected with the corresponding combination of the digital inputs programmed as multireferences. The reference is expressed in the unit of measure set with **P267** (see the DISPLAY/KEYPAD MENU) and is based on parameter **P257** (Gain for PID Scaling). Example: The max. value for the PID feedback is 100%. This value corresponds to a level of 25m in a tank. When **P257** = 0.25, 100% of PID feedback corresponds to 25 metres. When setting a reference level of 15 meters, multireference 1 shall be set as **P081a** = 15.0 m.	

P099a PID Reference in Fire Mode

P099a	**Range**	–1000 ÷ 1000	±1000
	Default	500	50.0 %
	Level	ENGINEERING	
	Address	988	
	Function	This parameter sets the value of the PID reference when in Fire Mode. The value of the PID reference depends on the scale factor set in **P257**.	

16. MULTITORQUE MENU

16.1. Overview

NOTE The Multitorque mode described in this section is active for the **VTC** and **FOC** controls only.

NOTE Please refer to the DIGITAL INPUTS MENU in this Programming Guide.

Maximum 3 torque **limit** values may be set up via parameters **P101** to **P103**.
The torque limits may be selected via the 2 digital inputs set via parameters **C187a, C187b** (see DIGITAL INPUTS MENU).
If these inputs are both inactive, the Multitorque functionality is disabled and the torque limit is selected as follows:

- From the limit source (if any) set in **C147**;
- From the values set in **C047**, **C048** and **C049** (see LIMITS MENU).

The torque limits in the Multitorque Menu are saturated by the minimum and maximum torque limits (**C047, C048** and **C049** for motor 1) and are disabled by the input programmed in **C187** (Limit Source Disable).

The Multitorque limit values are expressed as a percentage of the rated torque and are automatically limited within the range set by the minimum and maximum torque limits (**C047, C048** and **C049** for motor 1).

16.2. List of Parameters P101 to P103

Table 30: List of Parameters P101 to P103

Parameter	FUNCTION	User Level	DEFAULT VALUE	MODBUS Address
P101	Torque Limit 1	ADVANCED	0.0%	637
P102	Torque Limit 2	ADVANCED	0.0%	638
P103	Torque Limit 3	ADVANCED	0.0%	639

P101 to P103 Torque Limit 1 (2, 3)

P080a	**Range**	–5000 ÷ 5000	±500.0%
	Default	0	0.0%
	Level	ADVANCED	
	Address	637, 638, 639	
	Control	VTC and FOC	
	Function	These parameters set a forced torque limit. The active limit value depends on the status of the digital inputs set in **C187a ÷ C187b**.	

17. PROHIBIT SPEED MENU

17.1. Overview

This menu allows setting prohibit speed ranges that the motor cannot maintain at constant rpm due to mechanical resonance.
Three prohibit speed ranges are available: 3 intermediate values of the speed range and their semi-amplitude (one for all ranges).
In this way, the speed reference value is never included in one of the preset speed ranges; when decreasing, if the speed reference matches with the max. allowable value of a prohibit speed range, the value assigned to the reference is given by the min. allowable value of the speed range, and vice versa when the reference is increasing.
The discontinuity of the speed reference has no effect on the actual speed of the connected motor, because this will vary with continuity until it reaches the new rpm value of the speed reference.
The intermediate values of the prohibit speed ranges are to be intended as absolute values (independent of the reference sign, +/-).

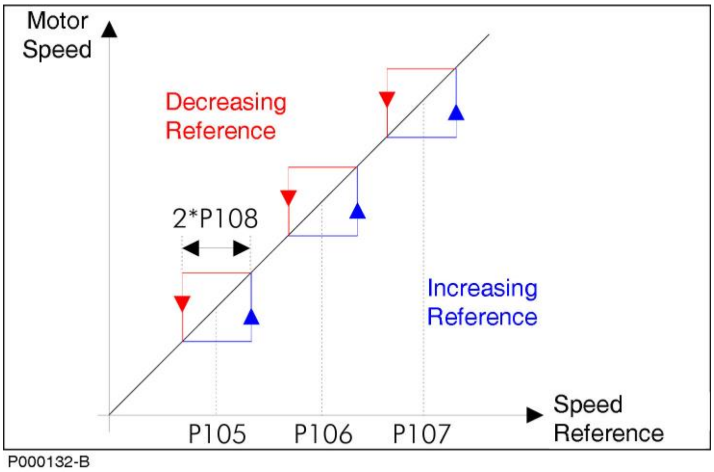


Figure 13: Prohibit Speed ranges

Figure 13 illustrates different trends of the speed reference when it matches with the max. allowable value of a prohibit speed range when decreasing (red) or when it matches with the min. allowable value of a prohibit speed range when increasing (blue).

Example:

P105 = 500 rpm Prohibit speed 1
P106 = 650 rpm Prohibit speed 2
P107 = 700 rpm Prohibit speed 3
P108 = 50 rpm Semi-amplitude of prohibit speed ranges

Range Number	Min. Allowable Value	Max. Allowable Value
1	450 rpm	550 rpm
2	600 rpm	700 rpm
3	650 rpm	750 rpm

In this case, the second and third prohibit ranges partially match, because the max. allowable value of the second range (700 rpm) is higher than the min. allowable value of the third range (650 rpm), thus forming a prohibit speed range ranging from 600 rpm to 750 rpm.

17.2. List of Parameters P105 to P108

Table 31: List of Parameters P105 to P108

Parameter	FUNCTION	User Level	MODBUS Address
P105	Prohibit speed 1	ADVANCED	705
P106	Prohibit speed 2	ADVANCED	706
P107	Prohibit speed 3	ADVANCED	707
P108	Hysteresis (band) of prohibit speed ranges	ADVANCED	708

P105 (P106, P107) Prohibit Speed 1 (2, 3)

P105			
	Range	0 ÷ 32000	0 ÷ 32000 rpm
	Default	0	0 rpm
	Level	ADVANCED	
	Address	705 706 707	
	Function	Determines the intermediate value of the first prohibit speed range. This value is to be considered as an absolute value, i.e. independent of the speed reference sign (+/-).	

P108 Hysteresis (band) of Prohibit Speed Ranges

P108			
	Range	0 ÷ 5000	0 ÷ 5000 rpm
	Default	0	0 rpm
	Level	ADVANCED	
	Address	708	
	Function	Sets the semi-amplitude of the prohibit speed ranges.	

18. REFERENCE VARIATION PERCENT MENU

18.1. Overview

The Reference Variation Percent Menu allows defining the variation values of the speed/torque or PID instant reference to be entered through digital inputs that have been properly programmed.
As per the selection of the variation percentage programmed to the reference and given by the combination of digital inputs configured with parameters **C175** ÷ **C177**, please refer to the DIGITAL INPUTS MENU.
The parameters included in this menu represent seven speed/torque or PID variation options to be applied to the speed reference.
Variation may range from **–100.0% to 100.0%** of the instant reference given by the addition of all the selected sources.

Example:

P115=	0.0%	Variation percent of reference 1
P116=	50.0%	Variation percent of reference 2
P117=	–80.0%	Variation percent of reference 3

Based on the speed/torque or PID variation selected through digital inputs, the speed reference at constant speed will be as follows:

Variation 1: the current reference with no changes (no effect).
Variation 2: the current reference increased by 50.0%.
Variation 3: the current reference decreased by 80.0%.

NOTE Whatever the speed/torque reference value resulting from the application of a speed variation, the value used to control the motor is saturated at max. and min. speed/torque values set in the parameters relating to the selected motor.

Speed control (example):

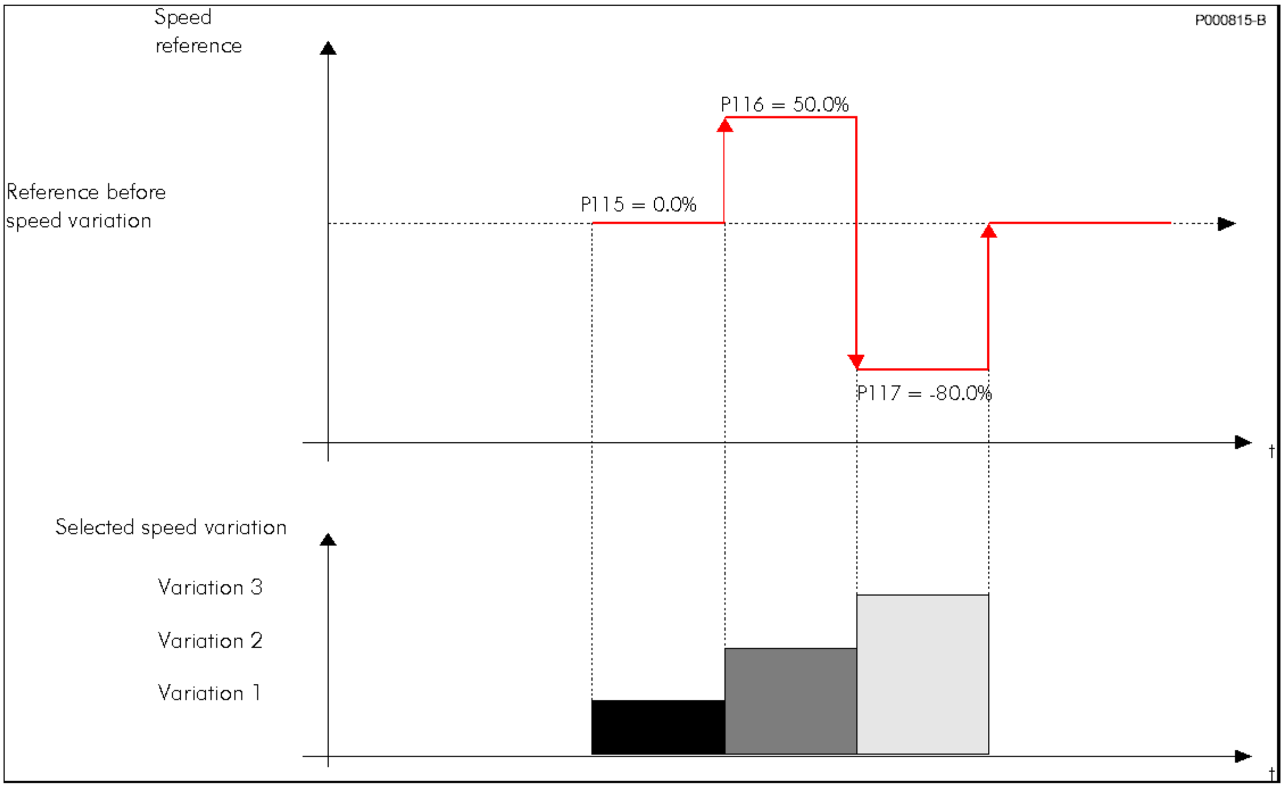


Figure 14: Speed Control (example)

18.2. List of Parameters P115 to P121

Table 32: List of Parameters P115 to P121

Parameter	FUNCTION	User Level	Default Values	MODBUS Address
P115	Reference variation percent n.1	ENGINEERING	0.0%	715
P116	Reference variation percent n.2	ENGINEERING	0.0%	716
P117	Reference variation percent n.3	ENGINEERING	0.0%	717
P118	Reference variation percent n.4	ENGINEERING	0.0%	718
P119	Reference variation percent n.5	ENGINEERING	0.0%	719
P120	Reference variation percent n.6	ENGINEERING	0.0%	720
P121	Reference variation percent n.7	ENGINEERING	0.0%	721

P115 (÷ P121) Reference Variation Percent n.1 (÷n.7)

P115 (÷ P121)			
	Range	±1000	±100.0%
	Default	0	0.0%
	Level	ENGINEERING	
	Address	715 (÷721)	
	Function	These parameters define the variation percent of the current reference (**M000** for speed control, **M007** for torque control, **M018** if PID control is activated) to be considered as a ramp reference when selecting variation percent 1 (÷7).	

19. SPEED LOOP AND CURRENT BALANCING MENU

19.1. Overview

The SPEED LOOP AND CURRENT BALANCING MENU, for VTC and FOC controls, allows setting the parameter values of the speed regulators for the three connected motors and to manually adjust the motor current balancing (see parameter **P152**).
The speed regulator for each motor has two parameterization functions: two integral terms and two proportional terms.

As per factory settings, only parameters **P126** (Maximum Integral Time) and **P128** (Minimum Integral Time) are used.

Adopting the remaining two parameters **P125** (Minimum Integral Time) and **P129** (Maximum Proportional Constant) is based on two possible control logics:

- Status of the digital input set in **C169a** (FOC control only);
- Logics based on the adjustment error.

Status of the digital input set in **C169a**: if the input is low, parameters **P126/P128** will be active; otherwise (high logic level) parameters **P125/P129** will be active.

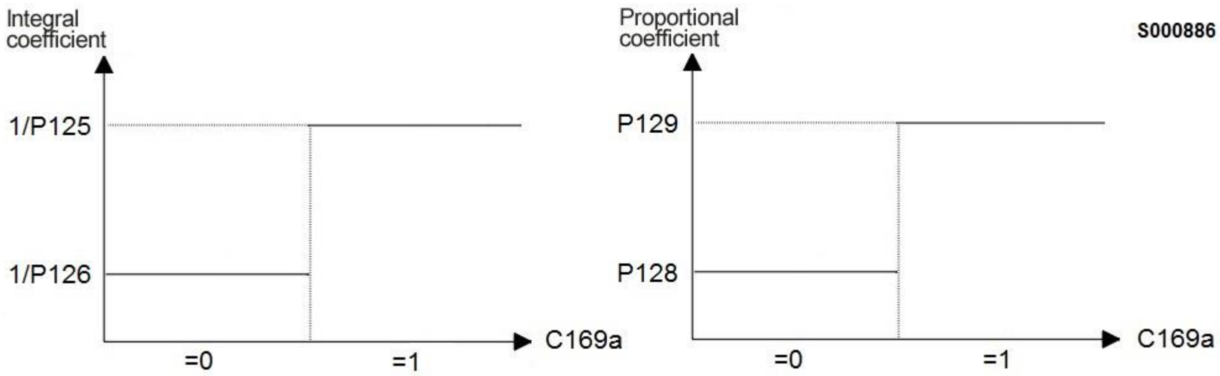


Figure 15: Example of dual parameterization activated by a digital input

Logic based on adjustment error: This second logic enables a regulator's response dynamically related to the speed error; in that way, the speed regulator will be more reactive to big errors and less sensitive to small errors. To activate this control logics, speed error thresholds **P130** and **P131** (expressed as a percentage of the rated speed) are to be set to different values.

The response of the speed regulator can be dynamically linked with the speed error; in this way, the speed regulator will be more sensitive to remarkable speed errors and less sensitive to negligible speed errors.
Factory setting: because two identical error thresholds are set, only two parameters are used: **P126** (maximum integral time) and **P128** (minimum proportional constant).
The setup of min. integral time and max. proportional constant is enabled provided that two different error thresholds are used.

Example:

P125	100	[ms]	Minimum integral time
P126	500	[ms]	Maximum integral time
P128	10.00		Minimum proportional constant
P129	25.00		Maximum proportional constant
P130	2	[%]	Minimum error threshold
P131	20	[%]	Maximum error threshold

Error ≤ **P130**
For speed errors lower than or equal to 2% of the motor rated speed, the speed regulator adopts parameters **P126** and **P128**.

Error ≥ **P131**
If the speed error is higher than or equal to 20% of the rated motor speed, the speed regulator adopts parameters **P125** and **P129**.

P130<Error<**P131**

When the speed error is included between the two error thresholds, the speed regulator will use coefficients that are dynamically linked with the speed error (see figure below).

Integral coefficient	= (1/**P126**) + [(err%–**P130**)* (1/**P125** – 1/**P126**) / (**P131** – **P130**)]
Proportional coefficient	= **P128** + [(err%–**P130**)* (**P129** – **P128**) / (**P131** – **P130**)]

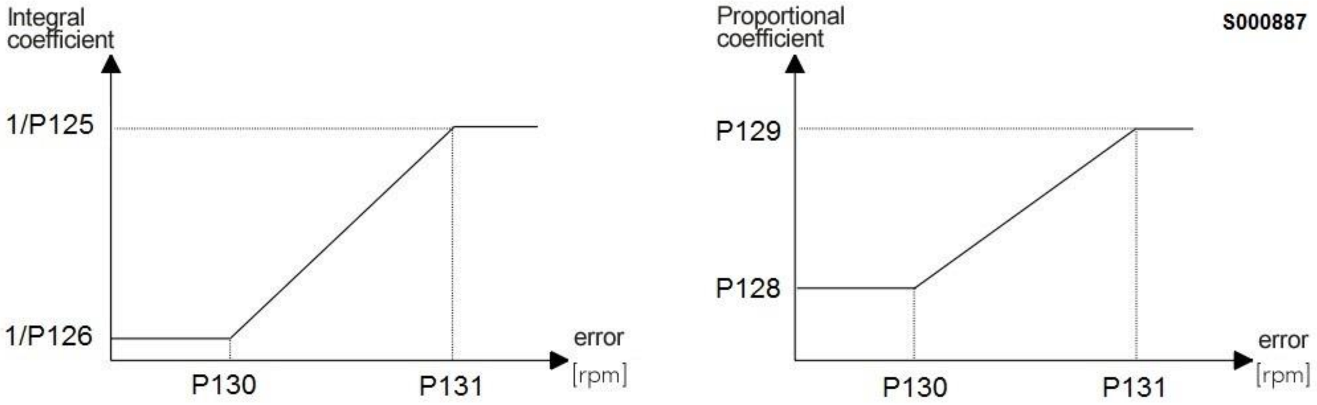


Figure 16: Error threshold Dual Parameterization function (example)

19.2. List of Parameters P125 to P153

Table 33: List of Parameters P125 to P153

44.4Parameter		FUNCTION	User Level	MODBUS Address	Default Values
P125	**M1**	Minimum Integral Time	BASIC	725	500 ms
P135	**M2**		ENGINEERING	735	
P145	**M3**			745	
P126	**M1**	Maximum Integral Time	BASIC	726	500 ms
P136	**M2**		ENGINEERING	736	
P146	**M3**			746	
P128	**M1**	Minimum Proportional Coefficient	BASIC	728	10.00
P138	**M2**		ENGINEERING	738	
P148	**M3**			748	
P129	**M1**	Maximum Proportional Coefficient	BASIC	729	10.00
P139	**M2**		ENGINEERING	739	
P149	**M3**			749	
P130	**M1**	Minimum Error Threshold	BASIC	730	1.00%
P140	**M2**		ENGINEERING	740	
P150	**M3**			750	
P131	**M1**	Maximum Error Threshold	BASIC	731	1.00%
P141	**M2**		ENGINEERING	741	
P151	**M3**			751	
P152		Symmetry Regulation of Three-Phase Current	ENGINEERING	752	0 %
P153		VTC Speed Error Filter Time Constant	ENGINEERING	753	10 ms

P125 (P135, P145) Minimum Integral Time

P125 (Motor n.1) **P135 (Motor n.2)** **P145 (Motor n.3)**	**Range**	1÷ 32000	0.001÷ 32.000 [Disable] ms
	Default	500	500 ms
	Level	BASIC (**P125**); ENGINEERING (**P135**, **P145**)	
	Address	725, 735, 745	
	Control	VTC and FOC	
	Function	This parameter sets the min. integral time for the speed regulator. It may be accessed if the min. and max. error thresholds are different (**P130≠P131** for Motor1, **P140≠P141** for Motor2, **P150≠P151** for Motor3), or if the switch digital input **C169a** (FOC mode only) is activated.	

P126 (P136, P146) Maximum Integral Time

P126 (Motor n.1) **P136 (Motor n.2)** **P146 (Motor n.3)**	**Range**	1÷ 32000	0.001÷ 32.000 [Disable] ms
	Default	500	500 ms
	Level	BASIC (**P126**); ENGINEERING (**P136**, **P146**)	
	Address	726, 736, 746	
	Control	VTC and FOC	
	Function	This parameter sets the max. integral time for the speed regulator. If the min. and max. error thresholds are set the same values (**P130**=**P131** for Mot1, **P140**=**P141** for Mot2, **P150**=**P151** for Mot3), or the switch digital input set to **C169a** (FOC only) has a low logic value, this parameter is the integral time of the speed regulator.	

P128 (P138, P148) Minimum Proportional Coefficient

P128 (Motor n.1) P138 (Motor n.2) P148 (Motor n.3)	Range	0 ÷ 65000	0.00 ÷ 650.00
	Default	1000	10.00
	Level	BASIC (**P128**); ENGINEERING (**P138**, **P148**)	
	Address	728,738,748	
	Control	VTC and FOC	
	Function	This parameter sets the min. proportional coefficient for the speed regulator. If the minimum and maximum error thresholds are set the same value (**P130**=**P131** for Mot1, **P140**=**P141** for Mot2, **P150**=**P151** for Mot3), or the switch digital input set in **C169a** (FOC mode only) has a low logic value, this parameter represents the proportional coefficient of the speed regulator. Default value (10): if a speed error of 1% occurs, the regulator will require 10% of the rated motor torque.	

P129 (P139, P149) Maximum Proportional Coefficient

P129 (Motor n.1) P139 (Motor n.2) P149 (Motor n.3)	Range	0 ÷ 65000	0.00 ÷ 650.00
	Default	1000	10.00
	Level	BASIC (**P129**); ENGINEERING (**P139**, **P149**)	
	Address	729,739,749	
	Control	VTC and FOC	
	Function	This parameter sets the max. proportional coefficient for the speed regulator. Default value (10): if a speed error of 1% occurs, the regulator will require 10% of the rated motor torque. This parameter may be accessed if the min. and max. error thresholds are different (**P130** ≠ **P131** for Motor1, **P140** ≠ **P141** for Motor2, **P150** ≠ **P151** for Motor3), or if the switch digital input **C169a** (FOC mode only) is activated**.**	

P130 (P140, P150) Min. Error Threshold

P130 (Motor n.1) P140 (Motor n.2) P150 (Motor n.3)	Range	0 ÷ 32000	0.00 ÷ 320.00
	Default	100	1.00%
	Level	BASIC (**P130**); ENGINEERING (**P140**, **P150**)	
	Address	730,740,750	
	Control	VTC and FOC	
	Function	This parameter determines the min. error threshold expressed as a percentage of the rated motor speed. When the switch logics based on **C169a** is disabled, if the speed error is lower than or equal to the min. threshold, parameters **P126** and **P128** will be used.	

P131 (P141, P151) Max. Error Threshold

P131 (Motor n.1) **P141 (Motor n.2)** **P151 (Motor n.3)**	**Range**	0 ÷ 32000	0.00 ÷ 320.00
	Default	100	1.00%
	Level	BASIC (**P131**); ENGINEERING (**P141**, **P151**)	
	Address	731,741,751	
	Control	VTC and FOC	
	Function	This parameter sets the max. error threshold expressed as a percentage of the rated motor speed. When the switch logics based on **C169a** is disabled, if the speed error is lower than or equal to the max. threshold, parameters **P125** and **P129** will be used.	

P152 Symmetry Regulation of Three-phase Current

P152	**Range**	± 100	± 100%
	Default	0	0%
	Level	ENGINEERING	
	Address	752	
	Function	This parameter affects three-phase current balancing. It must be used when dissymmetry of the motor currents occurs, especially when no-load currents are delivered and the motor rotates at low rpm.	

P153 VTC Speed Error Filter Time Constant

P153	**Range**	0 ÷ 32000	0 ÷ 32000 ms
	Default	10	10 ms
	Level	ENGINEERING	
	Address	753	
	Control	VTC	
	Function	Input speed error filter time constant, in speed loop of VTC control.	

20. FOC REGULATORS MENU

20.1. Overview

NOTE Please refer to the MOTOR CONFIGURATION MENU as well.

NOTE This menu may be accessed only if the FOC control is programmed for one of the connected motors (**C010**=2 for motor n.1, **C053**=2 for motor n.2, **C096**=2 for motor n.3).

The FOC control has the same basic structure as that of any classic field oriented control.
The inner loops of FOC control are **two PI current regulators** having the same parameterization.
The first regulator controls **Iq torque current**; the second regulator controls **Id flux current**.
Iq Torque current is computed based on the required torque set-point.
In **Slave mode** (torque reference), the required set–point comes from the external reference; in **Master mode,** the torque set–point is given by the output of the **speed regulator** (see the SPEED LOOP AND CURRENT BALANCING MENU) for the regulation of the motor speed of rotation.
Id Flux current results from the output of the **flux regulator**, ensuring that the connected motor is always properly fluxed.
This menu allows accessing the current PI regulators and flux regulators for the FOC control.

20.2. List of Parameters P155 to P173

Table 34: List of Parameters P155 to P173

Parameter		FUNCTION	User Level	Default Values	MODBUS Address
P155	**M1**	Current Regulator Proportional Constant	ENGINEERING	3.00	755
P162	**M2**				762
P169	**M3**				769
P156	**M1**	Current Regulator Integral Time	ENGINEERING	20.0 ms	756
P163	**M2**				763
P170	**M3**				770
P158	**M1**	Flux Regulator Proportional Constant	ENGINEERING	0.00	758
P165	**M2**				765
P172	**M3**				772
P159	**M1**	Flux Regulator Integral Time	ENGINEERING	33 ms	759
P166	**M2**				766
P173	**M3**				773

P155 (P162, P169) Current Regulator Proportional Constant

P155 (Motor n.1) **P162 (Motor n.2)** **P169 (Motor n.3)**	**Range**	0 ÷ 65000	0.00 ÷ 650.00
	Default	300	3.00
	Level	ENGINEERING	
	Address	755 762 769	
	Control	FOC	
	Function	**Kp** Proportional coefficient of **PI** current regulator Id and Iq in field rotary reference for motor n.1 (**P162** and **P169** relate to motors 2 and 3). The regulator's structure is as follows: error = Set_Point – Measure; integral_status = integral_status + error ***Ki*****Ts**; Output = **Kp***error + integral_status; where Kp is the proportional coefficient **Ki** is the integral coefficient = 1/Ti , where Ti is the integral time **Ts** is the regulator operating time (ranging from 200 to 400 microseconds based on carrier frequency).	

NOTE This parameter is **automatically computed and saved** when the Autotune procedure is performed (see the AUTOTUNE MENU).

P156 (P163, P170) Current Regulator Integral Time

P156 (Motor n.1) **P163 (Motor n.2)** **P170 (Motor n.3)**	**Range**	1 ÷ 32000	1.0 ÷ 32000. (Disabled)
	Default	200	20.0 ms
	Level	ENGINEERING	
	Address	756 763 (motor n.2) 770 (motor n.3)	
	Control	FOC	
	Function	**Ti** Integral time of **PI** current regulator Id and Iq in the field rotary reference for motor n.1 (**P166** and **P170** relate to motors 2 and 3). The regulator's structure is as follows: error = *Set_Point – Measure*; *integral_status = integral_status + error* ***Ki*****Ts**; *Output* = **Kp***error + integral_status*; where Kp is the proportional coefficient **Ki** is the integral coefficient = 1/Ti , where Ti is the integral time **Ts** is the regulator operating time (ranging from 200 to 400 microseconds based on carrier frequency).	

NOTE This parameter is **automatically computed and saved** when the Autotune procedure is performed (see the AUTOTUNE MENU).

P158 (P165, P172) Flux Regulator Proportional Constant

P158 (Motor n.1) **P165 (Motor n.2)** **P172 (Motor n.3)**	**Range**	0 ÷ 65000	0.00 ÷ 650.00
	Default	0	0.00
	Level	ENGINEERING	
	Address	758 765 772	
	Control	FOC	
	Function	**Kp** Proportional coefficient of **PI** flux regulator for motor n.1 (**P165** and **P172** relate to motors 2 and 3). The regulator's structure is as follows: error = *Set_Point – Measure*; *integral_status* = *integral_status* + *error* ***Ki*****Ts**; *Output* = **Kp****error* + *integral_status*; where Kp is the proportional coefficient **Ki** is the integral coefficient = 1/Ti , where Ti is the integral time **Ts** is the regulator operating time (ranging from 200 to 400 microseconds based on carrier frequency).	

P159 (P166, P173) Flux Regulator Integral Time

P159 (Motor n.1) **P166 (Motor n.2)** **P173 (Motor n.3)**	**Range**	1 ÷ 32000	1.0 ÷ 32000. (Disabled)
	Default	33	33 ms
	Level	ENGINEERING	
	Address	759 766 773	
	Control	FOC	
	Function	**Ti** Integral time of flux regulator **PI** for motor n.1 (**P166** and **P173** relate to parameters 2 and 3). The regulator's structure is as follows: error = *Set_Point – Measure*; *integral_status* = *integral_status* + *error* ***Ki*****Ts**; *Output* = **Kp****error* + *integral_status*; where Kp is the proportional coefficient **Ki** is the integral coefficient = 1/Ti , where Ti is the integral time **Ts** is the regulator operating time (ranging from 200 to 400 microseconds based on carrier frequency).	

NOTE Parameters P159-P166-P173 are **automatically recomputed and saved** whenever the Rotor Time Constant parameter (**C025**) is changed.

21. VTC REGULATORS MENU

21.1. Overview

NOTE A comprehensive review of the MOTOR CONFIGURATION MENU and the FIRST STARTUP section is recommended.

NOTE The VTC Regulators menu may be accessed only if the VTC Control is set up for one of the connected motors (**C010**=1 for motor N.1, **C053**=1 for motor N.2, **C096**=1 for motor N.3).

The sensorless VTC control algorithm is based on the same principles as the FOC algorithm, but instead of using the speed value read from the encoder, it exploits an estimated value of that speed value. Estimation is made possible via a dedicated status observer.
As is the case of the FOC algorithm, **two PI current regulators** are available.
The first regulator adjusts the **torque current (Iq)**, whilst the second regulator adjusts the **flux current (Id)**.
Torque current Iq is computed based on the torque setpoint required.
In **Slave Mode** (torque reference), the torque setpoint is required by the external reference; in **Master Mode**, the set–point is given by the **speed regulator** (see SPEED LOOP AND CURRENT BALANCING MENU) that adjusts the motor speed of rotation.
Flux current Id is given by the output of the **flux regulator**, that keeps the motor fluxing correct.
The VTC Regulators menu includes the parameters of the current PI regulators and flux regulators for the VTC Control.

21.2. List of Parameters P175h1 to P175w

Table 35: List of Parameters P175a1 to P175w

Parameter		FUNCTION	User Level	DEFAULT VALUE	MODBUS Address
P175h1	**M1**	Low-Frequency Flux Increment Percentage	ENGINEERING	0.0%	684
P175h2	**M2**				1000
P175h3	**M3**				1005
P175i1	**M1**	Minimum Frequency for Flux Increment	ENGINEERING	15.0%	733
P175i2	**M2**				1006
P175i3	**M3**				1007
P175j1	**M1**	Maximum Frequency for Flux Increment	ENGINEERING	30.0%	734
P175j2	**M2**				1027
P175j3	**M3**				1049
P175t1	**M1**	Proportional Gain of Current Controller	ENGINEERING	500.0	640
P175t2	**M2**				641
P175t3	**M3**				767
P175u1	**M1**	Integral Time of Current Controller	ENGINEERING	50 ms	709
P175u2	**M2**				732
P175u3	**M3**				768
P175a		Current Distortion Threshold	ENGINEERING	5.00%	831
P175b		Current Distortion Compensation	ENGINEERING	80.00%	833
P175c		Current Distortion Compensation Allocation	ENGINEERING	50.00%	834
P175k		Extra-flux Percentage	ENGINEERING	110.0%	727
P175l		Minimum Flux Percentage	ENGINEERING	10.0%	742
P175o		Filter Time Constant of Flux Rate Limiter	ENGINEERING	300 ms	737
P175w		Type of Control at Stop with Start Open	ENGINEERING	Speed	611

P175h1 (P175h2, P175h3) Low-Frequency Flux Increment Percentage for Motor 1 (2,3)

P175h1 (Mot1) P175h2 (Mot2) P175h3 (Mot3)	**Range**	0 ÷ 1000	0.0 ÷ 100.0 %
	Default	0	0.0 %
	Level	ENGINEERING	
	Address	684, 1000, 1005	
	Control	VTC	
	Function	Percentage of the flux increment at low frequency. Indicates the increment percentage of the motor flux, in respect of its nominal value, adopted up to the frequency value displayed in **P175i1**. The flux increment is dropped to 0 linearly with the frequency (flux equal to the nominal value) at the frequency value displayed in **P175j1**.	

P175i1 (P175i2, P175i3) Minimum Frequency for Motor 1 (2,3) Flux Increment

P175i1 (Mot1) P175i2 (Mot2) P175i3 (Mot3)	**Range**	0 ÷ 1000	0.0 ÷ 100.0 %
	Default	150	15.0 %
	Level	ENGINEERING	
	Address	733, 1006, 1007	
	Control	VTC	
	Function	Minimum frequency of the interpolation for the flux increment at low frequency. Indicates the frequency (as a percentage of the rated frequency **C015/C058/C101**) up to which a flux increment equal to the value set in parameter **P175h1** is adopted. See the description for **P175h1**.	

P175j1 (P175j2, P175j3) Maximum Frequency for Motor 1 (2,3) Flux Increment

P175j1 (Mot1) P175j2 (Mot2) P175j3 (Mot3)	**Range**	0 ÷ 1000	0.0 ÷ 100.0 %
	Default	300	30.0 %
	Level	ENGINEERING	
	Address	734, 1027, 1049	
	Control	VTC	
	Function	Maximum frequency of the interpolation for the flux increment at low frequency. Indicates the frequency (as a percentage of the rated frequency **C015/C058/C101**) from which the nominal value of the flux is adopted. See the description for **P175h1**.	

P175t1 (P175t2, P175t3) Proportional Gain of Motor 1 (2,3) Current Controller

P175t1 (Mot1) P175t2 (Mot2) P175t3 (Mot3)	**Range**	0 ÷ 32000	0.000 ÷ 3200.0
	Default	500	500.0
	Level	ENGINEERING	
	Address	640, 641, 767	
	Control	VTC	
	Function	Proportional gain of the torque and flux current control (d and q axis).	

P175u1 (P175u2, P175u3) Integral Time of Motor 1 (2,3) Current Controller

P175u1 (Mot1) **P175u2 (Mot2)** **P175u3 (Mot3)**	**Range**	1 ÷ 32000	1 ÷ 32000 ms [Disabled]
	Default	50	50 ms
	Level	ENGINEERING	
	Address	709, 732, 768	
	Control	VTC	
	Function	Integral time constant of the torque and flux current control (d and q axis).	

NOTE Parameters **P175t1**, **P175u1** are automatically computed and saved by performing the autotune procedure **I074 = [1: Control NO rot]** or **I074 = [2: Control YES rot]**.

P175a Current Distortion Threshold

P175a	**Range**	1 ÷ 10000	0.01 ÷ 100.00 %
	Default	500	5.00 %
	Level	ENGINEERING	
	Address	831	
	Control	VTC	
	Function	Current threshold for the compensation of positive and negative current distortion. The positive current compensation equal to **P175b** x **P175c** is applied to positive current values exceeding the rated drive current multiplied by the threshold set in **P175a**. The negative current compensation **P175b** x (100% - **P175c)** is applied to negative current values having absolute values greater than the rated drive current multiplied by **P175a**. When lower currents than the threshold currents are applied, compensation is obtained via linear pattern. Null current means null compensation. For tuning criteria, please refer to the FIRST STARTUP section.	

P175b Current Distortion Compensation

P175b	**Range**	-30000 ÷ 30000	-300.00 ÷ 300.00 %
	Default	8000	80.00 %
	Level	ENGINEERING	
	Address	833	
	Control	VTC	
	Function	Compensation to suppress current distortion due to dead times. That compensation activates when the positive current is greater than **P175a** (in respect to the rated drive current). See parameter **P175a** for a detailed description. For tuning criteria, please refer to the FIRST STARTUP section.	

P175c Current Distortion Compensation Allocation

P175c	**Range**	0 ÷ 10000	0 ÷ 100.00 %
	Default	5000	50.00 %
	Level	ENGINEERING	
	Address	834	
	Control	VTC	
	Function	Allocation of the compensation to suppress current distortion due to dead times between positive and negative current. See parameter **P175a** for a detailed description. For tuning criteria, please refer to the FIRST STARTUP section	

P175k Extra-flux Percentage

P175k			
	Range	1000 ÷ 1500	100.0 ÷ 150.0 %
	Default	1100	110.0 %
	Level	ENGINEERING	
	Address	727	
	Control	VTC	
	Function	Extra-flux percentage, in respect to the nominal flux, used when decelerating to increase the motor resistor losses and to dissipate the incoming energy produced by the motor in order to limit the DC bus voltage.	

P175l Minimum Flux

P175l			
	Range	0 ÷ 1000	0.0 ÷ 100.0 %
	Default	100	10.0 %
	Level	ENGINEERING	
	Address	742	
	Control	VTC	
	Function	Minimum reference flux expressed as a percentage with respect of the nominal flux.	

P175o Filter Time Constant of Flux Rate Limiter

P175o			
	Range	1 ÷ 32000	1 ÷ 32000 ms
	Default	300	300 ms
	Level	ENGINEERING	
	Address	737	
	Control	VTC	
	Function	Time constant of the filter adopted in the fluxing rate limiter.	

P175w Type of Control at Stop with START Open

P175w			
	Range	0 ÷ 1	0: Speed 1: Fluxing only
	Default	0	0: Speed
	Level	ENGINEERING	
	Address	611	
	Control	VTC	
	Function	Selects the type of control when the motor is stopped and the START input is open. The speed control is disabled if this parameter is set to 1: [Fluxing only] when the START input is open and the motor is stopped.	

22. ANALOG AND FREQUENCY OUTPUTS MENU

22.1. Overview

NOTE Please refer to the Sinus Penta's Installation Guide for the hardware description of the analog output and the frequency output or for the configuration of the DIP-switches for voltage/current outputs.

NOTE MDO1 digital output is used when the frequency output is enabled (**P200** other than Disabled). Any configuration set in the DIGITAL OUTPUTS MENU will have no effect.

The Sinus Penta drive allows configuring three programmable analog outputs as voltage outputs or current outputs, as well as one frequency output.

22.1.1. Factory-setting of the Analog Outputs

Analog outputs are factory set to voltage values ranging from ± 10V and the following variables are selected:

TERMINALS	OUTPUTS	SELECTED VARIABLE	OUTPUT RANGE	MIN. VALUE	MAX. VALUE
10	AO1	Speed (speed of the connected motor)	±10V	-1500	1500
11	AO2	Speed Ref. (speed reference at constant rpm)	±10V	-1500	1500
12	AO3	Current of the connected motor	±10V	0	Imax *

* Depending on the inverter model.

22.1.2. Analog Outputs

As per the analog outputs, the ANALOG AND FREQUENCY OUTPUTS MENU allows selecting the variable to be represented, its range, its acquisition mode (± or as an absolute value), the type of analog output (voltage/current) and the output values corresponding to the min. value and the max. value of the selected variable. An offset value and a filtering function may also be applied to the analog outputs. For the frequency output, this menu contains the parameters for the selection of the represented variable, its acquisition mode (± or as an absolute value), its min. value and max. value and the corresponding output frequency value, and a filtering function. The figure below shows the typical structure of the analog outputs; in particular, AO1analog output and its parameter set are illustrated.

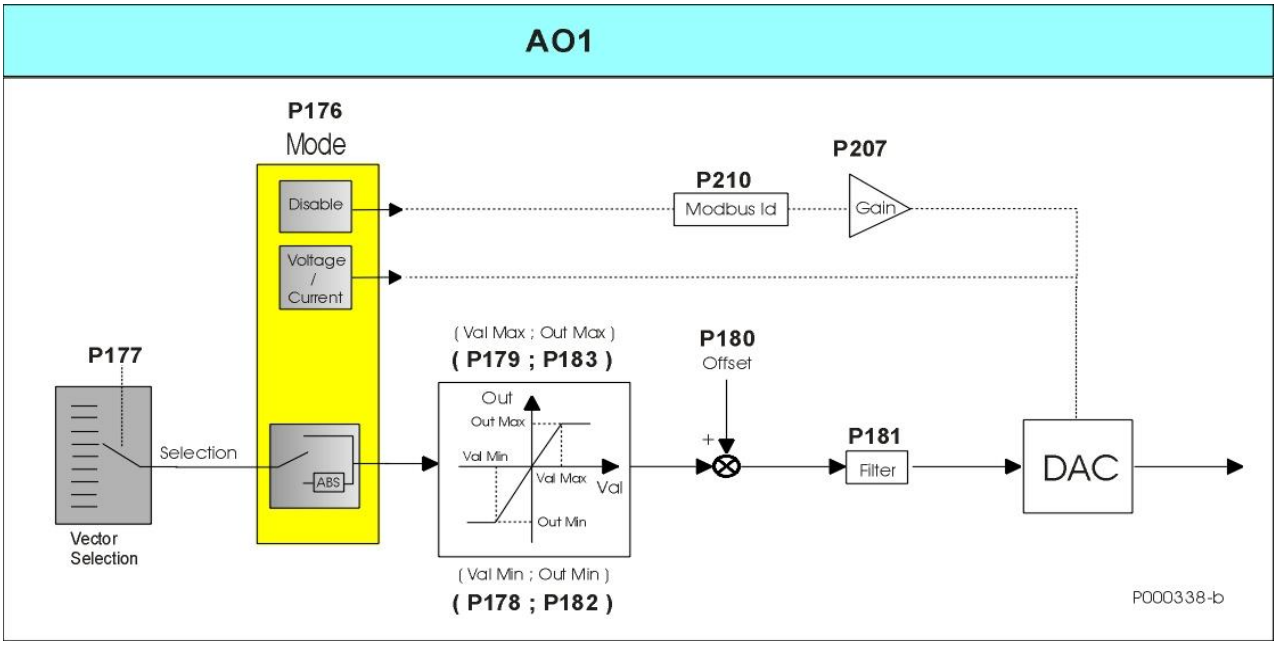


Figure 17: Typical structure of the Analog Outputs

- **Vector Selection** Selects the variable to be represented through the digital analog converter (DAC). **P177** is the selection parameter for AO1analog output and **P185** and **P193** for AO2 and AO3 respectively.
- **Mode** Sets the acquisition mode of the selected variable (± or as an absolute value) and the type (voltage/current) for the analog output. If Mode = **Disable**, a different operating mode is activated for the analog output for which the represented variable is determined by the MODBUS address set in Address and the gain value set in Gain is applied:
  P176 (Mode), **P207** (Gain), **P210** (Address) for AO1;
  P184 (Mode), **P208** (Gain), **P211** (Address) for AO2;
  P192 (Mode), **P209** (Gain), **P212** (Address) for AO3.

- **(Val Min; Out Min)** Defines the minimum saturation value of the variable to be represented and the corresponding value to be assigned to the analog output. For values equal to or lower than Val Min, Out Min will be assigned to the selected analog output. For analog outputs AO1, AO2, and AO3, the following parameters will be used: **(P178; P182)**, **(P186; P190)** and **(P194; P198)** for values **(Val Min; Out Min).**

- **(Val Max; Out Max)** Defines the maximum saturation value of the variable to be represented and the corresponding value to be assigned to the analog output. For values equal to or higher than Val Max, Out Max will be assigned to the selected analog output. For analog outputs AO1, AO2, and AO3, the following parameters will be used: **(P179; P183)**, **(P187; P191)** and **(P195; P199)** for values **(Val Max; Out Max).**

- **Offset** Defines the offset value applied to the analog output. Offset is set in parameter **P180** for AO1 analog output, in parameters **P188**, **P196** for AO2 and AO3 respectively.

- **Filter** Defines the filter time constant applied to the analog output. The filter time constant is set in parameter **P181** for AO1 analog output, in parameters **P189**, **P197** for AO2 and AO3 respectively.

22.1.3. Frequency Output

When programming the frequency output, the setting of MDO1 in the DIGITAL OUTPUTS MENU **is disabled**. The figure below illustrates the structure of the frequency output. Parameterization is similar to the one used for the analog outputs.

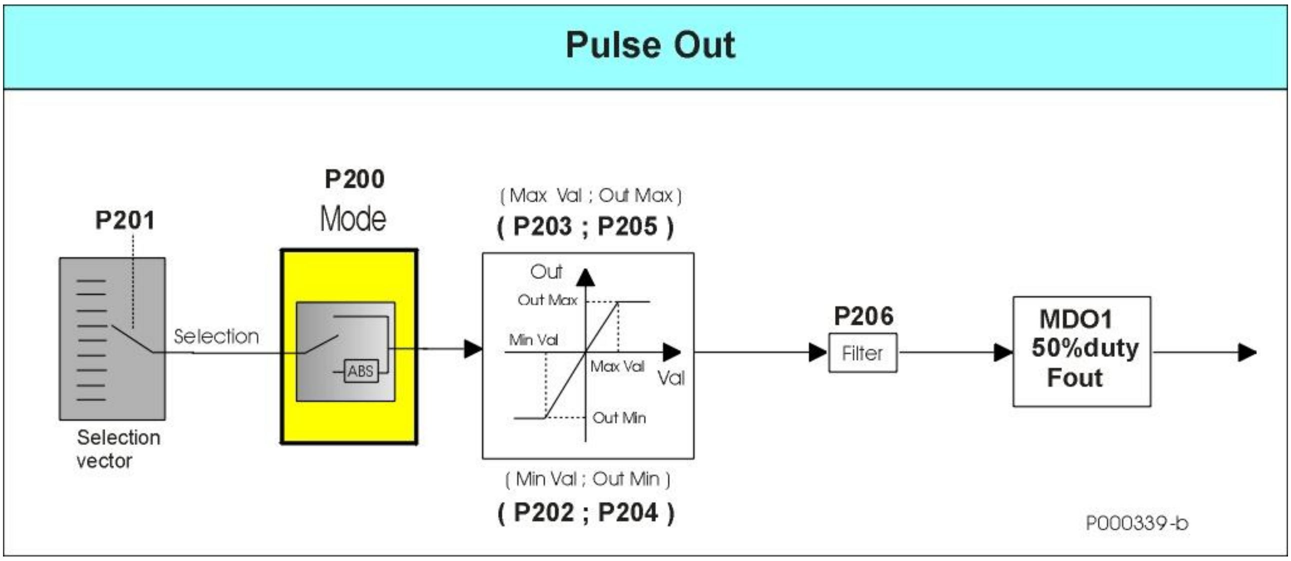


Figure 18: Structure of the Frequency Output

22.2. Variables

This section covers the variables that can be represented for the analog and frequency outputs.

Table 36: Selectable variables for the Analog and Frequency Outputs

SELECTION CODE		
Selection Value	**Full-scale Value**	**Description**
0: Disable		Disabled output
1: Speed	10000 rpm	Speed of the connected motor
2: Speed Ref.	10000 rpm	Speed reference at constant speed
3: Ramp Out	10000 rpm	“Ramped” speed reference
4: Mot. Freq.	1000.0 Hz	Frequency produced by the drive
5: Mot. Curr.	5000.0 A	Current RMS
6: Out Volt	2000.0 V	Output voltage RMS
7: OutPower	5000.0 kW	Output power
8: DC Vbus	2000.0 V	DC-link voltage
9: Torq.Ref	10000 %	Torque reference at constant speed
10: Torq.Dem	10000 Nm	Torque demand (Nm)
11: Torq.Out	10000 %	Estimated torque output
12: Torq.Lim	10000 %	Setpoint of the torque limit
13: PID Ref%	100.00 %	PID reference at constant speed
14: PID RMP%	100.00 %	“Ramped” PID reference
15: PID Err%	100.00 %	Error between PID reference and feedback
16: PID Fbk%	100.00 %	Feedback to the PID
17: PID Out%	100.00 %	Output of the PID
18: REF	100.00 %	Analog input REF
19: AIN1	100.00 %	Analog input AIN1
20: AIN2/PTC	100.00 %	Analog input AIN2
21: Enc. In	10000 rpm	Speed read by the encoder used as a reference
22: PulseIn	100.00 kHz	Frequency input
23: Flux Ref	1.0000 Wb	Flux reference at constant speed
24: Flux	1.0000 Wb	Current flux reference
25: iq ref.	5000.0 A	Current reference in Q-axis
26: id ref.	5000.0 A	Current reference in D-axis
27: iq	5000.0 A	Current measure in Q-axis
28: id	5000.0 A	Current measure in D-axis
29: Volt.Vq	2000.0 V	Voltage measure in Q-axis
30: Volt Vd	2000.0 V	Voltage measure in D-axis
31: Cosine	100.00 %	Cosine waveform (see **P214**)
32: Sine	100.00 %	Sine waveform (see **P214**)
33: Angle	1.0000 rad	Electric angle (see **P214**)
34: +10V	10.000 V	Voltage level +10V
35: –10V	10.000 V	Voltage level –10V
36: Flux Current	5000.0 A	Flux Current
37: Sqr Wave	100.00 %	Square wave
38: Saw Wave	100.00 %	Saw wave
39: Hts Temp.	100.00 °C	Temperature of the heatsink
40: Amb Temp.	100.00 °C	Ambient temperature
41÷49: RESERVED		RESERVED
50: PT100_1	100.00 %	PT100 Channel 1
51: PT100_2	100.00 %	PT100 Channel 2
52: PT100_3	100.00 %	PT100 Channel 3
53: PT100_4	100.00 %	PT100 Channel 4
54: I2t%	100.00 %	Motor thermal capacity
55: XAIN4	100.00 %	XAIN4 Analog input
56: XAIN5	100.00 %	XAIN5 Analog input
57: OT Count	100000 h	Maintenance Operation Time Counter
58: ST Count	100000 h	Maintenance Supply Time Counter

59: PID2 Reference	100.00 %	Reference at constant speed of PID2
60: PID2 Set Point	100.00 %	"Ramped" reference of PID2
61: PID2 Feedback	100.00 %	PID2 Feedback
62: PID2 Error	100.00 %	Error between reference and feedback of PID2
63: PID2 Out	100.00 %	Output of PID2
64: Torque Demand	100.00 %	Torque demand (value percent)
65: Actual Current Iv	5000 A	Output Current Iv
66÷69: RESERVED		RESERVED

Table 36 provides a brief description of each variable and its full-scale value used to set the minimum and maximum value.

22.2.1. Operating Mode of Analog and Frequency Outputs

This section covers the different representation modes to be selected for the analog and frequency outputs.

The following modes can be used for analog outputs:

0: Disabled Disabled analog output (enables a RESERVED operating mode).
1: ± 10V The analog output is set as a voltage output and the possible min. and max. output values range from +/ – 10V. The selected variable has a positive or negative sign.
2: 0÷10V The analog output is set as a voltage output and the possible min. and max. output values range from 0 to 10V. The selected variable has a positive or negative sign.
3: 0÷20mA The analog output is set as a current output and the possible min. and max. output values range from 0 to 20mA. The selected variable has a positive or negative sign.
4: 4÷20mA The analog output is set as a current output and the possible min. and max. output values range from 4 to 20mA. The selected variable has a positive or negative sign.
5: ABS 0÷10V As 0÷10V output mode, but the selected variable is considered as an absolute value.
6: ABS 0÷20mA As 0÷20mA output mode, but the selected variable is considered as an absolute value.
7: ABS 4÷20mA As 4÷20mA output mode, but the selected variable is considered as an absolute value.

NOTE Always check the min. and max. values of the outputs programmed in the relevant parameters.

Three operating modes can be selected for the **Frequency Output**:
0: Disabled The output frequency is disabled.
1: Pulse Out MDO1 Digital Output is programmed as a frequency output. The selected variable has a positive or negative sign.
2: ABS Pulse Out As Pulse Out, but the selected variable is considered as an absolute value.

NOTE When **P200** is not set to DISABLE, MDO1digital output is used as a frequency output and any MDO1 settings in the DIGITAL OUTPUTS MENU are ignored.

22.2.2. ANALOG OUTPUT PROGRAMMING EXAMPLES

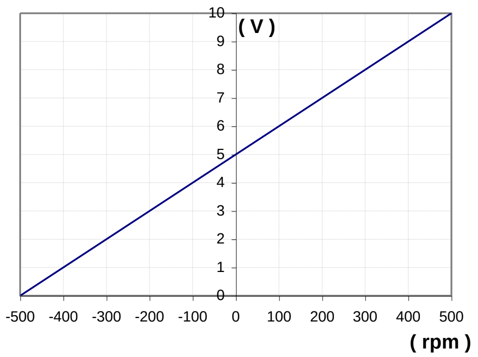
This section contains a description of operating examples of the analog outputs obtained with different programming modes.

Example 1:

Table 37: Programming AO1 (0 ÷ 10V)

Parameterization of AO1 Analog Output		
Parameter	**Value**	**Description**
P176	0÷10V	AO1 Analog output
P177	1: Speed	Selected variable for AO1 analog output
P178	–500 rpm	Min. value of AO1 selected variable
P179	+500 rpm	Max. value of AO1 selected variable
P180	0.000 V	AO1 Analog output offset
P181	0 ms	Filter for AO1 analog output
P182	0.0 V	Min. AO1 output value with reference to **P178**
P183	10.0 V	Max. AO1 output value with reference to **P179**

Figure 19: Curve (voltage; speed) implemented by AO1 (Example 1)

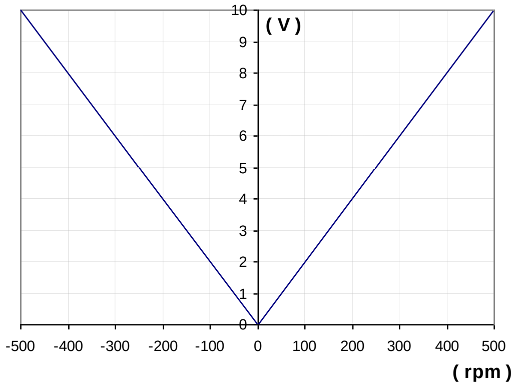


Example 2:

Table 38: Programming AO1 (0 ÷ 10V)

Parameterization of Analog Output AO1		
Parameter	**Value**	**Description**
P176	ABS 0÷10V	AO1 Analog output
P177	1: Speed	Selected variable for AO1 analog output
P178	0 rpm	Min. value of AO1 selected variable
P179	+500 rpm	Max. value of AO1 selected variable
P180	0.000 V	AO1 Analog output offset
P181	0 ms	Filter for AO1 analog output
P182	0.0 V	Min. AO1 output value with reference to **P178**
P183	10.0 V	Max. AO1 output value with reference to **P179**

Figure 20: Curve (voltage; speed) implemented by AO1 (Example 2)

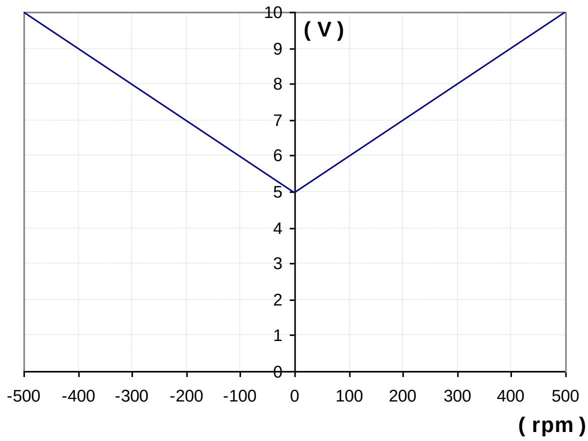


Example 3:

Table 39: Programming AO1 (ABS 0 ÷ 10V)

Parameterization of Analog Output AO1		
Parameter	**Value**	**Description**
P176	ABS 0÷10V	AO1 Analog output
P177	1: Speed	Selected variable for AO1 analog output
P178	–500 rpm	Min. value of AO1 selected variable
P179	+500 rpm	Max. value of AO1 selected variable
P180	0.000 V	AO1 Analog output offset
P181	0 ms	Filter for AO1 analog output
P182	0.0 V	Min. AO1 output value with reference to P178
P183	10.0 V	Max. AO1 output value with reference to P179

Figure 21: Curve (voltage; speed) implemented by AO1 (Example 3)



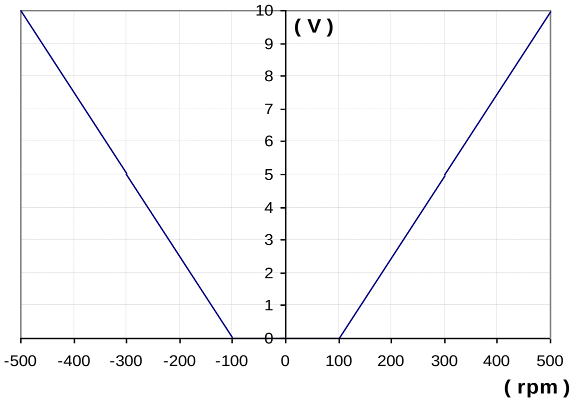
NOTE The programming mode above would imply a straight line passing through (–500rpm; 0V) and (+500rpm; 10V), but based on the selected mode and considering the variable as an absolute value, the min. point for output AO1 will be (0 rpm; 5 V).

Example 4:

Table 40: Programming AO1 (ABS 0 ÷ 10V)

Parameterization of Analog Output AO1		
Parameter	**Value**	**Description**
P176	ABS 0÷10V	AO1 Analog output
P177	1: Speed	Selected variable for AO1 analog output
P178	+100 rpm	Min. value of AO1 selected variable
P179	+500 rpm	Max. value of AO1 selected variable
P180	0.000 V	AO1 Analog output offset
P181	0 ms	Filter for AO1 analog output
P182	0.0 V	Min. AO1 output value with reference to P178
P183	10.0 V	Max. AO1 output value with reference to P179

Figure 22: Curve (voltage; speed) implemented by AO1 (Example 4)



Example 5:

Table 41: Programming AO1 (± 10V)

Parameterization of Analog Output AO1		
Parameter	**Value**	**Description**
P176	±10V	AO1 Analog output
P177	1: Speed	Selected variable for AO1 analog output
P178	+500 rpm	Min. value of AO1 selected variable
P179	–500 rpm	Max. value of AO1 selected variable
P180	0.000 V	AO1 Analog output offset
P181	0 ms	Filter for AO1 analog output
P182	–10.0 V	Min. AO1 output value with reference to P178
P183	+10.0 V	Max. AO1 output value with reference to P179

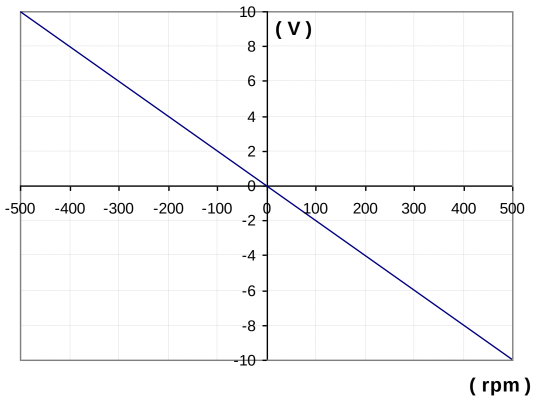


Figure 23: Curve (voltage; speed) implemented by AO1 (Example 5)

22.3. List of Parameters P176 to P215

Table 42: List of Parameters P176 to P215

Param.	Function	User Level	DEFAULT VALUES	Modbus Address
P176	AO1 analog output	ADVANCED	1: ± 10V	776
P177	Selected variable for AO1 analog output	ADVANCED	1: Motor speed	777
P178	Min. value of AO1 selected variable	ADVANCED	–1500 rpm	778
P179	Max. value of AO1 selected variable	ADVANCED	+1500 rpm	779
P180	AO1 Analog output offset	ADVANCED	0.000 V	780
P181	Filter for AO1 analog output	ADVANCED	0 ms	781
P182	Min. AO1 output value with reference to **P178**	ADVANCED	–10.0 V	782
P183	Max. AO1 output value with reference to **P179**	ADVANCED	+10.0V	783
P184	AO2 analog output	ADVANCED	1: ± 10V	784
P185	Selected variable for AO2 analog output	ADVANCED	2: Speed reference at constant rpm	785
P186	Min. value of AO2 selected variable	ADVANCED	–1500 rpm	786
P187	Max. value of AO2 selected variable	ADVANCED	+1500 rpm	787
P188	AO2 Analog output offset	ADVANCED	0.000 V	788
P189	Filter for AO2 analog output	ADVANCED	0 ms	789
P190	Min. AO2 output value with reference to **P186**	ADVANCED	–10.0 V	790
P191	Max. AO2 output value with reference to **P187**	ADVANCED	+10.0V	791
P192	AO3 analog output	ADVANCED	2: 0÷10V	792
P193	Selected variable for AO3 analog output	ADVANCED	5: Output current	793
P194	Min. value of AO3 selected variable	ADVANCED	0 A	794
P195	Max. value of AO3 selected variable	ADVANCED	Inverter Imax	795
P196	AO3 Analog output offset	ADVANCED	0.000 V	796
P197	Filter for AO3 analog output	ADVANCED	0 ms	797
P198	Min. AO3 output value with reference to **P194**	ADVANCED	0.0 V	798
P199	Max. AO3 output value with reference to **P195**	ADVANCED	+10.0V	799
P200	FOUT output in [MDO1] frequency	ADVANCED	0: Disabled	800
P201	Selected variable for FOUT frequency output	ADVANCED	1: Motor speed	801
P202	Min. FOUT value of selected variable	ADVANCED	0	802
P203	Max. FOUT value of selected variable	ADVANCED	0	803
P204	Min. FOUT output value with reference to **P202**	ADVANCED	10.00 kHz	804
P205	Max. FOUT output value with reference to **P203**	ADVANCED	100.00 kHz	805
P206	Filter for FOUT frequency output	ADVANCED	0 ms	806
P207	AO1: Gain	ADVANCED	RESERVED	807
P208	AO2: Gain	ADVANCED		808
P209	AO3: Gain	ADVANCED		809
P210	AO1: Variable MODBUS address	ADVANCED		810
P211	AO2: Variable MODBUS address	ADVANCED		811
P212	AO3: Variable MODBUS address	ADVANCED		812
P213	Amplitude of sinusoidal analog output signal	ENGINEERING	100.0%	813
P214	Frequency of sinusoidal analog output signal	ENGINEERING	1.00 Hz	814
P215	Frequency of saw wave analog output signal	ENGINEERING	1.00 Hz	815

P176 AO1Analog Output

P176	**Range**	0 ÷ 7	0: Disabled, 1: ± 10V, 2: 0 ÷ 10V, 3: 0 ÷ 20mA, 4: 4 ÷ 20mA, 5: ABS 0 ÷ 10V, 6: ABS 0 ÷ 20mA, 7: ABS 4 ÷ 20mA.
	Default	1	1: ± 10V
	Level	ADVANCED	
	Address	776	
	Function	Selects the operating mode of AO1analog output.	

```
P176  Type  of
Output  Signal
AO1      SW2-1  -2
→     0-20mA  □   ■
```

In the example above, A01 is set as a current input. Contact 1 of SW2 DIP-switch is open, contact 2 is closed.

NOTE Analog outputs are set as voltage outputs by default. To set them as current outputs, see the DIP-switch configuration and follow the instructions displayed on the keypad, or refer to the Sinus Penta's Installation Guide.

P177 Selected Variable for AO1 Analog Output

P177	**Range**	0 ÷ 69	See Table 36
	Default	1	Motor speed
	Level	ADVANCED	
	Address	777	
	Function	Selects the variable to be allocated to AO1 digital output.	

P178 Min. value of AO1 Selected Variable

P178	**Range**	-32000 ÷ +32000 Depending on the value selected in **P177**	- 320.00% ÷ + 320.00 % of the full-scale value See Table 36
	Default	–1500	–15.00% of 10000 rpm = –1500 rpm
	Level	ADVANCED	
	Address	778	
	Function	Minimum value of the variable selected via **P177,** corresponding to the min. output value of AO1 set in **P182.**	

P179 Max. value of AO1 Selected Variable

P179	**Range**	-32000 ÷ +32000 Depending on the value selected in **P177**	- 320.00% ÷ + 320.00 % of the full-scale value See Table 36
	Default	+1500	+15.00% of 10000 rpm = +1500 rpm
	Level	ADVANCED	
	Address	779	
	Function	Maximum value of the variable selected via **P177**, corresponding to the max. output value of AO1 set in **P183**.	

P180 AO1 Analog Output Offset

P180	**Range**	–9999 ÷ +9999 Depending on the value selected in **P176**	–9.999 ÷ +9.999
	Default	0	0.000 V
	Level	ADVANCED	
	Address	780	
	Function	Offset value applied to AO1 analog output.	

P181 Filter for AO1 Analog Output

P181	**Range**	0 ÷ 65000	0.000 ÷ 65.000 sec.
	Default	0	0.000 sec.
	Level	ADVANCED	
	Address	781	
	Function	Value of the filter time constant applied to AO1 analog output.	

P182 Min. AO1 Output Value with Reference to P178

P182	**Range**	–100 ÷ +100 –200 ÷ +200 Depending on the value selected in **P176**	–10.0 ÷ +10.0 V –20.0 ÷ +20.0 mA
	Default	–100	–10.0 V
	Level	ADVANCED	
	Address	782	
	Function	Minimum output value obtained when the minimum value of the variable set in **P178** is implemented.	

P183 Max. AO2 Output Value with Reference to P179

P183	**Range**	–100 ÷ +100 –200 ÷ +200 Depending on the value selected in **P176**	–10.0 ÷ +10.0 V –20.0 ÷ +20.0 mA
	Default	+100	+10.0 V
	Level	ADVANCED	
	Address	783	
	Function	Maximum output value obtained when the maximum value of the variable set in **P179** is implemented.	

P184 AO2 Analog Output

P184	**Range**	0 ÷ 7	0: Disabled, 1: ± 10V, 2: 0 ÷ 10V, 3: 0 ÷ 20mA, 4: 4 ÷ 20mA, 5: ABS 0 ÷ 10V, 6: ABS 0 ÷ 20mA, 7: ABS 4 ÷ 20mA.
	Default	1	1: ± 10V
	Level	ADVANCED	
	Address	784	
	Function	Selects the operating mode of AO2 analog output.	

NOTE

Analog outputs are set as voltage outputs by default. To set them as current outputs, see the DIP-switch configuration and follow the instructions displayed on the keypad, or refer to the Sinus Penta's Installation Guide.

P185 Selected Variable for AO2 Analog Output

P185	**Range**	0 ÷ 69	See Table 36
	Default	2	Reference at constant speed
	Level	ADVANCED	
	Address	785	
	Function	Selects the variable to be allocated to AO2 digital output.	

P186 Min. Value of AO2 Selected Variable

P186	**Range**	–32000 ÷ +32000 Depends on the value selected in **P185**	–320.00 % ÷ +320.00 % of the full-scale value See Table 36
	Default	–1500	–1500 rpm
	Level	ADVANCED	
	Address	786	
	Function	Minimum value of the variable selected via **P185**, corresponding to the min. output value of AO2 set in **P190**.	

P187 Max. value of AO2 Selected Variable

P187	**Range**	–32000 ÷ +32000 Depends on the value selected in **P185**	–320.00 % ÷ +320.00 % of the full-scale value See Table 36
	Default	+1500	+1500 rpm
	Level	ADVANCED	
	Address	787	
	Function	Maximum value of the variable selected via **P185**, corresponding to the max. output value of AO2 set in **P191**.	

P188 AO2 Analog Output Offset

P188	**Range**	–9999 ÷ +9999 Depends on the value selected in **P184**	-9.999 ÷ 9.999
	Default	0	0.000 V
	Level	ADVANCED	
	Address	788	
	Function	Offset value applied to AO2 analog output.	

P189 Filter for AO2 Analog Output

P189	**Range**	0 ÷ 65000	0.000÷65.000 sec.
	Default	0	0.000 sec.
	Level	ADVANCED	
	Address	789	
	Function	Value of the filter time constant applied to AO2 analog output.	

P190 Min. AO2 Output Value with Reference to P186

P190	**Range**	–100 ÷ +100 –200 ÷ +200 Depends on the value selected in **P184**	–10.0 ÷ +10.0 V –20.0 ÷ +20.0 mA
	Default	–100	–10.0 V
	Level	ADVANCED	
	Address	790	
	Function	Minimum output value obtained when the minimum value of the variable set in **P186** is implemented.	

P191 Max. AO2 Output Value with Reference to P187

P191	**Range**	-100 ÷ +100 –200 ÷ +200 Depends on the value selected in **P184**	–10.0 ÷ +10.0 V –20.0 ÷ +20.0 mA
	Default	+100	+10,0 V
	Level	ADVANCED	
	Address	791	
	Function	Maximum output value obtained when the maximum value of the variable set in **P187** is implemented.	

P192 AO3 Analog Output

P192	**Range**	0 ÷ 7	0: Disabled, 1: ± 10V, 2: 0 ÷ 10V, 3: 0 ÷ 20mA, 4: 4 ÷ 20mA, 5: ABS 0 ÷ 10V, 6: ABS 0 ÷ 20mA, 7: ABS 4 ÷ 20mA.
	Default	2	2: 0 ÷ 10V
	Level	ADVANCED	
	Address	792	
	Function	Selects the operating mode of AO3 analog output.	

NOTE Analog outputs are set as voltage outputs by default. To set them as current outputs, see the DIP-switch configuration and follow the instructions displayed on the keypad, or refer to the Sinus Penta's Installation Guide.

P193 Selected Variable for AO3 Analog Output

P193			
	Range	0 ÷ 69	See Table 36
	Default	5	5: Motor current
	Level	ADVANCED	
	Address	793	
	Function	Selects the variable to be allocated to AO3 analog output.	

P194 Min. Value of AO3 Selected Variable

P194			
	Range	–320.00 % ÷ +320.00 % of the full-scale value Depends on the value selected through **P193**	–320.00 % ÷ +320.00 % of the full-scale value See Table 36
	Default	0	0 A
	Level	ADVANCED	
	Address	794	
	Function	Minimum value of the variable selected via **P193**, corresponding to the min. output value of AO3 set in **P198**.	

P195 Max. Value of AO3 Selected Variable

P195			
	Range	–320.00 % ÷ +320.00 % Depends on the value selected through **P193**	–320.00 % ÷ +320.00 % of the full-scale value See Table 36
	Default	Inverter Imax	Max. drive current depending on the drive model – see Table 81 and Table 85
	Level	ADVANCED	
	Address	795	
	Function	Maximum value of the variable selected via **P193**, corresponding to the max. output value of AO3 set in **P199**.	

P196 AO3 Analog Output Offset

P196			
	Range	–9999 ÷ +9999 Depends on the value selected through **P192**	–9.999 ÷ +9.999
	Default	0	0.000 V
	Level	ADVANCED	
	Address	796	
	Function	Offset value applied to AO3 analog output.	

P197 Filter for AO3 Analog Output

P197			
	Range	0 ÷ 65000 sec.	0.000 ÷ 65.000 sec.
	Default	0	0.000 sec.
	Level	ADVANCED	
	Address	797	
	Function	Value of the filter time constant applied to AO3 analog output.	

P198 Min. AO3 Output Value with Reference to P194

P198	**Range**	–100 ÷ +100 –200 ÷ +200 Function according to the selection of **P192**	–10.0 ÷ +10.0 V –20.0 ÷ +20.0 mA
	Default	0	00.0 V
	Level	ADVANCED	
	Address	798	
	Function	Minimum output value obtained when the minimum value of the variable set in **P194** is implemented.	

P199 Max. AO3 Output Value with Reference to P195

P199	**Range**	–100 ÷ +100 –200 ÷ +200 Function according to selection of **P192**	–10.0 ÷ +10.0 V –20.0 ÷ +20.0 mA
	Default	+100	+10.0 V
	Level	ADVANCED	
	Address	799	
	Function	Maximum output value obtained when the maximum value of the variable set in **P195** is implemented.	

P200 FOUT Output in [MDO1] Frequency

P200	**Range**	0 ÷ 2	0: Disabled, 1: Pulse, 2: ABS Pulse
	Default	0	0: Disabled
	Level	ADVANCED	
	Address	800	
	Function	Selects the operating mode of FOUT frequency output.	

NOTE When **P200** is not set to DISABLE, MDO1digital output is used as a frequency output and any settings for MDO1 in the DIGITAL OUTPUTS MENU are ignored.

P201 Selected Variable for FOUT Frequency Output

P201	**Range**	0 ÷ 69	See Table 36
	Default	1	Motor speed
	Level	ADVANCED	
	Address	801	
	Function	Selects the variable to be allocated to FOUT frequency output.	

P202 Min. FOUT Value of Selected Variable

P202	**Range**	–32000 ÷ +32000 Depends on the value selected through **P201**	–320.00 % ÷ +320.00 % of the full-scale value See Table 36
	Default	0	0
	Level	ADVANCED	
	Address	802	
	Function	Minimum value of the selected variable.	

P203 Max. FOUT Value of Selected Variable

P203	**Range**	–32000 ÷ +32000 Depends on the value selected through **P201**	–320.00 % ÷ +320.00 % of the full-scale value See Table 36
	Default	0	0
	Level	ADVANCED	
	Address	803	
	Function	Maximum value of the selected variable.	

P204 Min. FOUT Output Value with Reference to P202

P204	**Range**	1000÷10000	10.00÷100.00 kHz
	Default	1000	10.00 kHz
	Level	ADVANCED	
	Address	804	
	Function	Minimum output value obtained when the minimum value of the variable set in **P202** is implemented**.**	

P205 Min. FOUT Output Value with Reference to P203

P205	**Range**	1000÷10000	10.00÷100.00 kHz
	Default	10000	100.00 kHz
	Level	ADVANCED	
	Address	805	
	Function	Maximum output value obtained when the maximum value of the variable set in **P203** is implemented.	

P206 Filter for FOUT Frequency Output

P206	**Range**	0 ÷ 65000	0.000 ÷ 65.000 sec
	Default	0	0.000 sec.
	Level	ADVANCED	
	Address	806	
	Function	Value of the filter time constant applied to FOUT frequency output.	

P207 AO1: Gain **P208 AO2: Gain** **P209 AO3: Gain** **P210 AO1: Variable MODBUS Address** **P211 AO2: Variable MODBUS Address** **P212 AO3: Variable MODBUS Address**	**RESERVED**

P213 Amplitude of Sinusoidal Analog Output Signal

P213	**Range**	0 ÷ 1000	0 ÷ 100.0%
	Default	1000	100.0%
	Level	ENGINEERING	
	Address	813	
	Function	Amplitude of the sinusoidal analog output signal when Sine or Cosine variables are selected.	

P214 Frequency of Sinusoidal Analog Output Signal

P214			
	Range	0 ÷ 20000	0 ÷ 200.00Hz
	Default	100	1.00Hz
	Level	ENGINEERING	
	Address	814	
	Function	Frequency of the sinusoidal analog output signal when Sine or Cosine variables are selected.	

P215 Frequency of Saw Wave Analog Output Signal

P215			
	Range	0 ÷ 20000	0 ÷ 200.00Hz
	Default	100	1.00Hz
	Level	ENGINEERING	
	Address	815	
	Function	Frequency of saw wave analog output signal when Sine or Cosine variables are selected. This can be used as the carrier frequency when setting MDO1 or MDO2 in PWM mode (see the example given in the DIGITAL OUTPUTS MENU).	

23. TIMERS MENU

23.1. Overview

The Timers menu allows setting enable and disable delay times for digital inputs/outputs.

NOTE For the **ENABLE-A** and **ENABLE-B** digital inputs, no disable delay is allowed, because their logic status is utilized directly by the hardware activating IGBT switching; when no **ENABLE-A**, **ENABLE-B** command is sent, the output power stage is instantly deactivated.

NOTE The **ENABLE-A** and **ENABLE-B** inputs are allocated to the STO function. If this safety function is to be adopted, the control mode and the control circuit of these signals must be accomplished as per the Safe Torque Off Function - Application Manual**.**
That manual also includes a detailed validation procedure of the control configuration of the STO function to be executed upon first start-up and also periodically at yearly intervals.

NOTE The reset function for the alarms on the leading edge of **RESET** terminal (**MDI3** as factory default) is not delayed.

NOTE Any auxiliary alarm set to the digital inputs is not delayed.

NOTE Five timers are available; the use can set an enabling/disable delay for each of them. The same timer may also be assigned to multiple digital inputs/outputs.

NOTE The ENABLE-SW function cannot be delayed.

Example 1:

The drive enable (**MDI1 START**) depends on a signal coming from a different source. An activation delay of 2 seconds and a deactivation delay of 5 seconds are needed. To do so, set two delay times for activation and deactivation for the same timer and assign it to **MDI1** (**START**) digital input. In the example below, timer 1 is used.

P216	2.0 sec	Activation delay T1
P217	5.0 sec	Deactivation delay T1
P226	0x0001	Timer assigned to **MDI1** (**START**)

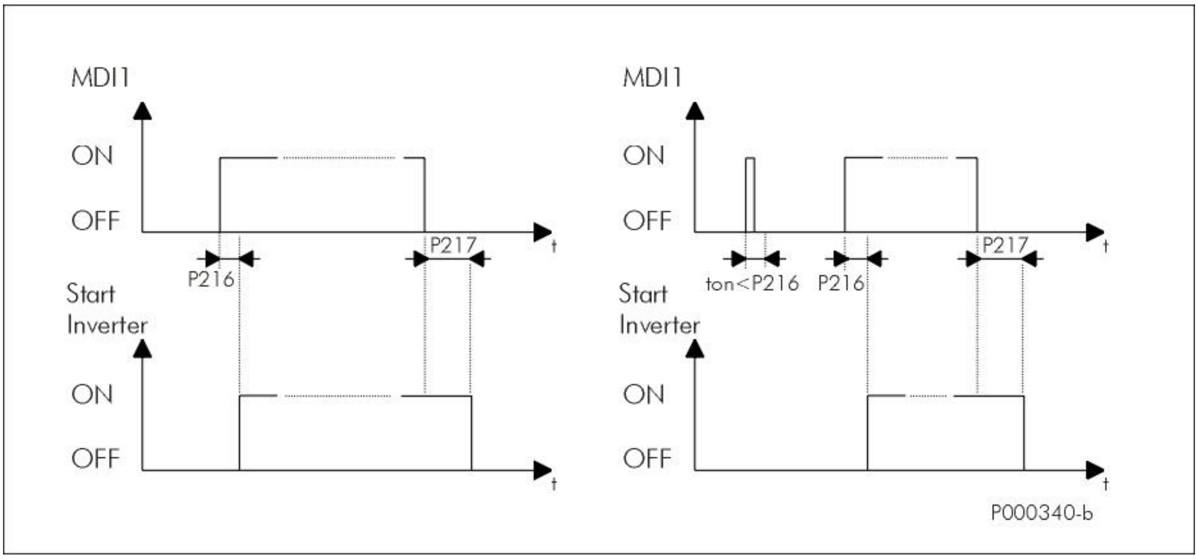


Figure 24: Using Timers (example)

The figure shows two possible operating modes:
- on the left: application of the delay times set for the drive enabling/disabling;
- on the right: the start signal persists for a shorter time than the delay set for enabling; in this case, the Start function is not enabled. The Start function will be enabled only when **MDI1** digital input is ON for a time longer than the time set in **P216**.

23.2. List of Parameters P216 to P229

Table 43: List of Parameters P216 to P229

Parameter	FUNCTION	User Level	Default Values	MODBUS Address
P216	T1 Enable delay	ENGINEERING	0.0	816
P217	T1 Disable delay	ENGINEERING	0.0	817
P218	T2 Enable delay	ENGINEERING	0.0	818
P219	T2 Disable delay	ENGINEERING	0.0	819
P220	T3 Enable delay	ENGINEERING	0.0	820
P221	T3 Disable delay	ENGINEERING	0.0	821
P222	T4 Enable delay	ENGINEERING	0.0	822
P223	T4 Disable delay	ENGINEERING	0.0	823
P224	T5 Enable delay	ENGINEERING	0.0	824
P225	T5 Disable delay	ENGINEERING	0.0	825
P226	Timer assigned to inputs MDI1÷4	ENGINEERING	0: No timer assigned	826
P227	Timer assigned to inputs MDI5÷8	ENGINEERING	0: No timer assigned	827
P228	Timer assigned to outputs MDO1÷4	ENGINEERING	0: No timer assigned	828
P229	Timer assigned to virtual outputs MPL1÷4	ENGINEERING	0: No timer assigned	829

P216 T1 Enable delay

P216	**Range**	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	816	
	Function	This parameter sets T1 enable time. Using **P226** or **P227**, if **timer T1** is assigned to a digital input having a particular function, P216 represents the delay occurring between the input closure and the function activation. Use **P228** to assign timer 1 to a digital output; in that case, the digital output energizing will be delayed according to the time set in **P216**.	

P217 T1 Disable delay

P217	**Range**	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	817	
	Function	This parameter sets T1 disabling time. Using **P226** or **P227**, if **timer T1** is assigned to a digital input having a particular function, this parameter represents the delay occurring between the input opening and the function deactivation. Use **P228** to assign timer 1 to a digital output; in that case, the digital output de-energizing will be delayed according to the time set in **P217.**	

P218 T2 Enable delay

P218			
	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	818	
	Function	This parameter sets T2 enable time. (Operation as per **P216**.)	

P219 T2 Disable delay

P219			
	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	819	
	Function	This parameter sets T2 disable time. (Operation as per **P217**.)	

P220 T3 Enable delay

P220			
	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	820	
	Function	This parameter sets T3 enable time. (Operation as per **P216**.)	

P221 T3 Disable delay

P221			
	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	821	
	Function	This parameter sets T3 disable time. (Operation as per **P217**.)	

P222 T4 Enable delay

P222			
	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	822	
	Function	This parameter sets T4 enable time. (Operation as per **P216**.)	

P223 T4 Disable delay

P223			
	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	823	
	Function	This parameter sets T4 disable time. (Operation as per **P217**.)	

P224 T5 Enable delay

P224			
	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	824	
	Function	This parameter sets T5 enable time. (Operation as per **P216**.)	

P225 T5 Disable delay

P225			
	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	825	
	Function	This parameter sets T5 disable time. (Operation as per **P217**.)	

P226 Timers Assigned to Inputs MDI1÷4

P226			
	Range	[0; 0; 0; 0] ÷ [5; 5; 5; 5]	0: No timer assigned 1 ÷ 5: T1 ÷ T5
	Default	[0; 0; 0; 0]	0: No timer assigned
	Level	ENGINEERING	
	Address	826	
	Function	The first group of four digital inputs may be assigned to any of the five timers and the same timer may be assigned to multiple inputs. Select “zero” to avoid delaying the digital inputs. Setting via serial link: see Table 44.	

Table 44: Coding of Parameters P226 to P229

bits [15..12]	bits [11..9]	bits [8..6]	bits [5..3]	bits [2..0]
not used	MDI4	MDI3	MDI2	MDI1

Coding example for P226:
MDI1=Timer T2
MDI2=No timer assigned
MDI3=Timer T2
MDI4=Timer T5
⇒ value in **P226** 101 010 000 010 bin = 2690 dec

P227 Timers Assigned to Inputs MDI5÷8

P227			
	Range	[0; 0; 0; 0] ÷ [5; 5; 5; 5]	0: No timer assigned 1 ÷ 5: T1 ÷ T5
	Default	[0; 0; 0; 0]	0: No timer assigned
	Level	ENGINEERING	
	Address	827	
	Function	The second group of four digital inputs may be assigned to any of the five timers and the same timer may be assigned to multiple inputs. Select “zero” to avoid delaying the digital inputs. Setting via serial link: see Table 44.	

P228 Timers Assigned to Outputs MDO1÷4

P228	**Range**	[0; 0; 0; 0] ÷ [5; 5; 5; 5]	0: No timer assigned 1 ÷ 5: T1 ÷ T5
	Default	[0; 0; 0; 0]	0: No timer assigned
	Level	ENGINEERING	
	Address	828	
	Function	The digital outputs may be assigned to any of the five timers and the same timer may be assigned to multiple outputs. Select “zero” to avoid delaying the digital outputs. Setting via serial link: see Table 44.	

P229 Timers Assigned to Virtual Outputs MPL 1÷4

P229	**Range**	[0; 0; 0; 0] ÷ [5; 5; 5; 5]	0: No timer assigned 1 ÷ 5: T1 ÷ T5
	Default	[0; 0; 0; 0]	0: No timer assigned
	Level	ENGINEERING	
	Address	829	
	Function	The virtual digital outputs may be assigned to any of the five timers and the same timer may be assigned to multiple outputs. Select “zero” to avoid delaying the virtual digital outputs. Setting via serial link: see Table 44.	

24. PID PARAMETERS MENU

24.1. Overview

This menu defines the parameters for the digital PID regulator integrated in the drive.
The PID regulator may be used to control a physical variable which is external to the drive; the variable measure shall be available in the system and must be connected to the "feedback" input.

The PID regulator is used to keep the reference and the control variable constant (feedback); to do so, the PID regulator controls three internal variables, which are described below:

- ✓ Proportional term: this the variable detecting the instant difference between the reference and the measured value of the physical variable to be controlled ("error ");
- ✓ Integral term: this is the variable keeping track of the "history" of the detected errors (summation of all errors);
- ✓ Derivative term: this is the variable keeping track of the evolution of the error or the controlled variable (difference between two consecutive errors or between two consecutive values of the feedbacked variable);

The weighted summation of these terms represents the output signal of the PID regulator.
The weight of these three terms may be defined by the user with the parameters below.

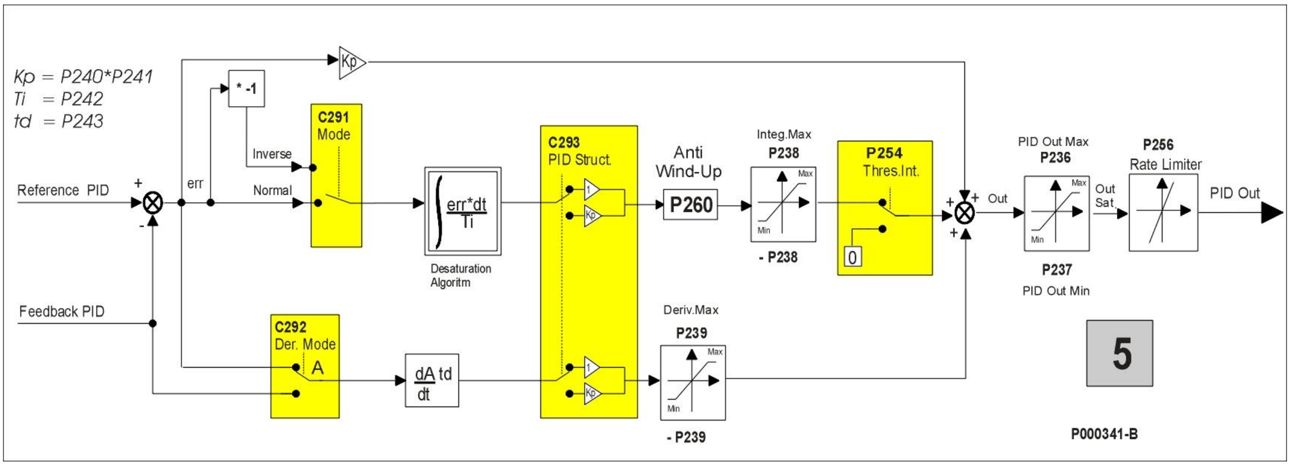


Figure 25: PID Block Diagram

NOTE In **LOCAL mode**, the PID regulator is disabled if it is used to correct the reference or the voltage values (**C294 = 2: Add Reference** or **C294 =3: Add Voltage**).

NOTE In **LOCAL mode,** if the drive reference is the PID output **C294=Reference** and the Type parameter on the Keypad page in Local mode is **P266=Ref.Active+Spd**, the PID reference can be changed by activating the Local mode from the Keypad page. Press the **LOC/REM** key again when the drive is disabled (or the MDI LOC/REM key if it is programmed as a pushbutton: **C180a=Pushbutton**) to disable the PID and to set the speed reference directly from the Keypad page.

24.2. PID Regulator Tuning – Method of Ziegler and Nichols

Tuning a PID regulator consists in selecting and allocating values to PID parameters in order to adjust the operation of the system to the technical requirements of the process and to the equipment restrictions.
One of the possible PID tuning procedures is the ***Method of Ziegler and Nichols.***

This method implies the following steps:
1. Set the integral action and the derivative action to zero: Ti (**P242**) = 0, Td (**P243**) = 0.
2. Assign very low values to Kp (**P240**), then apply a little step to the reference signal (setpoint) selected with **C285/286/287.**
3. Gradually increase the value of Kp until **permanent oscillation** is attained in the PID loop.
4. Tune the parameters for a **P, PI** or **PID** regulator based on the table below—where Kp_c is the value of the proportional gain corresponding to the permanent oscillation (critical gain) and T_c is the period of the permanent oscillation:

	Kp (**P240**)	Ti (**P242**)	Td (**P243**)
P	0.5 Kp_c		
PI	0.45 Kp_c	T_c/1.2	
PID	0.6 Kp_c	T_c/2	T_c/8

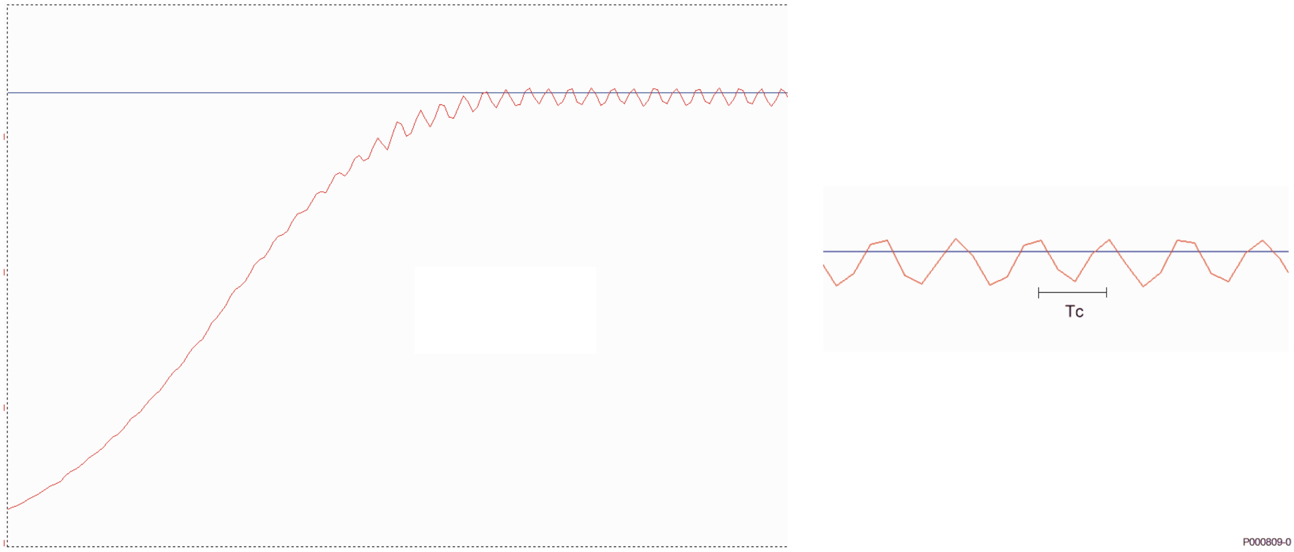


Figure 26: Permanent oscillation with Kp_c critical gain

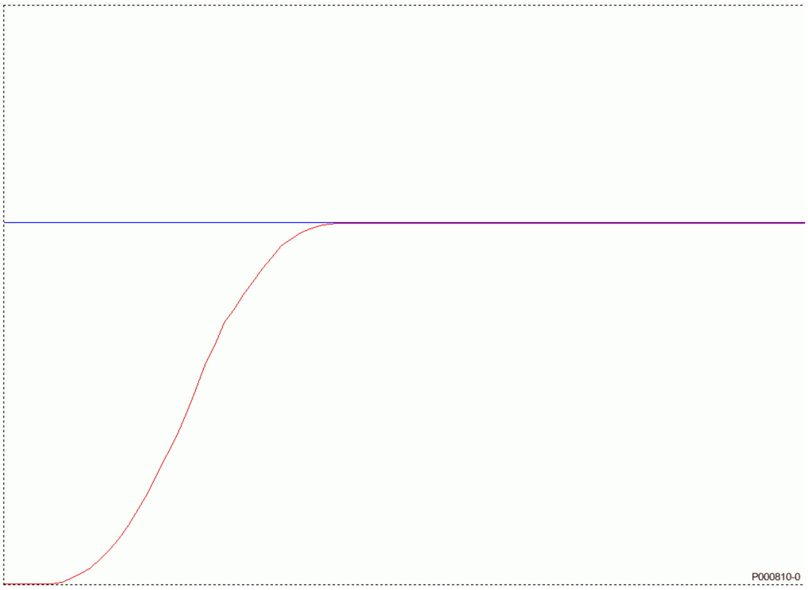


Figure 27: Response to a system tuned with the method of Ziegler and Nichols

NOTE The method of Ziegler and Nichols is not always applicable, because some systems do not produce any oscillations, even in presence of large proportional gains.
However, leading a system close to instability can be very dangerous.

24.3. Manual Tuning of the PI Regulator

The PI regulator con be manually tuned when the tuning method of Ziegler and Nichols is not applicable. The sections below cover the following:

- how the transient is affected from the proportional action when the integral action is kept constant in a PI regulator;
- how the transient is affected from the integral action when the proportional action is kept constant in a PI regulator;
- how the transient is affected from the derivative action in a PID regulator.

24.3.1. Proportional Action (P)

Symbol	Tuning function	Main goal
Kp	An input variance (error) produces an output variance proportional to the variance amplitude	Changes the tuning variable based on the variable being tuned

PI Regulator Ti=Constant	Response to the step	Response time
Small Kp	Overshoot	Longer
Optimum Kp	Optimum	Optimum
Large Kp	Undershoot	Shorter

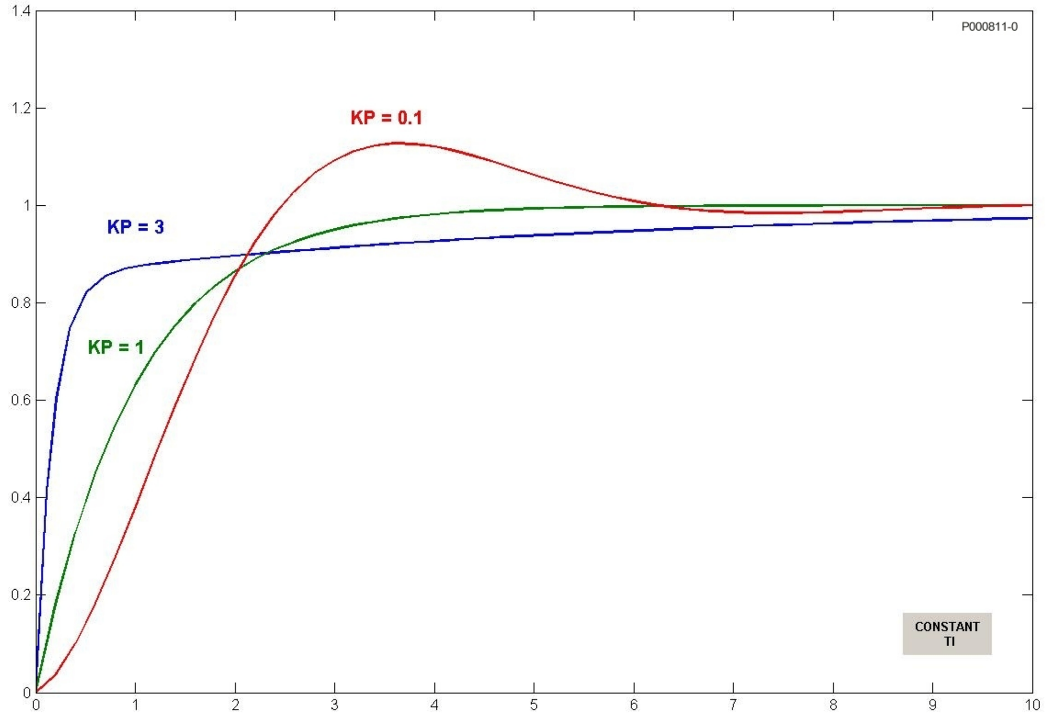


Figure 28: Response to the step based on the value of Kp when Ti is kept constant

When Kp is increased, the error is reduced at constant rate, but the transient can also be adversely affected. Adverse effects can be a longer transient with stronger oscillations due to the damping reduction, or even instability. This is shown in the figure below:

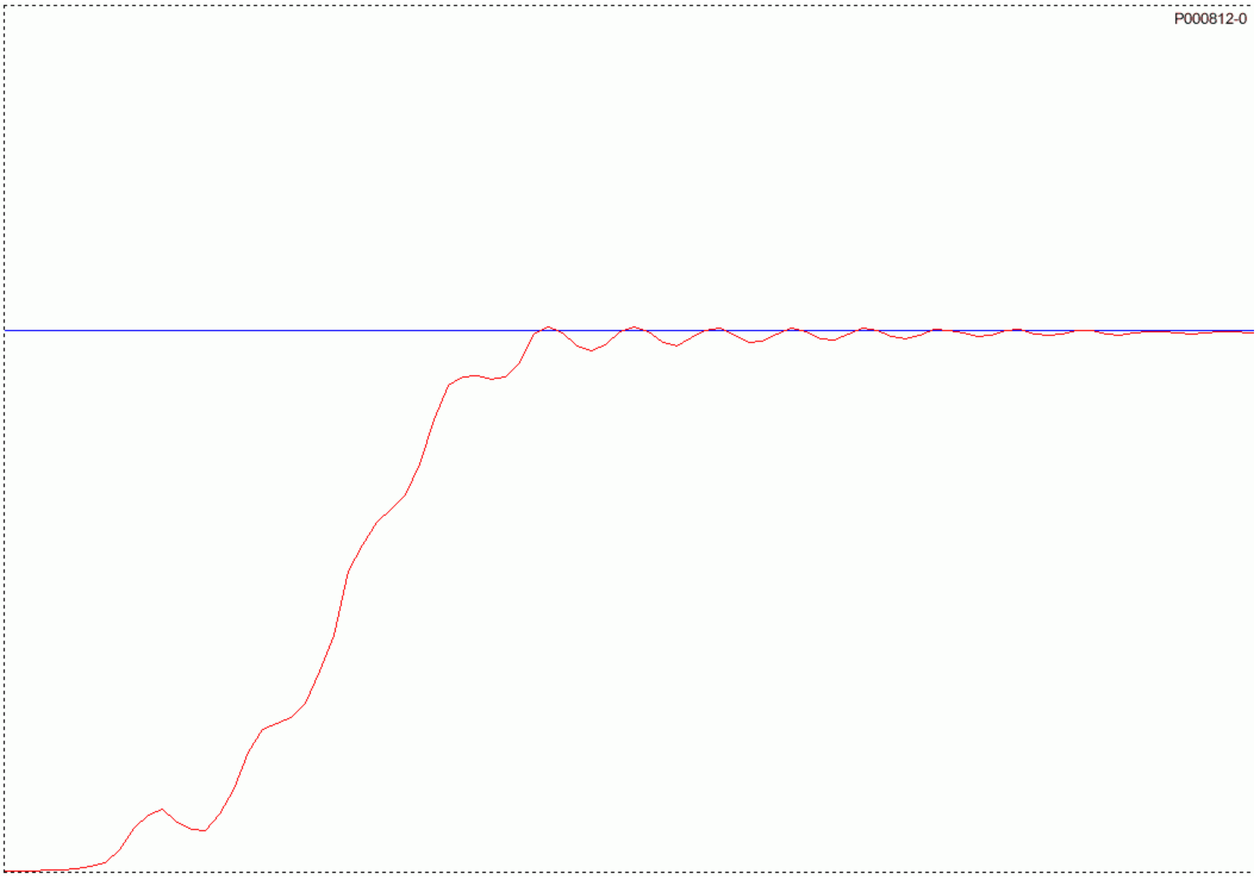


Figure 29: Response to the step when Kp is too large

24.3.2. INTEGRAL ACTION (I)

Symbol	Tuning function	Main goal
Ti	As soon as an input variance occurs (Error), an output variance occurs. The variation rate is proportional to the error magnitude.	Sets the tuning point (eliminates the offset from the proportional action).

PI Regulator	Response to the step	Response time
Small Kp	Overshoot	Shorter
Optimum Kp	Optimum	Optimum
Large Kp	Undershoot	Longer

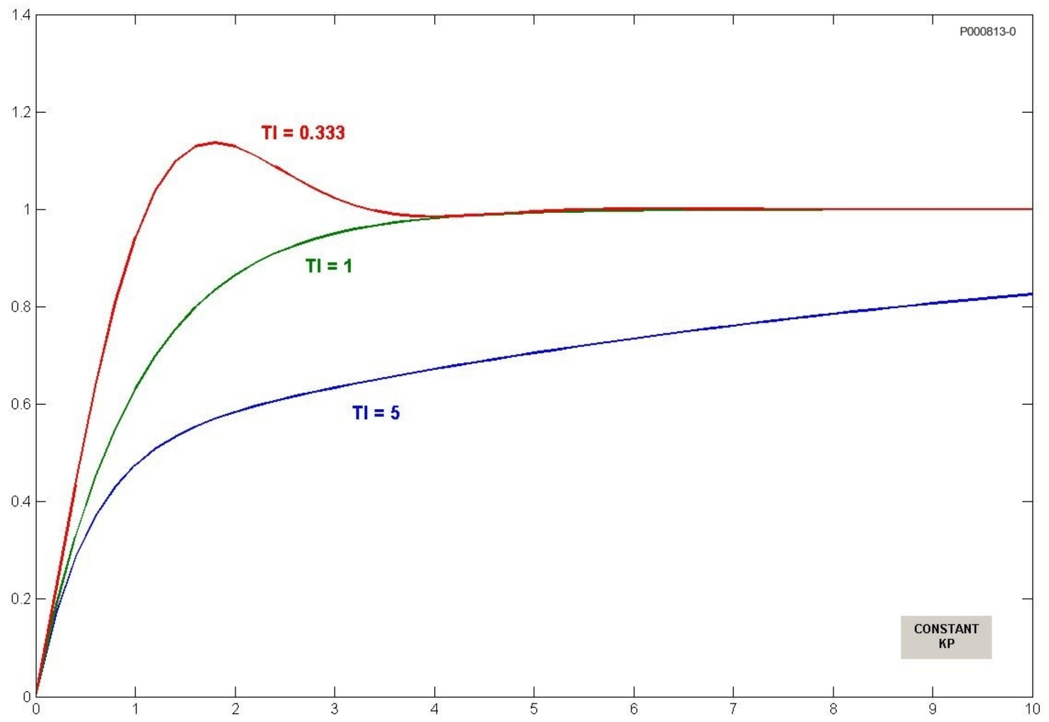


Figure 30: Response to the step based on the value of Ti when Kp is kept constant

The figure below represents the response of the PI regulator when the values for Kp and Ti are lower than the optimum value computed with the ***method of Ziegler and Nichols***.

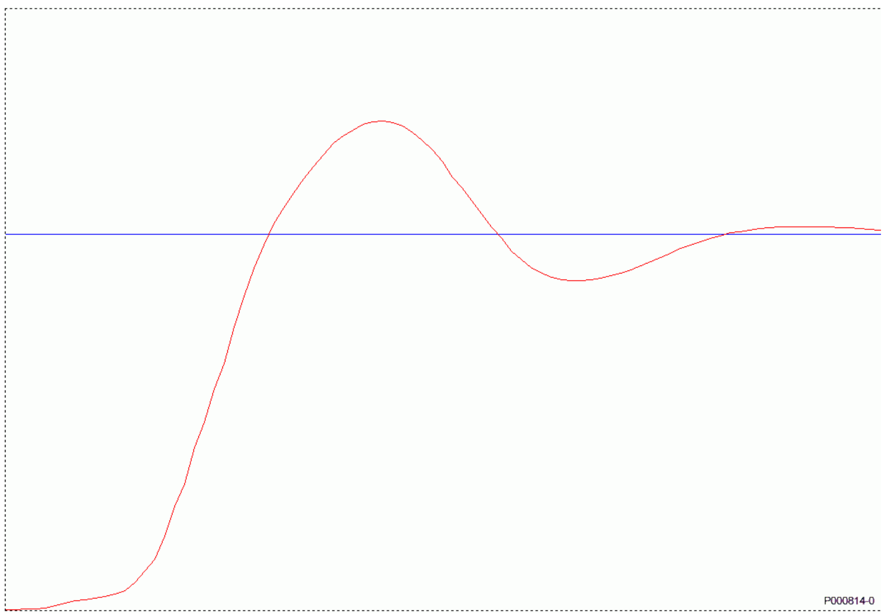


Figure 31: Response to the step when the values of Kp and Ti are too small

24.3.3. Derivative Action (D)

Symbol	Tuning function	Main goal
Td	An input variance (error) generates an output variance proportional to the variance rate	Decreases the response time for the return to the tuning point

The derivative action set with Td increases the stability of the system, thus increasing the transient response. The derivative action tends to get an earlier response, but it increases the system sensitivity to the disturbance overriding the error signal.

24.3.4. Tuning Actions at Constant Speed

When the system is operating at constant speed, the system response shall be the most accurate as possible (minimum error) and shall adjust any little reference variations.

When at constant speed, if the system does not promptly respond to little reference variations, a shorter integral time may solve this problem. Otherwise, when little and long-lasting oscillations affect the reference value, setting a longer integral time could be the right solution.

24.4. Anti-windup

The major benefit of the integral action is to ensure null errors at steady speed. However, just like the derivative action, the integral action shall be applied with caution to avoid worse performance.
A case in point is the output saturation occurring at the same time as an excessive integral action. When the output saturates, the control action is limited, so the error is still remarkable. If the error persists, the actuator will saturate, because the longer the time the error persists, the stronger the integral action is; this phenomenon is called “windup”.
In case of output saturation, the integral term can reach very high values; as a result, the error shall have opposite sign for a long period before exiting from saturation.

The PID regulator of the Penta drive is provided with an Anti-windup function which compensates the effect described above. This Anti-windup action is described below (P=proportional term; I=integral term; D=derivative term).

The output is always calculated as follows:
OUT ← P + I + D

When output saturation occurs:
OUT ← OUTsat

The integral term is forced based on the following:
I ← OUTsat – P – D
(which is the Anti-windup function).

This prevents the integral term from reaching very high values; the integral term is then kept constantly in line with the saturated output value OUTsat that is present at each moment; any variations of the error (i.e. the P) that allows exiting from saturation have immediate effect to the output, without having to wait for a long time before discharging the integral term itself.
The effect of the Anti-windup can be adjusted with parameter **P260**; if **P260**<1, the effect is reduced and the system is less sensitive to error variations; if **P260**=0, the effect is cancelled.

The value of **P260**=1 is correct for the applications requiring to quickly exit from saturation.
On the other hand, reducing **P260** can be useful when output variations are to be avoided for negligible error variations.

24.5. List of Parameters P236 to P260

Table 45: List of Parameters P236 to P260

Parameter	FUNCTION	User Level	Default Values	MODBUS Address
P236	Max. value of PID output	ENGINEERING	+100.00%	836
P237	Min. value of PID output	ENGINEERING	–100.00%	837
P237a	Wake-up Mode	ENGINEERING	0: [Disabled]	858
P237b	Wake-up Level	ENGINEERING	0.00%	859
P238	Max. value of PID integral term	ENGINEERING	+100.00%	838
P239	Max. value of PID derivative term	ENGINEERING	+100.00%	839
P240	PID proportional constant	ENGINEERING	1.000	840
P241	Multiplicative factor of **P240**	ENGINEERING	0:1.0	841
P242	PID Integral time (multiples of **P244**)	ENGINEERING	500*Tc (ms)	842
P243	PID Derivative time (multiples of **P244**)	ENGINEERING	0*Tc (ms)	843
P244	Cycle time of PID regulator: Tc	ENGINEERING	5 ms	844
P245	Min. value of PID reference	ENGINEERING	0.00%	845
P246	Max. value of PID reference	ENGINEERING	+100.00%	846
P247	Min. value of PID feedback	ENGINEERING	0.00%	847
P248	Max. value of PID feedback	ENGINEERING	+100.00%	848
P249	PID reference ramp up time	ENGINEERING	0 s	849
P250	PID reference ramp down time	ENGINEERING	0 s	850
P251	Unit of measure of PID ramp	ENGINEERING	1: [0.1s]	851
P252	PID ramp start rounding off	ENGINEERING	50%	852
P253	PID ramp end rounding off	ENGINEERING	50%	853
P254	Integral term activation threshold	ENGINEERING	0.00%	854
P255	**START** Disable delay with PID Out=**P237**	ENGINEERING	0: [Disabled]	855
P256	PID output gradient limit	ENGINEERING	1 ms	856
P257	Gain for PID measure scaling	ENGINEERING	1.000	857
P260	Gain for Anti-windup	ENGINEERING	1.00	860

P236 Max. Value of PID Output

P236	**Range**	–10000 ÷ +10000	–100.00 ÷ +100.00 %
	Default	+10000	+100.00 %
	Level	ENGINEERING	
	Address	836	
	Function	This is the max. allowable value of PID regulator output. This value is expressed as a percentage; its allocation depends on parameter **C294**, defining PID action. Example: if **C294 = External Out**, the PID regulator delivers a reference obtained based on the controlled variable and its setpoint. In this case, the PID output can be brought outside through an analog output. The matching between **P236** and the output value (see the ANALOG AND FREQUENCY OUTPUTS MENU) is user-defined. If **C294 = Reference**, the PID regulator output is the motor speed/torque reference (the system will ignore any other reference source), parameter **P236** is a percentage referring to the max. value, considered as an absolute value, between the max. and the min. speed/torque reference of the active motor. If **C294 = Add Reference**, the percentage in **P236** relates to the instant value of the speed/torque reference to be adjusted. If a Frequency control is used, the PID regulator can be used to adjust the drive output voltage; in this case, **P236** relates to the instant voltage value (E.g. If a drive delivers 50V and an adjustment of 10% is implemented, the drive will deliver 55V).	

P237 Min. Value of PID Output

P237	**Range**	–10000 ÷ +10000	–100.00 ÷ +100.00 %
	Default	–10000	–100.00 %
	Level	ENGINEERING	
	Address	837	
	Function	This is the min. allowable value of PID regulator output. For the value percent of **P237**, see the description of parameter **P236**.	

P237a Wake-up Mode

P237a	**Range**	0 ÷ 4	0: Disabled 1: Feedback < **P237b** 2: Feedback > **P237b** 3: Error < **P237b** 4: Error > **P237b**
	Default	0	0: Disabled
	Level	ENGINEERING	
	Address	858	
	Function	If this parameter is disabled, the PID control re-activates only when the PID output exceeds the value set in parameter **P237**. If this parameter is enabled, the PID control re-activates when the PID output exceeds the threshold set in parameter **P237** and: **P237a**=1: the Feedback value drops below the level set with **P237b;** **P237a**=2: the Feedback value exceeds the level set with **P237b;** **P237a**=3: the Error value drops below the level set with **P237b**; **P237a**=4: the Error value exceeds the level set with **P237b**.	

P237b Wake-up Level

P237b			
	Range	–10000 ÷ +10000	–100.00 ÷ +100.00 %
	Default	0	0.00 %
	Level	ENGINEERING	
	Address	859	
	Function	Level of the Feedback or Error signal allowing re-activating the PID control (see **P237a**).	

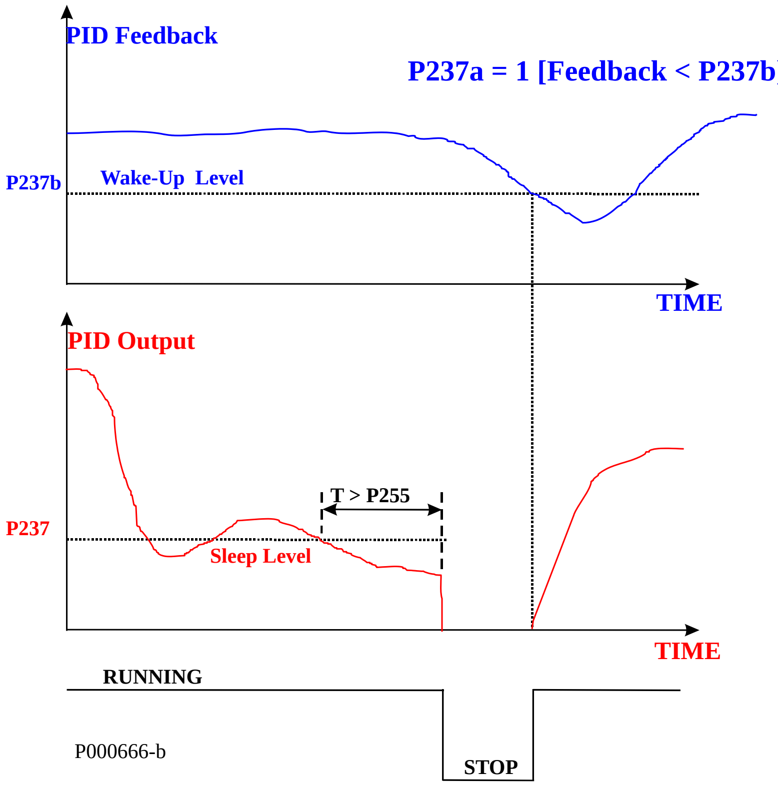


Figure 32: PID Sleep and Wake-up Mode when P237a is set to 1

P238 Max. Value of Integral Term

P238			
	Range	0 ÷ 10000	–100.00 ÷ +100.00 %
	Default	10000	+100.00 %
	Level	ENGINEERING	
	Address	838	
	Function	This is the max. allowable value of the integral term. It is to be considered as an absolute value; the output value resulting from the integral term ranges from + **P238** to **– P238.**	

P239 Max. Value of Derivative Term

P239	**Range**	0 ÷ 10000	–100.00 ÷ +100.00 %
	Default	10000	+100.00 %
	Level	ENGINEERING	
	Address	839	
	Function	This is the max. allowable value of the derivative term; it is to be considered as an absolute value; the output value resulting from the derivative term ranges from **+ P239** to **– P239**.	

P240 PID Proportional Constant

P240	**Range**	0 ÷ 65000	0 ÷ 65.000
	Default	1000	1.000
	Level	ENGINEERING	
	Address	840	
	Function	This is the value of the proportional coefficient. The PID regulator will use Kp resulting from the product of **P240** multiplied by **P241** (multiplicative factor).	

P241 Multiplicative Factor of P240

P241	**Range**	0÷2	0: 1.0 1: 10.0 2: 100.0
	Default	0	0: 1.0
	Level	ENGINEERING	
	Address	841	
	Function	Multiplicative factor of the proportional coefficient. This is used to obtain a wider range for the proportional coefficient used in PID regulator and ranging from 0.000 to 6500.0. Supposing that the default values are used for **P240** and **P241**, the proportional coefficient used in the PID regulator is unitary: in case an error of 1% occurs between the reference and the controlled variable, the proportional term, representing one of the three values of the regulator output, will be 1%.	

P242 PID Integral Time (Multiples of P244)

P242	**Range**	0 ÷ 65000	0: Disabled ÷ 65000 * Tc (ms)
	Default	500	500* Tc (ms)
	Level	ENGINEERING	
	Address	842	
	Function	**Ti** constant dividing the integral term of PID regulator: **Ki** = 1/**Ti** = 1/(**P242***Ts) It is expressed in sampling time units **Ts** (see **P244**). If this parameter is set to zero, the integral action is cancelled.	

P243 PID Derivative Time (Multiples of P244)

P243	**Range**	0 ÷ 65000	0 ÷ 65.000 * Tc (ms)
	Default	0	0*Tc (ms)
	Level	ENGINEERING	
	Address	843	
	Function	Constant multiplying the derivative term of PID regulator. If this parameter is set to zero, the derivative action is disabled.	

P244 Cycle Time of PID Regulator: Tc

P244			
	Range	5 ÷ 65000	0 ÷ 65000 ms
	Default	5	5 ms
	Level	ENGINEERING	
	Address	844	
	Function	This parameter sets the cycle time of PID regulator. It is expressed in ms (multiples of 5 only). Example: if **P244** = 1000 ms, the PID regulator cycle will be executed every second, and the output will be refreshed every second as well.	

P245 Min. Value of PID Reference

P245			
	Range	–32000 ÷ +32000	±320.00%
	Default	0	0.00%
	Level	ENGINEERING	
	Address	845	
	Function	This parameter defines the min. allowable value of the PID reference. The PID references are to be considered as percentage values. If analog references are selected, **P245** relates to the minimum value of the selected analog input. Example: Select AIN1 analog input as the PID reference and suppose that its max. and min. values are +10V and –10V respectively. If **P245** is –50%, this means that the PID reference will be saturated at –50% for voltage values lower than –5V.	

P246 Max. Value of PID Reference

P246			
	Range	–32000 ÷ +32000	±320.00%
	Default	+10000	+100.00%
	Level	ENGINEERING	
	Address	846	
	Function	This parameter defines the max. allowable value of the PID reference. See the description of **P245**.	

P247 Min. Value of PID Feedback

P247			
	Range	–32000 ÷ +32000	±320.00%
	Default	0	0.00%
	Level	ENGINEERING	
	Address	847	
	Function	This parameter defines the min. allowable value of the PID feedback. See the description of **P245**.	

P248 Max. Value of PID Feedback

P248			
	Range	–32000 ÷ +32000	±320.00%
	Default	+10000	+100.00%
	Level	ENGINEERING	
	Address	848	
	Function	This parameter defines the max. allowable value of the PID feedback. See the description of **P245**.	

P249 PID Reference Ramp Up Time

P249			
	Range	0 ÷ 32700	Function of **P251**
	Default	0	0 s
	Level	ENGINEERING	
	Address	849	
	Function	This parameter defines the ramp up time of the PID regulator reference from 0% to the max. allowable absolute value (max. {|**P245**|,|**P246**|}).	

P250 PID Reference Ramp Down Time

P250			
	Range	0 ÷ 32700	Function of **P251**
	Default	0	0 s
	Level	ENGINEERING	
	Address	850	
	Function	This parameter defines the ramp down time of the PID regulator reference, from max. allowable value (max. {|**P245**|,|**P246**|}) to 0%.	

P251 Unit of measure of PID Ramp

P251			
	Range	0 ÷ 3	0: 0.01 s 1: 0.1 s 2: 1.0 s 3: 10.0 s
	Default	1	1: 0.10 s
	Level	ENGINEERING	
	Address	851	
	Function	This parameter defines the unit of measure for the PID reference ramp times. It defines the unit of measure for the time of the third ramp of the PID reference **P249** and **P250**, so that the allowable range becomes 0s – 327000s.	

Example:

P251		**Range P249 – P250**	
Value	**Coding**	**Min.**	**Max.**
0	0.01 s	0	327.00 s
1	0.1s	0	3270.0 s
2	1.0 s	0	32700 s
3	10.0 s	0	327000 s

NOTE

Factory-setting: the PID reference ramp is zero; if a given ramp time is set up, the ramp will be rounded off (50% at the beginning and at the end of the ramp). See parameters **P252** and **P253**.

P252 PID Ramp Start Rounding Off

P252			
	Range	0 ÷ 100	0 % ÷ 100%
	Default	50	50%
	Level	ENGINEERING	
	Address	852	
	Function	This parameter sets the time period of the rounding off applied to the first stage of the ramps. It is expressed as a percentage of the ramp up/down time. Example: ramp up of 5sec.: **P252** = 50% means that the speed reference is limited in acceleration for the first 2.5 sec of the ramp up.	

NOTE When **P252** is used, the preset ramp time is increased by (**P252**%)/2.

P253 PID Ramp End Rounding Off

P253			
	Range	0 ÷ 100	0 % ÷ 100%
	Default	50	50%
	Level	ENGINEERING	
	Address	853	
	Function	As **P252**, but **P253** sets the rounding off applied at the end of the ramps.	

NOTE When **P253** is used, the preset ramp time is increased by (**P253%**)/2.

P254 Integral Term Activation Threshold

P254			
	Range	0.0 ÷ 5000	0.0 % ÷ 500.0%
	Default	0	0.0 %
	Level	ENGINEERING	
	Address	854	
	Function	This parameter sets a threshold value below which the integrator is kept to zero. It has effect only when the PID regulator is used as a reference corrector or generator. In this case, the threshold percentage value refers to the max. speed (or torque) absolute value set for the active motor. The integral term is not calculated when the speed (or torque) percentage value expressed as an absolute value is lower than the value set in **P254**. If **P254** is set to zero, the integrator is always activated.	

P255 START Disable Delay with PID Out=P237

P255			
	Range	0 ÷ 60000	0: Disabled 1 ÷ 60000 s
	Default	0	0: Disabled
	Level	ENGINEERING	
	Address	855	
	Function	This parameter sets the max. time for the drive operation when the PID regulator output continuously operates at its min. value (**P237**). If this is true for a time equal to the time set in **P255**, the drive is automatically put on stand-by until 1) the PID output value exceeds the min. value (if **P237a**=Disabled); 2) the Feedback or the Error drops below the Wake-up level in **P237b** (if **P237a**=1 or =3 respectively); 3) when the Feedback or the Error exceeds the Wake-up level in **P237b** (if **P237a**=2 or =4 respectively). If **C294** is set as External Out or **P255** is set to zero, this function is disabled.	

P256 PID Output Gradient Limit

P256			
	Range	1 ÷ 65000	1 ÷ 65000msec
	Default	1	1msec
	Level	ENGINEERING	
	Address	856	
	Function	This parameter limits the max. acceleration for the PID regulator output. The max. acceleration for the PID regulator output is equal to 100% / **P256** [%/msec].	

P257 Gain for PID Measure Scaling

P257			
	Range	0 ÷ 65535	0.000 ÷ 65.535
	Default	1	1.000
	Level	ENGINEERING	
	Address	857	
	Function	Gain for the scaling of PID measures **M023** ÷ **M024**. This gain has effect only on the measures above. It does not affect the PID operation. This parameter allows scaling if you want to display PID measures with a different unit of measure: **M023** = **M020** * **P257** **M024** = **M021** * **P257**	

P260 Anti Wind-Up Gain

P260			
	Range	0 ÷ 100	0.00 ÷ 1.00
	Default	100	1.00
	Level	ENGINEERING	
	Address	860	
	Function	Value of the Anti Wind-Up coefficient that freezes the integral term of the PID when its output is being saturated (see Anti-windup). When leaving **P260**=1.00, Anti Wind-Up is complete (I ← OUTsat – P – D). If **P260**=0.00, Anti Wind-Up is inhibited (the integral term reaches the value of ±**P238** based on the error sign). Intermediate values for **P260** give intermediate effects.	

25. PID2 PARAMETERS MENU

25.1. Overview

This menu defines the parameters of the digital regulator PID2 as well as the parameters used in 2-zone mode.

To activate the PID2 regulator, set **C291a = 7: 2 PID** (PID CONFIGURATION MENU).
Once activated, the PID2 regulator has the same functionality and operates in line with the standard PID (PID PARAMETERS MENU). The output of the standard PID regulator is algebraically summed with the output of the PID2 regulator.
Add “200” to the parameter codes pertaining to the standard PID to obtain the relevant parameter codes for PID2. Example: **P236** for standard PID corresponds to **P436** for PID2.

To enable the 2-zone mode, set **C291a = 5: 2-Zone MIN** or **6: 2-Zone MAX** (PID CONFIGURATION MENU).
Once the 2-zone mode is enabled, the standard PID regulator operates on the system with the larger error (minimum feedback in respect to its reference, **2-Zone MIN**) or with the smaller error (maximum feedback in respect to its reference, **2-Zone MAX**).
In 2-zone mode, parameters **P236**..**P260** pertain to the system where the error results from the reference selected with **C285** and from the feedback selected with **C288**, whilst parameters **P436**..**P460** pertain to the system where the error results from the reference selected with **C286** and from the feedback selected with **C289.**

NOTE The PID2 regulator is disabled when operating in 2-zone mode.

Please refer to the block diagram in Figure 72.

25.2. List of Parameters P436 to P460

Table 46: List of Parameters P436 to P460

Parameter	FUNCTION	User Level	DEFAULT VALUES	MODBUS Address
P436	Max. value of PID2 output	ENGINEERING	+100.00%	1346
P437	Min. value of PID2 output	ENGINEERING	–100.00%	1347
P437a	Wake-up Mode	ENGINEERING	0: [Disabled]	1282
P437b	Wake-up Level	ENGINEERING	0.00%	1283
P438	Max. value of PID2 integral term	ENGINEERING	+100.00%	1348
P439	Max. value of PID2 derivative term	ENGINEERING	+100.00%	1349
P440	PID2 proportional constant	ENGINEERING	1.000	1350
P441	Multiplicative factor of **P440**	ENGINEERING	0:1.0	1351
P442	PID2 Integral time (multiples of **P444**)	ENGINEERING	500*Tc (ms)	1352
P443	PID2 Derivative time (multiples of **P444**)	ENGINEERING	0*Tc (ms)	1353
P444	Cycle time of PID2 regulator: Tc	ENGINEERING	5 ms	1354
P445	Min. allowable value of PID2 reference	ENGINEERING	0.00%	1355
P446	Max. allowable value of PID2 reference	ENGINEERING	+100.00%	1356
P447	Min. allowable value of PID2 feedback	ENGINEERING	0.00%	1357
P448	Max. allowable value of PID2 feedback	ENGINEERING	+100.00%	1358
P449	PID2 reference ramp up time	ENGINEERING	0 s	1359
P450	PID2 reference ramp down time	ENGINEERING	0 s	1360
P451	Unit of measure of PID2 ramp	ENGINEERING	1: [0.1s]	1361
P452	PID2 ramp start rounding off	ENGINEERING	50%	1362
P453	PID2 ramp end rounding off	ENGINEERING	50%	1363
P454	Integral term activation threshold	ENGINEERING	0.00%	1364
P455	**START** Disable delay with PID2 output=**P437**	ENGINEERING	0: [Disabled]	1284
P456	PID2 output gradient limit	ENGINEERING	1 ms	1368
P457	Gain for PID2 measure scaling	ENGINEERING	1.000	1369
P460	Gain for Anti Wind-Up	ENGINEERING	1.00	1370

NOTE Parameters **P437a**, **P437b** and **P455** are overridden if the Two PIDs mode is selected with “summed outputs” (**C291a** = **7: 2 PID** and **C171a** = **0: Disabled**).

NOTE For a detailed description of these parameters, see List of Parameters P236 to P260 related to PID.

26. DIGITAL OUTPUTS MENU

26.1. Overview

The Digital Outputs menu includes the parameters allowing configuring the drive digital outputs (MDO1, MDO2, MDO3 and MDO4).

NOTE The Digital Outputs menu may be accessed only if the user level is ADVANCED or ENGINEERING.

NOTE For a detailed hardware description of the digital outputs, please refer to the Sinus Penta's Installation Guide.

NOTE MDO1 digital output can be programmed only if the frequency output is not set up (**P200** = Disable; see the ANALOG AND FREQUENCY OUTPUTS MENU).

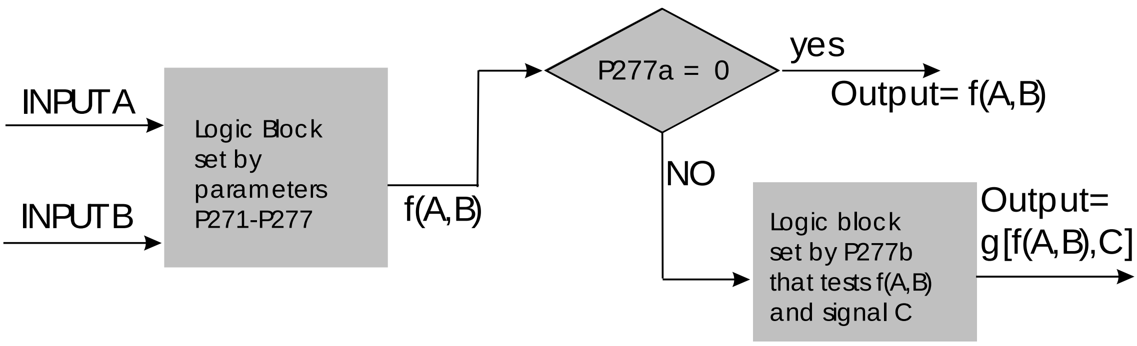
NOTE XMDI digital outputs (values from 13 to 20 in the parameters relating to the control functions) can be set up only after setting XMDI/O in parameter **R023**.

26.1.1. Factory Settings

The factory settings are as follows:
MDO1 is a zero speed relay (it energizes when a preset threshold is exceeded).
MDO2 controls an electromechanical brake used for hoisting applications (it energizes to release the brake).
MDO3 de-energizes (fail-safe logic) in case of “Inverter Alarm”.
MDO4 energizes when the drive is running and is enabling the power stage (“Inverter Run OK” condition).

26.1.2. Structure of the Digital Outputs

A digital output is composed of two logic blocks allowing data processing before actuating the actual digital output. Block 2 depends on the settings in parameters **P277a** (**P286a, P295a, P304a**).



P000659-b

Figure 33: MDO block-diagram

Operating modes set in MDO1 (2,3,4) Digital Output: P270, (P279, P288, P297)

The user can select one of the following operating modes:

Table 47: Digital Output Mode

DISABLE	The selected digital output is disabled.
DIGITAL	The digital output depends on a selected digital signal and on the logic output function (True/False). See Examples 1 and 2.
DOUBLE DIGITAL	The digital output depends on 2 selected digital signals, on the logic function calculating the output value and on the logic output function (True/False).
ANALOG	The digital output depends on a selected analog variable, which is tested through Test A obtaining one digital signal; starting from its value, the selected logic function calculates the True/False end value. See Example 3.
DOUBLE ANALOG	The digital outputs depends on 2 selected analog variables: Test A is performed for variable A, whilst Test B is performed for variable B, thus obtaining 2 digital signals; starting from their value, the selected logic function calculates the output value, whereas the logic output function True/False calculates the end value.
DOUBLE FULL	As DOUBLE ANALOG or DOUBLE DIGITAL mode, but both digital signals and analog variables can be selected. If you select a digital signal, its value (TRUE or FALSE) is used to calculate the selected logic function. If you select an analog variable, the test selected for this variable is performed, and its result (TRUE or FALSE) is used to calculate the selected logic function.
BRAKE (*)	As ABS BRAKE below, although the selected variables are not expressed as absolute values, but depend on the selected tests.
ABS BRAKE (*)	The ABS BRAKE mode allows controlling the electromechanical brake of a motor used for hoisting applications. The ABS BRAKE mode is applied by selecting the measured (or estimated) torque demand [A10] as the first variable, and the ramp output [A03] as the second variable. Variables are considered as absolute values. See Example 4: Digital output for electromechanical brake for hoisting applications (programming example related to MDO3 digital output).
ABS LIFT (*)	As ABS BRAKE, but the brake unlocks (digital output open) when a given torque value is attained, which is automatically determined based on the last torque value required in the previous stroke.
PWM MODE	The PWM mode may be selected for digital outputs MDO1 and MDO2 only (it cannot be selected for relay digital outputs MDO3 and MDO4). The digital output becomes a low-frequency PWM output with a duty–cycle proportional to the value of the selected analog output. See Example 5: Using the PWM Function.

(*) The activation and deactivation of the outputs programmed as **BRAKE**, **ABS BRAKE** and **ABS LIFT** is affected also by other conditions depending on the drive status. Namely:

Activation	Conditions to be considered in logic AND with the following programmed functions: • Drive accelerating and (AND) with absolute value speed >1 rpm or (OR) drive in pretensioning stage [*] AND Inverter running smoothly (no alarms triggered). [*] This means that the torque setpoint has attained the level set in **C300** or **C300a** (see BRIDGE CRANE MENU).
Deactivation	Conditions to be considered in logic OR with the following programmed functions: • Drive not running or locked due to an OR alarm condition (Inverter in tracking error [*] AND **C303** = YES [**]) [*] The tracking error does not necessarily lock the drive due to **A080**: this depends on **C194** (see ENCODER/FREQUENCY INPUTS MENU). [**] This means that in case of a tracking error, the relay output is deactivated (the brake is activated) (see BRIDGE CRANE MENU).

CAUTION

The digital outputs programmed as **BRAKE**, **ABS BRAKE** or **ABS LIFT** are inactive in a drive configured in slave mode (torque control).
In a master/slave system, both electromechanical brakes must be controlled by the master.

Variable A Selected for MDO1 (2,3,4): P271, (P280, P289, P298)

This selects the digital signal or the analog variable used for Test A (set with **P273/P282/P291/P300**).
The whole list of the selectable items and their description appears at the end of this section (see Table 48).
If a digital signal is selected, Test A is not performed: therefore, the comparison value for Test A (set with **P275/P284/P293/P302**) has no meaning.

NOTE This parameter can be accessed only if the operating mode of the digital output concerned is other than zero. Example: MDO1 **P270**≠0.

Variable B selected for MDO1 (2,3,4): P272, (P281, P290, P299)

This selects a different digital signal or the analog variable used for Test B (set with **P274/P283/P292/P301**).
The whole list of the selectable items and their description appears at the end of this section (see Table 48).
If a digital signal is selected, Test B is not performed: therefore, the comparison value for Test B (set with **P276**/**P285**/**P294**/**P303**) has no meaning.

NOTE Parameter **P272** cannot be accessed when the digital output operating mode is 1: DIGITAL or 3: ANALOG.

Example: MDO1 **P270**=1 OR **P270**=3.

Table 48: List of the selectable digital signals and analog variables

Selectable digital signals (BOOLEAN):

Selectable Value	Description
D0: Disabled	Always FALSE: 0
D1: Inverter Run Ok	Drive running (no standby)
D2: Inverter Ok On	Inverter ok: no alarms tripped
D3: Inverter Alarm	Drive alarm tripped
D4: Inverter Run Alarm	Drive KO: alarm tripped when the drive is running
D5: Fwd Running	Speed (measured or estimated) higher than +0.5 rpm
D6: Rev Running	Speed (measured or estimated) lower than –0.5 rpm
D7: Limiting Motor	Drive in limiting mode operating as a motor
D8: Limiting Generator	Drive in limiting mode operating as a generator
D9: Limiting	Drive in limiting mode (generator or motor)
D10: Precharge Ok	Capacitor Precharge relay closure and command return test
D11: PID Out Max	PID output max. saturation
D12: PID Out Min	PID output min. saturation
D13: MDI 1	Selected MDI1digital input (remote OR physical)
D14: MDI 2	Selected MDI2 digital input (remote OR physical)
D15: MDI 3	Selected MDI3 digital input (remote OR physical)
D16: MDI 4	Selected MDI4 digital input (remote OR physical)
D17: MDI 5	Selected MDI5 digital input (remote OR physical)
D18: MDI 6	Selected MDI6 digital input (remote OR physical)
D19: MDI 7	Selected MDI7 digital input (remote OR physical)
D20: MDI 8	Selected MDI8 digital input (remote OR physical)
D21: Enable	ENABLE function (remote AND physical)
D22: Enable SW	ENABLE-SW function (remote AND physical)
D23: MDI 1 Delayed	MDI1 Digital input (remote OR physical) DELAYED by MDI timers
D24: MDI 2 Delayed	MDI1 Digital input (remote OR physical) DELAYED by MDI timers
D25: MDI 3 Delayed	MDI1 Digital input (remote OR physical) DELAYED by MDI timers
D26: MDI 4 Delayed	MDI1 Digital input (remote OR physical) DELAYED by MDI timers
D27: MDI 5 Delayed	MDI5 Digital input (remote OR physical) DELAYED by MDI timers
D28: MDI 6 Delayed	MDI6 Digital input (remote OR physical) DELAYED by MDI timers
D29: MDI 7 Delayed	MDI7 Digital input (remote OR physical) DELAYED by MDI timers
D30: MDI 8 Delayed	MDI8 Digital input (remote OR physical) DELAYED by MDI timers
D31: Enable Delayed	ENABLE function (remote AND physical) DELAYED by MDI timers
D32: Tracking Error	Speed tracking error: |SetPoint – Measure| > Error_Par

Selectable Value	Description
D33: Fan Fault	Fault of the cooling fan
D34: Field Bus Cmd1	Command 1 from fieldbus
D35: Field Bus Cmd2	Command 2 from fieldbus
D36: Field Bus Cmd3	Command 3 from fieldbus
D37: Field Bus Cmd4	Command 4 from fieldbus
D38: Fire Mode	Fire Mode function
D39: Local	LOCAL Mode
D40: Speed Ok	Constant speed reference reached
D41: Fan ON	Fan activation command
D42: XMDI1	XMDI1 Auxiliary digital input
D43: XMDI2	XMDI2 Auxiliary digital input
D44: XMDI3	XMDI3 Auxiliary digital input
D45: XMDI4	XMDI4 Auxiliary digital input
D46: XMDI5	XMDI5 Auxiliary digital input
D47: XMDI6	XMDI6 Auxiliary digital input
D48: XMDI7	XMDI7 Auxiliary digital input
D49: XMDI8	XMDI8 Auxiliary digital input
D50: MPL1 Delayed	Virtual digital input resulting from MPL1 output DELAYED from MPL Timers
D51: MPL2 Delayed	Virtual digital input resulting from MPL2 output DELAYED from MPL Timers
D52: MPL3 Delayed	Virtual digital input resulting from MPL3 output DELAYED from MPL Timers
D53: MPL4 Delayed	Virtual digital input resulting from MPL4 output DELAYED from MPL Timers
D54: OTM Elapsed	Maintenance Operation Time elapsed
D55: STM Elapsed	Maintenance Supply Time elapsed
D56: MDO1 Delayed	Virtual digital input resulting from MDO1 output DELAYED from MDO Timers
D57: MDO2 Delayed	Virtual digital input resulting from MDO2 output DELAYED from MDO Timers
D58: MDO3 Delayed	Virtual digital input resulting from MDO3 output DELAYED from MDO Timers
D59: MDO4 Delayed	Virtual digital input resulting from MDO4 output DELAYED from MDO Timers
D60: TFL1	Timed flag TFL1
D61: TFL2	Timed flag TFL2
D62: TFL3	Timed flag TFL3
D63: TFL4	Timed flag TFL4
D64: NTC Fault	NTC Fault (heatsink temperature measurement)
D65: Cumulative Warning	Logic OR of W40 (FAN FAULT), W50 (NTC FAULT), W48 (OT TIME OVER), W49 (ST TIME OVER)
D66: Dec to Stop	Deceleration due to START opening or STOP activation
D67: Reserved	
D68: Accelerating	Motor accelerating
D69: Decelerating	Motor decelerating
D70-D73: Reserved	
D74: kWh pulse	One pulse 500 ms long each kWh
D75: 2nd Motor Active	Second Motor active
D76: 3rd Motor Active	Third Motor active
D77-D79: Reserved	

Selectable analog variables:

Selectable Value	Full-scale Value	Kri	Description
A00: GROUND			Analog 0 Volt
A01: Speed	10000 rpm	1	Motor speed
A02: Spd REF.	10000 rpm	1	Speed reference at constant speed
A03: RampOut	10000 rpm	1	Speed reference when ramps are over
A04: MotFreq	1000.0 Hz	10	Frequency produced by the drive
A05: MotCurr	5000.0 A	10	Current RMS
A06: OutVolt	2000.0 V	10	Output voltage RMS
A07: Out Pow	1000.0 kW	10	Output power
A08: DC Vbus	2000.0 V	10	DC-link voltage
A09: Torq.REF	100.00 %	100	Torque reference at constant speed
A10: Torq.DEM	100.00 %	100	Torque demand
A11: Torq.OUT	100.00 %	100	Estimation of the torque output
A12: Torq.LIM	100.00 %	100	Torque limit setpoint
A13: PID REF	100.00 %	100	PID reference at constant speed
A14: PID RMP	100.00 %	100	PID reference when ramps are over
A15: PID Err	100.00 %	100	Error between PID reference and PID feedback
A16: PID Fbk	100.00 %	100	PID feedback
A17: PID Out	100.00 %	100	PID output
A18: REF	100.00 %	100	Analog input REF
A19: AIN1	100.00 %	100	Analog input AIN1
A20: AIN2/Pt	100.00 %	100	Analog input AIN2/PTC
A21: EncIn	10000 rpm	1	Speed read from encoder and used as a reference
A22: PulseIn	100.00 kHz	100	Frequency input
A23: Flux REF	1.0000 Wb	10000	Flux reference at constant speed
A24: Flux	1.0000 Wb	10000	Active flux reference
A25: Iq REF	5000.0 A	10	Current reference in Q-axis
A26: Id REF	5000.0 A	10	Current reference in D-axis
A27: Iq	5000.0 A	10	Current measure in Q-axis
A28: Id	5000.0 A	10	Current measure in D-axis
A29: Volt Vq	2000.0 V	10	Voltage measure in Q-axis
A30: Volt Vd	2000.0 V	10	Voltage measure in D-axis
A31: Cosine	100.00 %	100	Cosine waveform (see **P214**)
A32: Sine	100.00 %	100	Sine waveform (see **P214**)
A33: Angle	100.00 %	100	Electric angle (see **P214**)
A34: +10V			Analog +10 Volt
A35: –10V			Analog –10 Volt
A36: Flux Current	5000.0 A	10	Flux current
A37: SqrWave	100.00 %	100	Square wave
A38: Saw Wave	100.00 %	100	Saw wave
A39: HtsTemp.	100.00 °C	100	Heatsink temperature
A40: AmbTemp.	100.00 °C	100	Ambient temperature
A41 ÷ A49: Reserved			
A50: PT100_1	320.00 °C	100	PT100 channel 1
A51: PT100_2	320.00 °C	100	PT100 channel 2
A52: PT100_3	320.00 °C	100	PT100 channel 3
A53: PT100_4	320.00 °C	100	PT100 channel 4
A54: I2t%	100.00 %	100	Motor thermal capacity
A55: XAIN4	100.00 %	100	XAIN4 analog input
A56: XAIN5	100.00 %	100	XAIN5 analog input
A57: OT Counter	320000 h	1	Maintenance Operation Time counter
A58: ST Counter	320000 h	1	Maintenance Supply Time counter
A59: PID2 REF	100.00 %	100	PID2 reference at constant speed
A60: PID2 RMP	100.00 %	100	PID2 reference when ramps are over
A61: PID2 Fbk	100.00 %	100	Error between PID2 reference and PID2 feedback
A62: PID2 Err	100.00 %	100	PID2 feedback
A63: PID2 Out	100.00 %	100	PID2 output
A64: Torque Demand %	100.00 %	100	Torque demand (percentage)
A65: Actual Current Iv	5000.0 A	10	Output current Iv
A66 ÷ A69: Reserved			
Minimum value = –3.2 x Full-scale value **Maximum value = 3.2 x Full-scale value** **MODBUS value = Parameter value x Kri** **Kri = full-scale number of decimals**			

Testing Variable A for MDO1 (2,3,4): P273, (P282, P291, P300)

If an analog variable is selected, a logic TEST is performed to obtain a TRUE/FALSE Boolean signal.
Seven different tests are available, that can be performed for selected variable A and its comparing value A:

Table 49: Test functions

GREATER THAN	Selected variable > comparing value
GREATER THAN/EQUAL TO	Selected variable ≥ comparing value
LOWER	Selected variable < comparing value
LOWER THAN/EQUAL TO	Selected variable ≤ comparing value
ABS, GREATER THAN	Absolute value (selected variable) > comparing value
ABS, GREATER THAN/EQUAL TO	Absolute value (selected variable) ≥ comparing value
ABS, LOWER	Absolute value (selected variable) < comparing value
ABS, LOWER THAN/EQUAL TO	Absolute value (selected variable) ≤ comparing value

NOTE This parameter can be accessed only if the operating mode of the selected digital output is > 2. Example: MDO1 **P270**>2.

Testing Variable B for MDO1 (2,3,4): P274, (P283, P292, P301)

If an analog variable is selected, a logic TEST is performed to obtain a TRUE/FALSE Boolean signal.
Seven different tests are available, that can be performed for selected variable B and its comparing value B (see Table 49).

NOTE This parameter can be accessed only if the operating mode of the selected digital output is > 2 and < 9. Example: MDO1 2<**P270**<9.

Reference threshold for P271 (P280, P289, P298) in MDO1: P275, (P284, P293, P302)

This defines the comparing value of Test A with the first selected variable.

NOTE This parameter can be accessed only if the operating mode of the selected digital output is > 2. Example: MDO1 **P270**>2.

Reference threshold for P272 (P281, P290, P299) in MDO2 (3,4): P276, (P285, P294, P303)

This defines the comparing value of Test B with the first selected variable.

NOTE This parameter can be accessed only if the operating mode of the selected digital output is > 2. Example: MDO1 **P270**>2.

MDO1 (2, 3, 4): Function Applied to the Result of Tests A and B: P277, (P286, P295, P304)

A logic function is applied to the two Boolean signals obtained in order to obtain the output TRUE/FALSE Boolean signal. Six different tests may be performed for variable (A) using the comparing value and variable (B).

(A) OR (B): The selected digital output is enabled when at least one of the two conditions below is true (this function also allows enabling the selected digital input based on one test only).

(A) OR (B)		
Test A	**Test B**	**Output**
0	0	**0**
1	0	**1**
0	1	**1**
1	1	**1**

(A) SET (B) RESET Rising Edge
(A) RESET (B) SET Rising Edge
(A) SET (B) RESET Falling Edge
(A) RESET (B) SET Falling Edge

The selected digital output is activated as the output of a Flip Flop Set Reset whose inputs are signal A and signal B. This function can be used in case of hysteresis.
The status of the input (Qn) depends on the previous value (Qn-1) and on the result of the two tests.
Signals A and B are considered only when passing from 0→1 (Rising Edge) or 1→0 (Falling Edge). Signal A and signal B may be used both as Set and Reset command.
Example: Suppose that the output enables only when the motor speed exceeds 50rpm and disables when the motor speed drops below 5 rpm. To do so, assign the first condition to Test A, representing the Set command for Flip Flop (**P271** = Motor Speed, **P273** >, **P275** = 50rpm), and assign the second condition to Test B, representing the Reset command (**P272** = Motor Speed, **P274** <=, **P276** = 5rpm). A more detailed example is given at the end of this section.

(A) SET (B) RESET Rising Edge		
Test A (Set)	**Test B (Reset)**	**Q_n**
0→1	X	**1**
X	0→1	**0**
In any other case		**Q_{n-1}**

(A) RESET (B) SET Rising Edge		
Test A (Reset)	**Test B (Set)**	**Q_n**
0→1	X	**0**
X	0→1	**1**
In any other case		**Q_{n-1}**

(A) SET (B) RESET Falling Edge		
Test A (Set)	**Test B (Reset)**	**Q_n**
1→0	X	**1**
X	1→0	**0**
In any other case		**Q_{n-1}**

(A) RESET (B) SET Falling Edge		
Test A (Reset)	**Test B (Set)**	**Q_n**
1→0	X	**0**
X	1→0	**1**
In any other case		**Q_{n-1}**

(A) AND (B): The selected digital output enables when both conditions are true.

(A) AND (B)		
Test A	**Test B**	**Output**
0	0	**0**
1	0	**0**
0	1	**0**
1	1	**1**

(A) XOR (B): The selected digital output enables when either one condition or the other is true (but not when both conditions are true at a time).

(A) XOR (B)		
Test A	**Test B**	**Output**
0	0	**0**
1	0	**1**
0	1	**1**
1	1	**0**

(**A) NOR (B)**: The selected digital output enables when no condition is true. The NOR function between two variables corresponds to the AND of the same false variables, i.e. (A)NOR (B) = (/A) AND (/B).

(A) NOR (B)		
Test A	**Test B**	**Output**
0	0	**1**
1	0	**0**
0	1	**0**
1	1	**0**

(A) NAND (B): The selected digital output enables when no condition is true or when only one of the two conditions is true. The NAND function between two variables corresponds to the OR of the same false variables, i.e. (A)NAND (B) = (/A) OR (/B).

(A) NAND (B)		
Test 1	**Test 2**	**Output**
0	0	**1**
1	0	**1**
0	1	**1**
1	1	**0**

NOTE This parameter can be accessed only if the operating mode of the selected digital output is > 2 and <9. Example: MDO1 2<**P270**<9.

Function applied to the result of f(A,B) C for MDO1 P277b, (P286b, P295b, P304b)

Once the Boolean signal resulting from f(A,B) is obtained, an additional logic function can be applied to obtain the output TRUE//FALSE Boolean signal.
If parameter **P277a** is disabled, the output of f(A,B) goes directly to the corresponding digital output; if parameter P277a is enabled, the output of the output of f(A,B) becomes one of the two inputs of the second programmed block.
The user can choose one of the six Boolean tests above for the first variable - f(A,B) – and for the second variable (C).
See Example 6.

MDO1 (2,3,4): Logic applied to MDO1 (2,3,4): P278, (P287, P296, P305)

The logic of the Boolean signal can be reversed at the end of the processing chain.
The user can choose whether the logic level of the digital output is POSITIVE or NEGATIVE.
(0) FALSE = a logic negation is applied (NEGATIVE logic)
(1) TRUE = no negation is applied (POSITIVE logic)

NOTE This parameter can be accessed only if the operating mode of the selected digital output is other than zero. Example: MDO1 **P270**≠0.

26.2. Programmable Operating Modes (Diagrams)

The diagrams shown in the figures illustrate the operating structure of MDO1 digital output; the remaining digital outputs (MDO2, MDO3, and MDO4) will follow the same logics, as implemented in the relevant parameters.

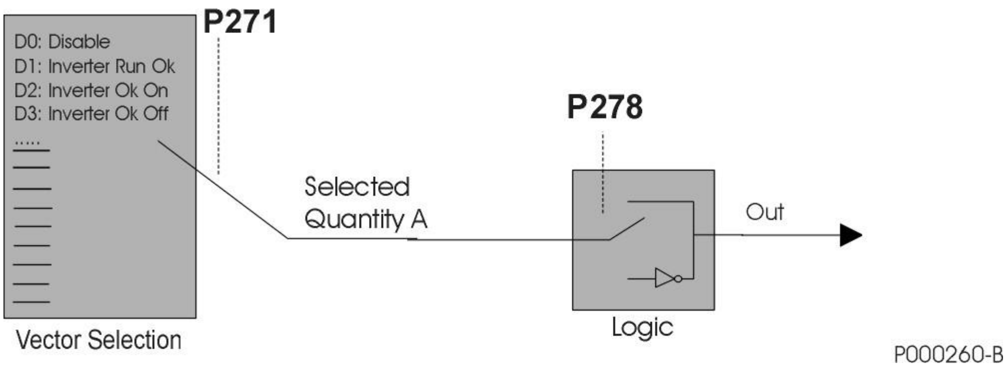


Figure 34: DIGITAL Mode

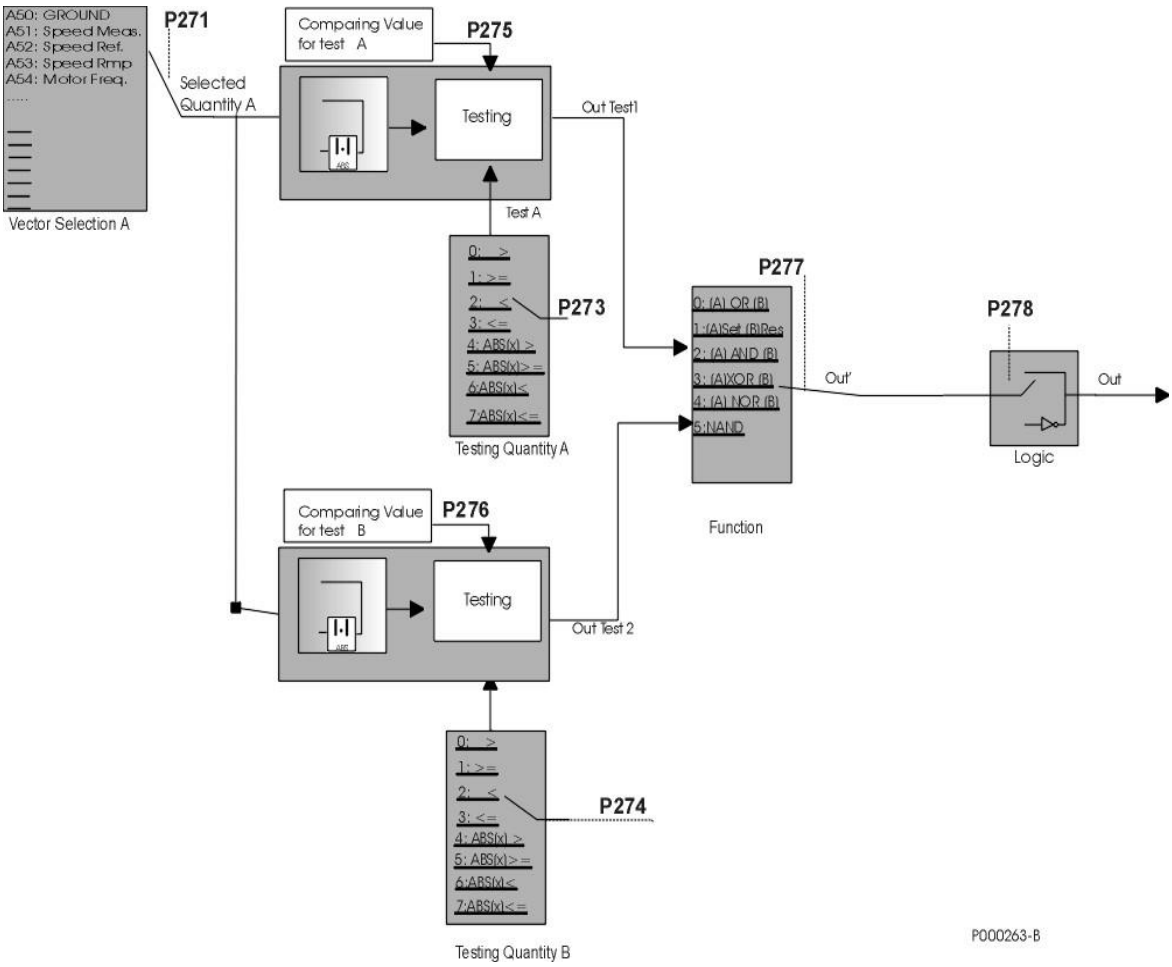


Figure 35: ANALOG Mode

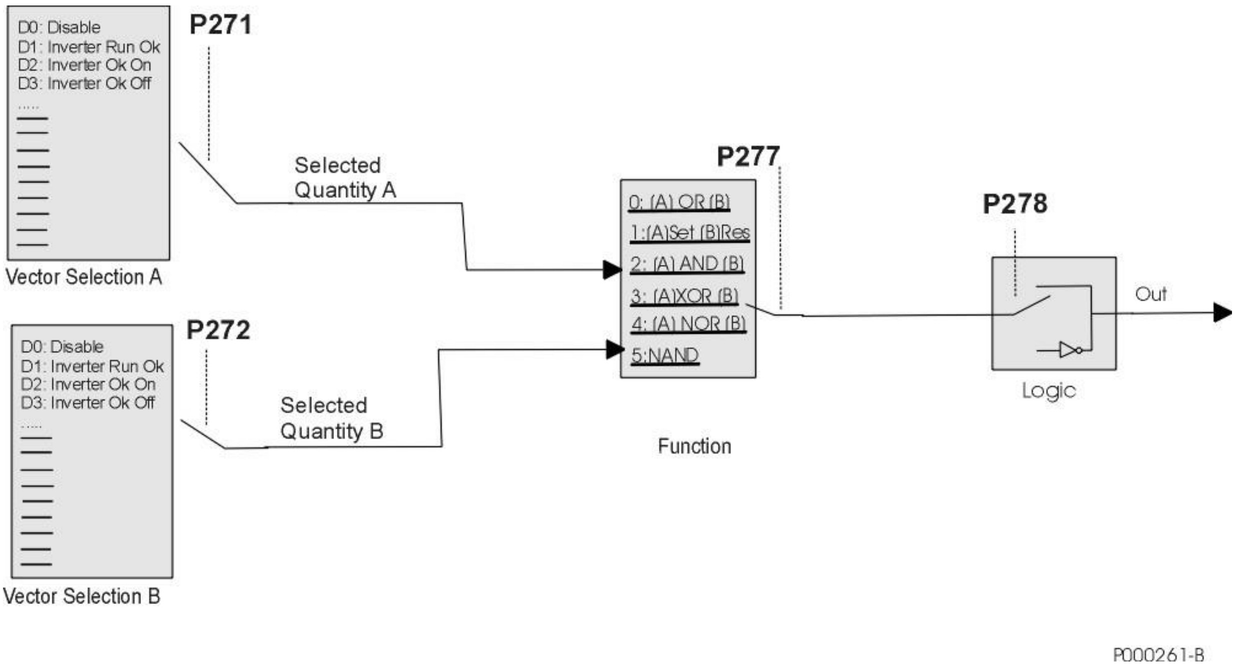


Figure 36: DOUBLE DIGITAL Mode

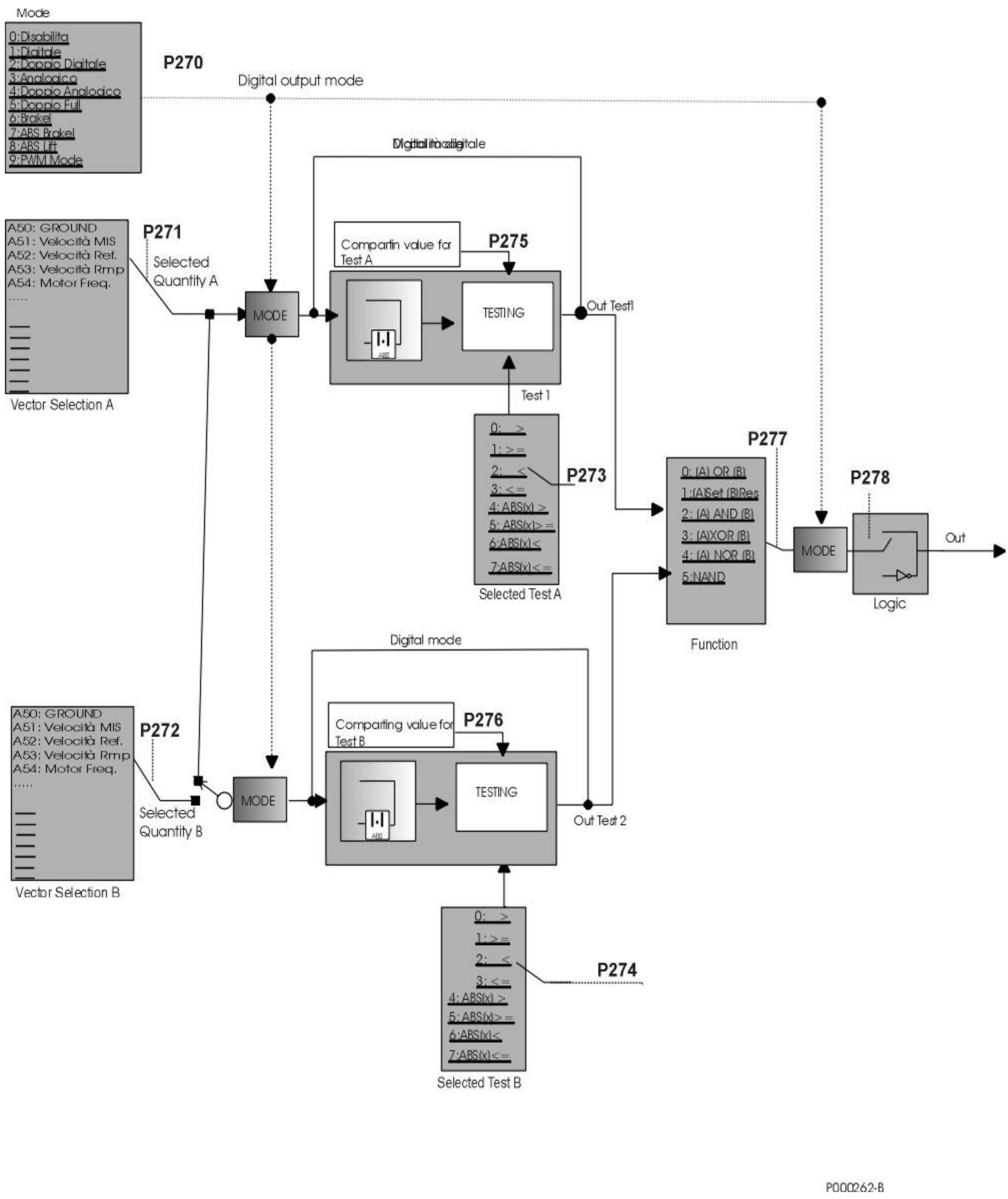


Figure 37: General structure of the parameterization of a digital output

26.3. Examples

This section illustrates some examples.
A table stating the setup of the parameters used is given for each example.
Parameters highlighted in grey have no effect due to their preset selection.

Example 1: Digital output for Inverter Alarm digital command (MDO3 digital output default setting).

Table 50: MDO parameterization for PD Status OK

P288	MDO3: Digital output mode	DIGITAL
P289	MDO3: Variable A selection	D3: Inverter Alarm
P290	MDO3: Variable B selection	
P291	MDO3: Testing variable A	
P292	MDO3: Testing variable B	
P293	MDO3: Comparing value for Test A	
P294	MDO3: Comparing value for Test B	
P295	MDO3: Function applied to the result of the two tests	
P295a	MDO3: Variable C selection	D0: Disabled
P295b	MDO3: Function applied to the result of f(A,B) and C test	
P296	MDO3: Output logic level	FALSE

The digital output status depends on the Boolean variable “Inverter Alarm”, which is TRUE only when an alarm trips. This output is a fail-safe contact: the relay energizes if the drive is on and no alarms tripped.

Example 2: Digital output for Drive Run OK digital command (MDO4 digital output default setting).

Table 51: MDO parameterization for drive Run OK

P297	MDO4: Digital output mode	DIGITAL
P298	MDO4: Variable A selection	D1: Drive Run Ok
P299	MDO4: Variable B selection	
P300	MDO4: Testing variable A	
P301	MDO4: Testing variable B	
P302	MDO4: Comparing value for Test A	
P303	MDO4: Comparing value for Test B	
P304	MDO4: Function applied to the result of the two tests	
P295a	MDO3: Variable C selection	D0: Disabled
P295b	MDO3: Function applied to the result of f(A,B) and C test	
P305	MDO4: Output logic level	TRUE

The digital output status depends on the Boolean variable “Drive Run Ok”, which is TRUE only when the drive is modulating (IGBTs on).

Example 3: Digital output for speed thresholds

Suppose that a digital output energizes if the motor speed exceeds 100rpm as an absolute value, and de-energizes when the motor speed is lower than or equal to 20rpm (as an absolute value). Parameter P270 sets ABS mode, so that the selected variables are considered as absolute values. The condition "greater than" is selected for test A, and "lower than/equal to" is selected for test B.

Table 52: MDO parameterization for speed thresholds

P270	MDO1: Digital output mode	DOUBLE ANALOG
P271	MDO1: Variable A selection	A01: Speed MEA
P272	MDO1: Variable B selection	A01: Speed MEA
P273	MDO1: Testing variable A	ABS(x) >
P274	MDO1: Testing variable B	ABS (x) ≤
P275	MDO1: Comparing value for Test A	100.00 rpm
P276	MDO1: Comparing value for Test B	20.00 rpm
P277	MDO1: Function applied to the result of the two tests	(A) Set (B) Reset Rising Edge
P277a	MDO1: Variable C selection	D0: Disabled
P277b	MDO1: Function applied to the result of f(A,B) and C test	
P278	MDO1: Output logic level	TRUE

Both tests are performed over the motor speed; **P271**, **P272** are set to "motor speed". The values of reference for the two tests are 100rpm and 20rpm; the function applied is Flip Flop Set Reset and the output is considered as a true logic. Test A is the Set signal of the Flip Flop and Test B is the Reset signal.

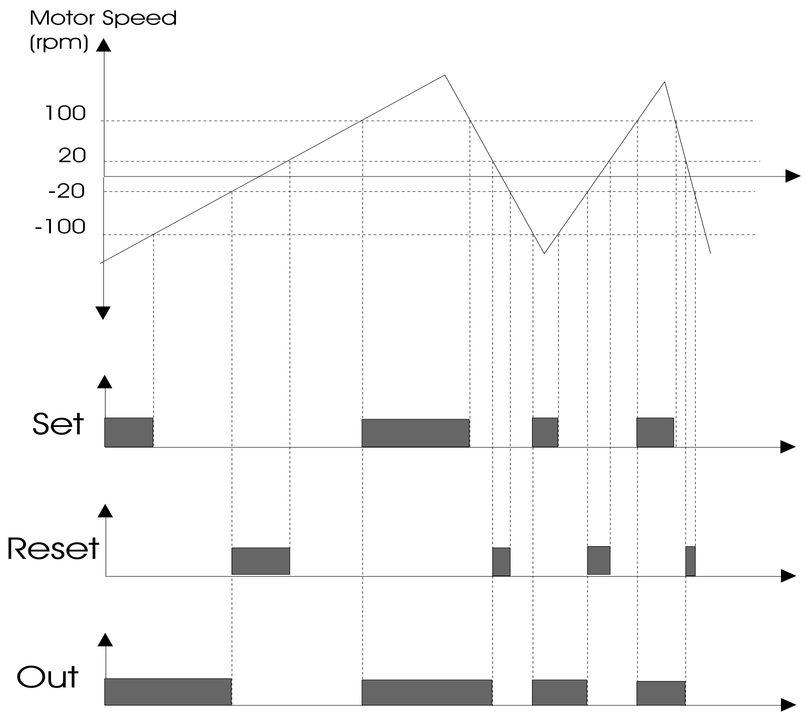


Figure 38: Digital output for speed thresholds (example)

Example 4: Digital output for electromechanical brake for hoisting applications (programming example related to MDO3 digital output).

Table 53: MDO parameterization for electromechanical brake command

P288	MDO3: Digital output mode	ABS BRAKE
P289	MDO3: Variable A selection	A11: Torque Demand
P290	MDO3: Variable B selection	A03: Ramp Output
P291	MDO3: Testing variable A	>
P292	MDO3: Testing variable B	≤
P293	MDO3: Comparing value for Test A	30.00%
P294	MDO3: Comparing value for Test B	100.00 rpm
P295	MDO3: Function applied to the result of the two tests	(A) Set (B) Reset Rising Edge
P295a	MDO3: Variable C selection	D0: Disabled
P295b	MDO3: Function applied to the result of f(A,B) and C test	
P296	MDO3: Output logic level	TRUE

The digital output energizes only if no alarm trips. The torque demand is greater than the value set in **P293** = 30.00% (Set). The digital output de-energizes if an alarm trips or if the decelerating speed is lower than the ramp output value set in **P294** = 100 rpm (Reset).

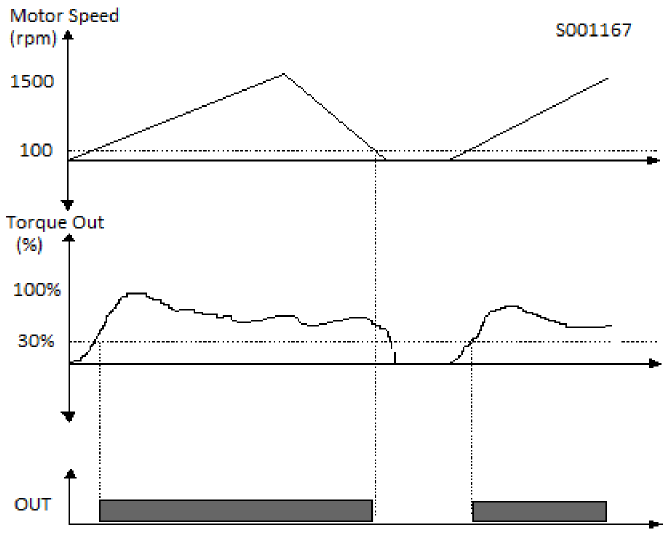


Figure 39: Electromechanical brake command (example)

CAUTION Always use the NO contact of the digital output for the electromechanical brake command.

NOTE For details about the electromechanical brake used for hoisting applications, see also the BRIDGE CRANE MENU.

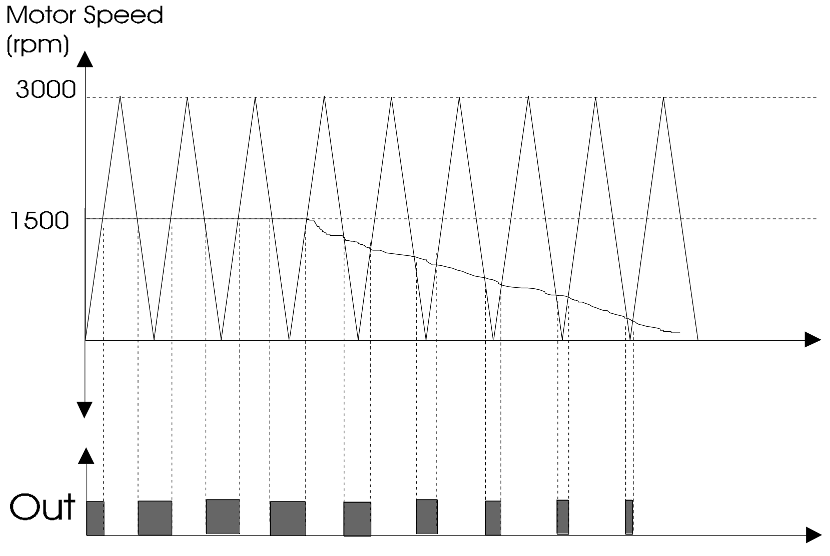
Example 5: Using the PWM Function.

Suppose that the motor of a machine tool is controlled by a drive. The tool must be lubricated based on the cutting speed. At max. cutting speed, the electrovalve controlling lubrication must work for 0.5 sec with a frequency of 1Hz (time period of 1 sec.): at max. speed, a duty cycle of 50% (Ton/T) is required, with a time period of 1 second; the time when the electrovalve opens is directly proportional to the cutting speed.
Spd1 is the max. cutting speed and dtc1 is the duty cycle required; the saw carrier frequency required for PWM must be 1 Hz (**P213**), the min. value must be 0rpm (when speed = 0rpm, the electrovalve is disabled) and max. value = Spd1*100/ dtc1 = 2*Spd1.
Supposing that the tool can rotate in both directions, that Spd1 = 1500rpm and that the first digital output is used, parameters are set as follows:

Table 54: MDO parameterization for the PWM function

P270	MDO1: Digital output mode	PWM MODE
P271	MDO1: Variable A selection	A72: Speed Ref.
P272	MDO1: Variable B selection	
P273	MDO1: Testing variable A	>
P274	MDO1: Testing variable B	
P275	MDO1: Comparing value for Test A	3000.00 rpm
P276	MDO1: Comparing value for Test B	0.0 rpm
P277	MDO1: Function applied to the result of the two tests	
P277a	MDO1: Variable C selection	D0: Disabled
P277b	MDO1: Function applied to the result of f(A,B) and C test	
P278	MDO1: Output logic level	TRUE
P215	Saw signal frequency	1Hz

Parameter **P215** in the ANALOG AND FREQUENCY OUTPUTS MENU sets the frequency of the saw wave, i.e. the PWM frequency of the digital output.
In PWM mode, parameter **P275** sets the max. value (peak value) of the saw wave, while parameter **P276** sets the min. value of the saw wave.
The test selected with **P273** is performed between the analog variable selected in **P271** and the saw wave.



Example 6: Digital output indicating the READY state to a PLC supervisor – using Inputs A, B, C

This example shows how to activate a digital output based on the logic AND of 3 conditions A,B,C—particularly the ENABLE input, the condition of constant speed reference achieved, and the “Inverter Ok On” condition.
An additional block applied to f(A,B) and C is used:

Table 55: MDO parameterization for the Ready state of a PLC supervisor

P270	MDO1: Digital output mode	DOUBLE DIGITAL
P271	MDO1: Variable A selection	D21: Enable
P272	MDO1: Variable B selection	D40: Speed OK
P273	MDO1: Testing variable A	
P274	MDO1: Testing variable B	
P275	MDO1: Comparing value for Test A	
P276	MDO1: Comparing value for Test B	
P277	MDO1: Function applied to the result of the two tests	(A) AND (B)
P277a	MDO1: Variable C selection	D2: Inverter Ok On
P277b	MDO1: Function applied to the result of f(A,B) and C test	f(A,B) AND (C)
P278	MDO1: Output logic level	TRUE

26.4. List of Parameters P270 to P305

Table 56: List of Parameters P270 to P305

Parameter	FUNCTION	User Level	DEFAULT VALUES	MODBUS Address
P270	MDO1: Digital output mode	ADVANCED	3:ANALOG	870
P271	MDO1: Selecting variable A	ADVANCED	A01: Speed	871
P272	MDO1: Selecting variable B	ADVANCED	A01: Speed	872
P273	MDO1: Testing variable A	ADVANCED	0: >	873
P274	MDO1: Testing variable B	ADVANCED	3: ≤	874
P275	MDO1: Comparing value for Test A	ADVANCED	50 rpm	875
P276	MDO1: Comparing value for Test B	ADVANCED	10 rpm	876
P277	MDO1: Function applied to the result of the 2 tests	ADVANCED	1: (A) SET (B) RESET	877
P277a	MDO1: Selecting variable C	ADVANCED	0: Disable	642
P277b	MDO1: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	643
P278	MDO1: Output logic level	ADVANCED	1: TRUE	878
P279	MDO2: Digital output mode	ADVANCED	6: BRAKE	879
P280	MDO2: Selecting variable A	ADVANCED	A11: Trq Output	880
P281	MDO2: Selecting variable B	ADVANCED	A01: Speed	881
P282	MDO2: Testing variable A	ADVANCED	0: >	882
P283	MDO2: Testing variable B	ADVANCED	3: ≤	883
P284	MDO2: Comparing value for Test A	ADVANCED	20%	884
P285	MDO2: Comparing value for Test B	ADVANCED	50 rpm	885
P286	MDO2: Function applied to the result of the 2 tests	ADVANCED	1: (A) SET (B) RESET	886
P286a	MDO2: Selecting variable C	ADVANCED	0: Disable	644
P286b	MDO2: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	645
P287	MDO2: Output logic level	ADVANCED	1: TRUE	887
P288	MDO3: Digital output mode	ADVANCED	1: DIGITAL	888
P289	MDO3: Selecting variable A	ADVANCED	D3: Inverter Alarm	889
P290	MDO3: Selecting variable B	ADVANCED	D3: Inverter Alarm	890
P291	MDO3: Testing variable A	ADVANCED	0: >	891
P292	MDO3: Testing variable B	ADVANCED	0: >	892
P293	MDO3: Comparing value for Test A	ADVANCED	0	893
P294	MDO3: Comparing value for Test B	ADVANCED	0	894
P295	MDO3: Function applied to the result of the 2 tests	ADVANCED	0: (A) OR (B)	895
P295a	MDO3: Selecting variable C	ADVANCED	0: Disable	646
P295b	MDO3: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	647
P296	MDO3: Output logic level	ADVANCED	0: FALSE	896
P297	MDO4: Digital output mode	ADVANCED	1: DIGITAL	897
P298	MDO4: Selecting variable A	ADVANCED	D1: Inverter Run Ok	898
P299	MDO4: Selecting variable B	ADVANCED	D1: Inverter Run Ok	899
P300	MDO4: Testing variable A	ADVANCED	0: >	900
P301	MDO4: Testing variable B	ADVANCED	0: >	901
P302	MDO4: Comparing value for Test A	ADVANCED	0	902
P303	MDO4: Comparing value for Test B	ADVANCED	0	903
P304	MDO4: Function applied to the result of the 2 tests	ADVANCED	0: (A) OR (B)	904
P304a	MDO4: Selecting variable C	ADVANCED	0: Disable	648
P304b	MDO4: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	649
P305	MDO4: Output logic level	ADVANCED	1: TRUE	905

P270 MDO1: Digital Output Mode

P270	**Range**	0 ÷ 9	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT 9: PWM MODE
	Default	3	3: ANALOG
	Level	ADVANCED	
	Address	870	
	Function	This parameter defines the operating mode of **digital output 1**. The different operating modes are described at the beginning of this chapter.	

NOTE MDO1 Digital output can be programmed only if the frequency output is not set up: **P200** = Disable (see ANALOG AND FREQUENCY OUTPUTS MENU).

P271 MDO1: Selecting Variable A

P271	**Range**	0 ÷ 149	See Table 48
	Default	61	A01: Speed MEA
	Level	ADVANCED	
	Address	871	
	Function	This parameter selects the digital signal used to calculate the value of **MDO1** digital output. It selects an analog variable used to calculate the value of **MDO1**digital output if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in See Table 48.	

P272 MDO1: Selecting Variable B

P272	**Range**	0 ÷ 149	See Table 48
	Default	61	A01: Speed MEA
	Level	ADVANCED	
	Address	872	
	Function	This parameter selects the second digital signal used to calculate the value of **MDO1** digital output. It selects an analog variable used to calculate the value of **MDO1** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in See Table 48.	

P273 MDO1: Testing Variable A

P273	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	873	
	Function	This parameter defines the test to be performed for the variable detected by **P271** using **P275** as a comparing value.	

P274 MDO1: Testing Variable B

P274	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	3	3: ≤
	Level	ADVANCED	
	Address	874	
	Function	This parameter defines the test to be performed for the variable detected by **P272** using **P276** as a comparing value.	

P275 MDO1: Comparing Value for Test A

P275	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A*, see Table 48
	Default	50	50 rpm
	Level	ADVANCED	
	Address	875	
	Function	This parameter defines the comparing value with the selected variable for test A.	

P276 MDO1: Comparing Value for Test B

P276	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B*, see Table 48
	Default	10	10 rpm
	Level	ADVANCED	
	Address	876	
	Function	This parameter defines the comparing value with the selected variable for test B.	

P277 MDO1: Function Applied to the Result of the 2 Tests

P277	**Range**	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	877	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P277a MDO1: Selecting Variable C

277a	**Range**	0 ÷ 79	See Table 48
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	642	
	Function	This parameter selects the digital signal used to calculate the value of **MDO1** digital output. The digital signals that can be selected are given in Table 48.	

P277b MDO1: Function Applied to the Result of f(A,B) C

P277b	**Range**	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: f(A,B)\ OR (C) 7: f(A,B) OR (C\) 8: f(A,B)\ AND (C) 9: f(A,B) AND (C\) 10: f(A,B) RESET (C) SET RISING EDGE 11: f(A,B) SET (C) RESET FALLING EDGE 12: f(A,B) RESET (C) SET FALLING EDGE
	Default	0	0: f(A,B) OR (C)
	Level	ADVANCED	
	Address	643	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P278 MDO1: Output Logic Level

P278	**Range**	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ADVANCED	
	Address	878	
	Function	MDO1 digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P279 MDO2: Digital Output Mode

P279	**Range**	0 ÷ 9	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT 9: PWM MODE
	Default	6	6 : BRAKE
	Level	ADVANCED	
	Address	879	
	Function	This parameter defines the operating mode of **digital output 2**. The different operating modes are described at the beginning of this chapter.	

P280 MDO2: Selecting Variable A

P280	**Range**	0 ÷ 149	See Table 48
	Default	71	A11: Torque Output
	Level	ADVANCED	
	Address	880	
	Function	This parameter selects the digital signal used to calculate the value of **MDO2** digital output. It selects an analog variable used to calculate the value of **MDO2** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P281 MDO2: Selecting Variable B

P281	**Range**	0 ÷ 149	See Table 48
	Default	61	A01: Speed MEA
	Level	ADVANCED	
	Address	881	
	Function	This parameter selects the second digital signal used to calculate the value of **MDO2** digital output. It selects an analog variable used to calculate the value of **MDO2** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P282 MDO2: Testing Variable A

P282	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	882	
	Function	This parameter defines the test to be performed for the variable detected by **P280** using **P284** as a comparing value**.**	

P283 MDO2: Testing Variable B

P283	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	3: ≤
	Level	ADVANCED	
	Address	883	
	Function	This parameter defines the test to be performed for the variable detected by **P281** using **P285** as a comparing value.	

P284 MDO2: Comparing Value for Test A

P284	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A,* see Table 48
	Default	2000	20%
	Level	ADVANCED	
	Address	884	
	Function	This parameter defines the comparing value with the selected variable for test A.	

P285 MDO2: Comparing Value for Test B

P285	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B*, see Table 48
	Default	50	50 rpm
	Level	ADVANCED	
	Address	885	
	Function	This parameter defines the comparing value with the selected variable for test B.	

P286 MDO2: Function Applied to the Result of the 2 Tests

P286	**Range**	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	886	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P286a MDO2: Selecting Variable C

P286a	**Range**	0 ÷ 79	See Table 48
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	644	
	Function	This parameter selects the digital signal used to calculate the value of **MDO2** digital output. The digital signals that can be selected are given in Table 48.	

P286b MDO2: Function Applied to the Result of f(A,B) C

P286b	**Range**	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: f(A,B)\ OR (C) 7: f(A,B) OR (C\) 8: f(A,B)\ AND (C) 9: f(A,B) AND (C\) 10: f(A,B) RESET (C) SET RISING EDGE 11: f(A,B) SET (C) RESET FALLING EDGE 12: f(A,B) RESET (C) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	645	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P287 MDO2: Output Logic Level

P287	**Range**	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ADVANCED	
	Address	887	
	Function	MDO2 digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P288 MDO3: Digital Output Mode

P288	**Range**	0 ÷ 8	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT
	Default	1	1: DIGITAL
	Level	ADVANCED	
	Address	888	
	Function	This parameter defines the operating mode of **digital output 3**. The different operating modes are described at the beginning of this chapter.	

P289 MDO3: Selecting Variable A

P289	**Range**	0 ÷ 149	See Table 48
	Default	3	D3: Inverter Alarm
	Level	ADVANCED	
	Address	889	
	Function	This parameter selects the digital signal used to calculate the value of **MDO3** digital output. It selects an analog variable used to calculate the value of **MDO3** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48	

P290 MDO3: Selecting Variable B

P290	**Range**	0 ÷ 149	See Table 48
	Default	3	D3: Inverter Alarm
	Level	ADVANCED	
	Address	890	
	Function	This parameter selects the second digital signal used to calculate the value of **MDO3** digital output. It selects an analog variable used to calculate the value of digital input **MDO3** if one of the “analog” operating modes is selected. Digital signals and analog variables detailed in Table 48.	

P291 MDO3: Testing Variable A

P291	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	891	
	Function	This parameter defines the test to be performed for the variable detected by **P289** using **P293** as a comparing value**.**	

P292 MDO3: Testing Variable B

P292	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	892	
	Function	This parameter defines the test to be performed for the variable detected by **P290** using **P294** as a comparing value.	

P293 MDO3: Comparing Value for Test A

P293	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A,* see Table 48
	Default	0	0
	Level	ADVANCED	
	Address	893	
	Function	This parameter defines the comparing value with the variable selected for test A.	

P294 MDO3: Comparing Value for Test B

P294	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B*, see Table 48
	Default	0	0
	Level	ADVANCED	
	Address	894	
	Function	This parameter defines the comparing value with the variable selected for test B.	

P295 MDO3: Function Applied to the Result of the 2 Tests

P295	**Range**	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	0	0: (A) OR (B)
	Level	ADVANCED	
	Address	895	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P295a MDO3: Selecting Variable C

P295a	**Range**	0 ÷ 79	See Table 48
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	646	
	Function	This parameter selects the digital signal used to calculate the value of **MDO3** digital output. The digital signals that can be selected are given in Table 48.	

P295b MDO3: Function Applied to the Result of f(A,B) C

P295b	**Range**	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: f(A,B)\ OR (C) 7: f(A,B) OR (C\) 8: f(A,B)\ AND (C) 9: f(A,B) AND (C\) 10: f(A,B) RESET (C) SET RISING EDGE 11: f(A,B) SET (C) RESET FALLING EDGE 12: f(A,B) RESET (C) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	647	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P296 MDO3: Output Logic Level

P296			
	Range	0–1	0: FALSE 1: TRUE
	Default	0	0: FALSE
	Level	ADVANCED	
	Address	896	
	Function	MDO3 digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P297 MDO4: Digital Output Mode

P297			
	Range	0 ÷ 8	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT
	Default	1	1: DIGITAL
	Level	ADVANCED	
	Address	897	
	Function	This parameter defines the operating mode of **digital output 4**. The different operating modes are described at the beginning of this chapter.	

P298 MDO4: Selecting Variable A

P298			
	Range	0 ÷ 149	See Table 48
	Default	1	D1: Inverter Run Ok
	Level	ADVANCED	
	Address	898	
	Function	This parameter selects the digital signal used to calculate the value of **MDO4** digital output. It selects an analog variable used to calculate the value of **MDO4** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P299 MDO4: Selecting Variable B

P299			
	Range	0 ÷ 149	See Table 48
	Default	1	D1: Inverter Run Ok
	Level	ADVANCED	
	Address	899	
	Function	This parameter selects the second digital signal used to calculate the value of **MDO4** digital output. It selects an analog variable used to calculate the value of **MDO4** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P300 MDO4: Testing Variable A

P300	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	900	
	Function	This parameter defines the test to be performed for the variable detected by **P298** using **P302** as a comparing value.	

P301 MDO4: Testing Variable B

P301	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	901	
	Function	This parameter defines the test to be performed for the variable detected by **P299** using **P303** as a comparing value.	

P302 MDO4: Comparing Value for Test A

P302	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A*, see Table 48
	Default	0	0
	Level	ADVANCED	
	Address	902	
	Function	This parameter defines the comparing value with the selected variable for test A.	

P303 MDO4: Comparing Value for Test B

P303	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B*, see Table 48
	Default	0	0
	Level	ADVANCED	
	Address	903	
	Function	This parameter defines the comparing value with the selected variable for test B.	

P304 MDO4: Function Applied to the Result of the 2 Tests

P304	**Range**	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	0	0: (A) OR (B)
	Level	ADVANCED	
	Address	904	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P304a MDO4: Selecting Variable C

P304a	**Range**	0 ÷ 79	See Table 48
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	648	
	Function	This parameter selects the digital signal used to calculate the value of **MDO4** digital output. The digital signals that can be selected are given in Table 48.	

P304b MDO4: Function Applied to the Result of f(A,B) C

P304b	**Range**	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: f(A,B)\ OR (C) 7: f(A,B) OR (C\) 8: f(A,B)\ AND (C) 9: f(A,B) AND (C\) 10: f(A,B) RESET (C) SET RISING EDGE 11: f(A,B) SET (C) RESET FALLING EDGE 12: f(A,B) RESET (C) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	649	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P305 MDO4: Output Logic Level

P305	**Range**	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ADVANCED	
	Address	905	
	Function	**MDO4** digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

27. AUXILIARY DIGITAL OUTPUTS MENU

27.1. Overview

This menu includes the parameters allowing allocating the control functions implemented via the digital inputs located on I/O expansion boards. This menu can be viewed only after enabling data acquisition from the expansion boards.

27.2. List of Parameters P306 to P317

Table 57: List of Parameters P306 to P317

Parameter	FUNCTION	User Level	DEFAULT VALUES	MODBUS Address
P306	XMDO1: Signal selection	ENGINEERING	D0: Disable	906
P307	XMDO1: Output logic level	ENGINEERING	1: True	907
P308	XMDO2: Signal selection	ENGINEERING	D0: Disable	908
P309	XMDO2: Output logic level	ENGINEERING	1: True	909
P310	XMDO3: Signal selection	ENGINEERING	D0: Disable	910
P311	XMDO3: Output logic level	ENGINEERING	1: True	911
P312	XMDO4: Signal selection	ENGINEERING	D0: Disable	912
P313	XMDO4: Output logic level	ENGINEERING	1: True	913
P314	XMDO5: Signal selection	ENGINEERING	D0: Disable	914
P315	XMDO5: Output logic level	ENGINEERING	1: True	915
P316	XMDO6: Signal selection	ENGINEERING	D0: Disable	916
P317	XMDO6: Output logic level	ENGINEERING	1: True	917

P306 XMDO1: Signal Selection

P306	**Range**	0 ÷ 79	See Table 48
	Default	0	D0: Disable
	Level	ENGINEERING	
	Address	906	
	Function	Selects the digital signal used to calculate the value of **XMDO1** digital output. It selects an analog variable used to calculate the value of **XMDO1** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P307 XMDO1: Output Logic Level

P307	**Range**	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ENGINEERING	
	Address	907	
	Function	**XMDO1** digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P308 XMDO2: Signal Selection

P308	**Range**	0 ÷ 79	See Table 48
	Default	0	D0: Disable
	Level	ENGINEERING	
	Address	908	
	Function	Selects the digital signal used to calculate the value of **XMDO2** digital output. It selects an analog variable used to calculate the value of **XMDO2** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P309 XMDO2: Output Logic Level

P309	**Range**	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ENGINEERING	
	Address	909	
	Function	**XMDO2** digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P310 XMDO3: Signal Selection

P310	**Range**	0 ÷ 79	See Table 48
	Default	0	D0: Disable
	Level	ENGINEERING	
	Address	910	
	Function	Selects the digital signal used to calculate the value of **XMDO3** digital output. It selects an analog variable used to calculate the value of **XMDO3** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P311 XMDO3: Output Logic Level

P311	**Range**	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ENGINEERING	
	Address	911	
	Function	**XMDO3** digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P312 XMDO4: Signal Selection

P312	**Range**	0 ÷ 79	See Table 48
	Default	0	D0: Disable
	Level	ENGINEERING	
	Address	912	
	Function	Selects the digital signal used to calculate the value of **XMDO4** digital output. It selects an analog variable used to calculate the value of **XMDO4** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P313 XMDO4: Output Logic Level

P313	**Range**	0–1	0: TRUE 1: FALSE
	Default	1	1: FALSE
	Level	ENGINEERING	
	Address	913	
	Function	**XMDO4** digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P314 XMDO5: Signal Selection

P314	**Range**	0 ÷ 79	See Table 48
	Default	0	D0: Disable
	Level	ENGINEERING	
	Address	914	
	Function	Selects the digital signal used to calculate the value of **XMDO5** digital output. It selects an analog variable used to calculate the value of **XMDO5** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P315 XMDO5: Output Logic Level

P315	**Range**	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ENGINEERING	
	Address	915	
	Function	**XMDO5** digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P316 XMDO6: Signal Selection

P316	**Range**	0 ÷ 59	See Table 48
	Default	0	D0: Disable
	Level	ENGINEERING	
	Address	916	
	Function	Selects the digital signal used to calculate the value of **XMDO6** digital output. It selects an analog variable used to calculate the value of **XMDO6** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P317 XMDO6: Output Logic Level

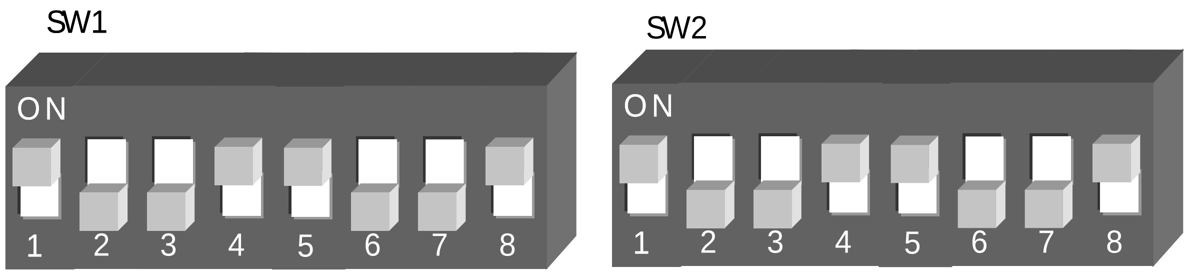
P317	**Range**	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ENGINEERING	
	Address	917	
	Function	**XMDO6** digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

28. MEASURE CONTROL FROM PT100

28.1. Overview

This menu relates to ES847 control board. It can be viewed only if **R023** (I/O board setting) = PT100 (see the EXPANSION BOARD CONFIGURATION MENU).
The analog inputs can be linked to measure sensors.

NOTE Set DIP-Switches 1 and 2 as follows for proper data acquisition from PT100:



28.2. List of Parameters P318 to P325

Table 58: List of Parameters P318 to P325

Parameter	FUNCTION	User Level	DEFAULT VALUES	MODBUS Address
P320	Channel 1: measure mode	ADVANCED	0: no input	920
P321	Channel 1: measure offset	ADVANCED	0.0 °C	921
P322	Channel 2: measure mode	ADVANCED	0: no input	922
P323	Channel 2: measure offset	ADVANCED	0.0 °C	923
P324	Channel 3: measure mode	ADVANCED	0: no input	924
P325	Channel 3: mesaure offset	ADVANCED	0.0 °C	925
P326	Channel 4: measure mode	ADVANCED	0: no input	926
P327	Channel 4: mesaure offset	ADVANCED	0.0 °C	927

P320 Channel 1: Measure Mode

P320	**Range**	0 ÷ 1	0: no input 1: val PT100
	Default	0	0: no input
	Level	ADVANCED	
	Address	920	
	Function	This parameter selects the type of analog signal available in terminals 27–28 in ES847 expansion board. **0:** no signal is used. The P parameter relating to the analog input disappears. **1**: val PT100. The acquired signal is transformed into degrees centigrade. See Measure **M069.**	

P321 Channel 1: Measure Offset

P321	**Range**	–30000 ÷ 30000	–300.00 ÷ 300.00
	Default	0	0.0 °C
	Level	ADVANCED	
	Address	921	
	Function	Value of the measure offset for channel 1: an offset can be applied to the measure to correct possible errors.	

P322 Channel 2: Measure Mode

P322	**Range**	0 ÷ 1	0: no input 1: val PT100
	Default	0	0: no input
	Level	ADVANCED	
	Address	922	
	Function	This parameter selects the type of analog signal available in terminals 29–30 in ES847 expansion board. **0:** no signal is used. The P parameter relating to the analog input disappears. **1**: val PT100. The acquired signal is transformed into degrees centigrade. See Measure **M070.**	

P323 Channel 2: Measure Offset

P323	**Range**	–30000 ÷ 30000	–300.00 ÷ 300.00
	Default	0	0.0 °C
	Level	ADVANCED	
	Address	923	
	Function	Value of the measure offset for channel 2: an offset can be applied to the measure to correct possible errors.	

P324 Channel 3: Measure Mode

P324			
	Range	0 ÷ 1	0: no input 1: val PT100
	Default	0	0: no input
	Level	ADVANCED	
	Address	924	
	Function	This parameter selects the type of analog signal available in terminals 31–32 in ES847 expansion board. **0:** no signal is used. The P parameter relating to the analog input disappears. **1**: val PT100. The acquired signal is transformed into degrees centigrade. See Measure **M071.**	

P325 Channel 3: Measure Offset

P325			
	Range	–30000 ÷ 30000	–300.00 ÷ 300.00
	Default	0	0.0 °C
	Level	ADVANCED	
	Address	925	
	Function	Value of the measure offset for channel 3: an offset can be applied to the measure to correct possible errors.	

P326 Channel 4: Measure Mode

P326			
	Range	0 ÷ 1	0: no input 1: val PT100
	Default	0	0: no input
	Level	ADVANCED	
	Address	926	
	Function	This parameter selects the type of analog signal available in terminals 33–34 in ES847 expansion board. **0:** no signal is used. The P parameter relating to the analog input disappears. **1**: val PT100. The acquired signal is transformed into degrees centigrade. See Measure **M072.**	

P327 Channel 4: Measure Offset

P327			
	Range	–30000 ÷ 30000	–300.00 ÷ 300.00
	Default	0	0.0 °C
	Level	ADVANCED	
	Address	927	
	Function	Value of the measure offset for channel 4: an offset can be applied to the measure to correct possible errors.	

29. FIELDBUS PARAMETERS MENU

29.1. Overview

This menu allows selecting the Third measure and the Fourth measure from the Fieldbus.
The list of the selectable measures is the same as the list in the MEASURES MENU.
The First measure and the Second measure are fixed (Output Current and Motor Speed) (see Exchanged P).

29.2. List of Parameters P330 to P331

Table 59: List of Parameters P330 to P331

Parameter	FUNCTION	User Level	Default Values	MODBUS Address
P330	Third measure from the Fieldbus	ENGINEERING	13:Torque Out %	930
P331	Fourth measure from the Fieldbus	ENGINEERING	23: PID Out%	931

P330 Third Measure from the Fieldbus

P330			
	Range	0 ÷ 103	See MEASURES MENU and Table 60
	Default	13	**M012**:[Torque Out %]
	Level	ENGINEERING	
	Address	930	
	Function	Third measure exchanged via Fieldbus.	

P331 Fourth Measure from the Fieldbus

P331			
	Range	0 ÷ 103	See MEASURES MENU and Table 60
	Default	23	**M022**:[PID Out %]
	Level	ENGINEERING	
	Address	931	
	Function	Fourth measure exchanged via Fieldbus.	

Table 60: List of the programmable measures for P330 to P331

0	NONE	53	M052 Op.Time (low)
1	M000 Speed Ref	54	M052 Op.Time (high)
2	M001 dcm.Spd.Ref	55	M054 Sply.Time (low)
3	M002 Ramp Out	56	M054 Sply.Time (high)
4	M003 dcm.Rmp.Out	57	M056 Digital Out
5	M004 Motor Speed	58	M057 Freq.Out
6	M005 dcm.Mot.Spd	59	M058 Analog Out AO1
7	M006 Mot.Freq.	60	M059 Analog Out AO2
8	M007 Torq.Ref	61	M060 Analog Out AO3
9	M008 Torq.Demand	62	M061 Aux. Dig.OUT
10	M009 Torq.Out	63	M062 Amb.Temp.
11	M010 Torq.Ref %	64	M036a Aux.Ser. Dig.IN
12	M011 Torq.Dem.%	65	M064 Hts.Temp.
13	M012 Torq.Out %	66	M065 OT Counter
14	M013 T.Lim.Ref	67	M066 ST Counter
15	M014 T.Lim.RmpOut	68	M036b Aux.FBus. Dig.IN
16	M015 T.Lim.Ref %	69	M022a PID2 Out %
17	M016 T.Lim.RmpOut %	70	M069 PT100 Temp.1
18	M017 Flux Ref	71	M070 PT100 Temp.2
19	M018 PID Ref %	72	M071 PT100 Temp.3
20	M019 PID RmpOut %	73	M072 PT100 Temp.4
21	M020 PID Fbk %	74	M028a Energy (low)
22	M021 PID Err %	75	M028a Energy (high)
23	M022 PID Out %	76	reserved
24	M023 PID Ref	77	M013a Speed Lim Ref
25	M024 PID Fbk	78	M014a Speed Lim Out
26	M056a Virtual Dig.Out	79	M026a I2t %
27	M026 Mot.Current	80	M039a Analog In XAIN4
28	M027 Out Volt	81	M039b Analog In XAIN5
29	M028 Power Out	82	M018a PID2 Ref %
30	M029 Vbus-DC	83	M019a PID2 RmpOut %
31	M030 V Mains	84	M020a PID2 Fbk %
32	M031 Delay.Dig.IN	85	reserved
33	M032 Istant.Dig.IN	86	reserved
34	M033 Term. Dig.IN	87	M021a PID2 Err %
35	M034 Ser. Dig.IN	88	M023a PID2 Ref
36	M035 Fbus. Dig.IN	89	M024a PID2 Fbk
37	M036 Aux. Dig.IN	90	M089 Status
38	M037 Analog In REF	91	M090 Alarm
39	M038 Analog In AIN1	92	M056b Timed Flags TFL
40	M039 Analog In AIN2	93	M027a Power Factor
41	M040 Ser.SpdRef	94	M004u Custom Mot. Speed
42	M041 dcm.Ser.SpdRef	95	M005u dcm.Cust.Mot.Spd
43	M042 Fbus.SpdRef	96	M009u Custom Torq.Out
44	M043 dcm.Fbus.SpdRef	97	M120 Enc. A Pulses
45	M044 Ser.TrqLimRef	98	M121 Enc. B Pulses
46	M045 Fbus.TrqLimRef	99	M064a IGBT Temp
47	M046 SerPID Ref	100	M110 Current Time (Low)
48	M047 FbusPID Ref	101	M110 Current Time (High)
49	M048 SerPID Fbk	102	M113 Current Date (Low)
50	M049 FbusPID Fbk	103	M113 Current Date (High)
51	M050 Encoder Ref	104	M106 Active Motor
52	M051 Freq.In Ref		

30. VIRTUAL DIGITAL OUTPUTS (MPL) MENU

30.1. Overview

The Virtual Digital Outputs menu includes the parameters allowing configuring the virtual digital outputs (MPL1..4) of the Sinus Penta drive.
Virtual digital outputs are logic blocks (no hardware output is provided) allocating more complex logic functions to outputs MDO1..4: MPL virtual outputs can be feedbacked at the input of a new block (hardware or virtual block), thus allowing implementing more complex functions.

NOTE The Virtual Digital Outputs menu may be accessed only if the user level is ADVANCED or ENGINEERING.

NOTE XMDI auxiliary digital outputs (values from 13 to 20 in the parameters relating to the control functions) can be set up only after setting XMDI/O in parameter **R023**.

30.1.1. Factory Setting

The four virtual digital outputs are disabled as a factory setting.

30.1.2. Structure of the Virtual Digital Outputs

A virtual digital output is composed of two logic blocks allowing data processing before actuating the actual digital output. Block 2 depends on the settings in parameters **P357a** (**P366a**, **P375a, P384a**).

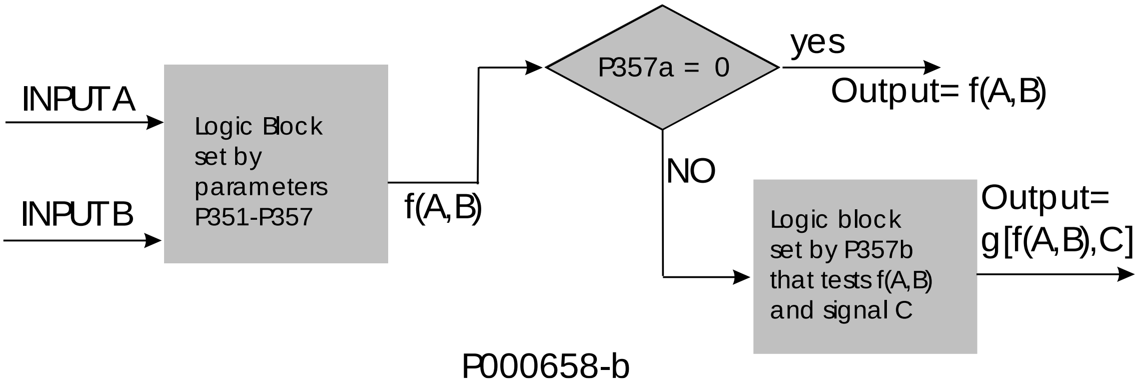


Figure 40: Block diagram of the virtual digital outputs (MPL)

Operating modes set in MPL1 (2, 3, 4): P350, (P359, P368, P377)

The user can select one of the following operating modes:

Table 61: Virtual Digital Output Modes

DISABLING	The selected digital output is disabled.
DIGITAL	The digital output depends on a selected digital signal and on the logic output function (True/False).
DOUBLE DIGITAL	The digital output depends on 2 selected digital signals, on the logic function calculating the output value and on the logic output function (True/False).
ANALOG	The digital output depends on a selected analog variable, which is tested through Test A obtaining one digital signal; starting from its value, the selected logic function calculates the True/False end value.
DOUBLE ANALOG	The digital outputs depends on 2 selected analog variables: Test A is performed for variable A, whilst Test B is performed for variable B, thus obtaining 2 digital signals; starting from their value, the selected logic function calculates the output value, whereas the logic output function True/False calculates the end value.
DOUBLE FULL	As DOUBLE ANALOG or DOUBLE DIGITAL mode, but both digital signals and analog variables can be selected. If you select a digital signal, its value (TRUE or FALSE) is used to calculate the selected logic function. If you select an analog variable, the test selected for this variable is performed, and its result (TRUE or FALSE) is used to calculate the selected logic function.
BRAKE (*)	As ABS BRAKE below, although the selected variables are not expressed as absolute values, but depend on the selected tests.
ABS BRAKE (*)	The ABS BRAKE mode allows controlling the electromechanical brake of a motor used for hoisting applications. The ABS BRAKE mode is applied by selecting the measured (or estimated) speed value [A01] as the first variable and the output torque [A10] as the second variable. Variables are considered as absolute values.
ABS LIFT (*)	As ABS BRAKE, but the brake unlocks (digital output open) when a given torque value is attained, which is automatically determined based on the last torque value required in the previous stroke.

(*) The activation and deactivation of the outputs programmed as **BRAKE**, **ABS BRAKE** and **ABS LIFT** is affected also by other conditions depending on the drive status. Namely:

Activation	Conditions to be considered in logic AND with the following programmed functions: • Drive accelerating or in pre-tensioning mode (see BRIDGE CRANE MENU). • Drive running, no alarm triggered
Deactivation	Conditions to be considered in logic OR with the following programmed functions: • Drive not running or locked due to an alarm condition • Drive in tracking error mode (see ENCODER/FREQUENCY INPUTS MENU), unless parameter **C303** is set to NO (see BRIDGE CRANE MENU).

CAUTION

The digital outputs programmed as **BRAKE**, **ABS BRAKE** or **ABS LIFT** are inactive in a drive configured in **slave** mode (torque control).
In a master/slave system, both electromechanical brakes must be controlled by the master.

Variable A Selected for MPL1 (2, 3, 4): P351, (P360, P369, P378)

Selects the digital signal or the analog variable used for Test A (set with **P353** / **P362** / **P371** / **P380**).
The whole list of the selectable items and their description are stated in Table 48.
If a digital signal is selected, Test A is not performed: therefore, the comparison value for Test A (set with **P355** / **P364** / **P373** / **P382**) has no meaning.

NOTE

This parameter can be accessed only if the operating mode of the digital output concerned is other than zero. Example: MPL1 **P350**≠0.

Variable B selected for MPL1 (2, 3, 4): P352, (P361, P370, P379)

This selects a different digital signal or the analog variable used for Test B (set with **P354** / **P363** / **P372** / **P381**).
The whole list of the selectable items and their description are stated in Table 48.

If a digital signal is selected, Test B is not performed: therefore, the comparison value for Test B (set with **P356** / **P365** / **P374** / **P383**) has no meaning.

NOTE

Parameter **P352** cannot be accessed when the digital output operating mode is 1: DIGITAL or 3: ANALOG.

Example: MPL1 **P350**=1 OR **P350**=3.

Testing Variable A for MPL1 (2, 3, 4): P353, (P362, P371, P380)

If an analog variable is selected, a logic TEST is performed to obtain a TRUE/FALSE Boolean signal.
Eight different tests are available, that can be performed for selected variable A and its comparing value A:

Table 62: Test functions

GREATER THAN	Selected variable > comparing value
GREATER THAN/EQUAL TO	Selected variable ≥ comparing value
LOWER	Selected variable < comparing value
LOWER THAN/EQUAL TO	Selected variable ≤ comparing value
ABS, GREATER THAN	Absolute value (selected variable) > comparing value
ABS, GREATER THAN/EQUAL TO	Absolute value (selected variable) ≥ comparing value
ABS, LOWER	Absolute value (selected variable) < comparing value
ABS, LOWER THAN/EQUAL TO	Absolute value (selected variable) ≤ comparing value

NOTE

This parameter can be accessed only if the operating mode of the selected digital output is > 2. Example: MPL1 **P350**>2.

Operation on variable B, digital output MPL1 (2, 3, 4): P354, (P363, P372, P381)

If an analog variable is selected, a logic TEST is performed to obtain a TRUE/FALSE Boolean signal.
Eight different tests are available, that can be performed for selected variable B and its comparing value B (see Table 62).

NOTE

This parameter can be accessed only if the operating mode of the selected digital output is > 2 and < 9. Example: MPL1 2<**P350**<9.

Reference threshold for P351 (P360, P369, P378) in MPL1 (2, 3, 4): P355, (P364, P373, P382)

Defines the comparing value of Test A with the first selected variable.

NOTE

This parameter can be accessed only if the operating mode of the selected digital output is > 2. Example: MPL1 **P350**>2.

Reference threshold for P352 (P361, P370, P379) in MPL1 (2, 3, 4): P356, (P365, P374, P383)

Defines the comparing value of Test B with the first selected variable.

NOTE

This parameter can be accessed only if the operating mode of the selected digital output is > 2. Example: MPL1 **P350**>2.

MPL1 (2, 3, 4): Function applied to the result of Tests A and B: P357, (P366, P375, P384)

A logic function is applied to the two Boolean signals obtained in order to obtain the output TRUE/FALSE Boolean signal.

(A) OR (B): The selected digital output is enabled when at least one of the two conditions below is true (this function also allows enabling the selected digital input based on one test only).

(A) OR (B)		
Test A	Test B	Output
0	0	0
1	0	1
0	1	1
1	1	1

(A) SET (B) RESET Rising Edge
(A) RESET (B) SET Rising Edge
(A) SET (B) RESET Falling Edge
(A) RESET (B) SET Falling Edge

The selected digital output is activated as the output of a Flip Flop Set Reset whose inputs are signal A and signal B. This function can be used in case of hysteresis.
The status of the input (Qn) depends on the previous value (Qn-1) and on the result of the two tests.
Signals A and B are considered only when passing from 0→1 (Rising Edge) or 1→0 (Falling Edge) and may be used both as Set and Reset command.
Example: Suppose that the output enables only when the motor speed exceeds 50rpm and disables when the motor speed drops below 5 rpm. To do so, assign the first condition to Test A, representing the Set command for Flip Flop (**P351** = Motor Speed, **P353** >, **P355** = 50rpm), and assign the second condition to Test B, representing the Reset command (**P352** = Motor Speed, **P354** ≤, **P356** = 5rpm). A more detailed example is given at the end of this section.

(A) SET (B) RESET Rising Edge		
Test A (Set)	**Test B (Reset)**	**Q_n**
0→1	X	**1**
X	0→1	**0**
In any other case		**Q_{n-1}**

(A) RESET (B) SET Rising Edge		
Test A (Reset)	**Test B (Set)**	**Q_n**
0→1	X	**0**
X	0→1	**1**
In any other case		**Q_{n-1}**

(A) SET (B) RESET Falling Edge		
Test A (Set)	**Test B (Reset)**	**Q_n**
1→0	X	**1**
X	1→0	**0**
In any other case		**Q_{n-1}**

(A) RESET (B) SET Falling Edge		
Test A (Reset)	**Test B (Set)**	**Q_n**
1→0	X	**0**
X	1→0	**1**
In any other case		**Q_{n-1}**

(A) AND (B): The selected digital output enables when both conditions are true.

(A) AND (B)		
Test A	**Test B**	**Output**
0	0	**0**
1	0	**0**
0	1	**0**
1	1	**1**

(A) XOR (B): The selected digital output enables when either one condition or the other is true (but not when both conditions are true at a time).

(A) XOR (B)		
Test A	**Test B**	**Output**
0	0	**0**
1	0	**1**
0	1	**1**
1	1	**0**

(A) NOR (B): The selected digital output enables when no condition is true. The NOR function between two variables corresponds to the AND of the same false variables, i.e. (A) NOR (B) = (/A) AND (/B).

(A) NOR (B)		
Test A	**Test B**	**Output**
0	0	**1**
1	0	**0**
0	1	**0**
1	1	**0**

(A) NAND (B): The selected digital output enables when no condition is true or when only one of the two conditions is true. The NAND function between two variables corresponds to the OR of the same false variables, i.e. (A) NAND (B) = (/A) OR (/B).

(A) NAND (B)		
Test 1	**Test 2**	**Output**
0	0	**1**
1	0	**1**
0	1	**1**
1	1	**0**

NOTE This parameter can be accessed only if the operating mode of the selected digital output is > 2 and <9. Example: MPL1 2<**P350**<9.

Function applied to the result of f(A,B) C for MPL1: P357b, (P366b, P375b, P384b)

Once the Boolean signal resulting from f(A,B) is obtained, an additional logic function can be applied to obtain the output TRUE//FALSE Boolean signal.
If parameter **P357a** is disabled, the output of f(A,B) goes directly to the corresponding digital output; if parameter **P357a** is enabled, the output of the output of f(A,B) becomes one of the two inputs of the second programmed block.
The user can choose one of the six Boolean tests above for the first variable—f(A,B)—and for the second variable (C).

Logic applied to MPL1 (2, 3,4): P358, (P367, P376, P385)
The logic of the Boolean signal can be reversed at the end of the processing chain.
The user can choose whether the logic level of the digital output is POSITIVE or NEGATIVE.
(0) FALSE = a logic negation is applied (NEGATIVE logic).
(1) TRUE = no negation is applied (POSITIVE logic).

NOTE This parameter can be accessed only if the operating mode of the selected digital output is other than zero. Example: MPL1 **P350**≠0

NOTE Please refer to Programmable Operating Modes (Diagrams) relating to the digital outputs.

30.2. Operating Diagram of the Virtual Digital Outputs

Virtual digital outputs are software outputs that can be used as digital inputs from the following items:

- digital inputs
- digital outputs
- auxiliary digital outputs
- virtual digital outputs themselves.

They can be used for special functionality of the system, thus avoiding loop wiring on the same control board.

Example:

It can be necessary to control the status of the physical **ENABLE** contacts (**ENABLE-A** and **ENABLE-B**) of the system to cause an external alarm to trip when MPL1 is selected in parameter **C164** (DIGITAL INPUTS MENU).

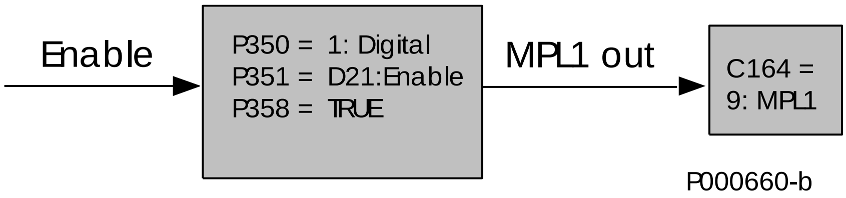


Figure 41: Example of MPL functionality

For more details about possible configurations of the virtual digital outputs, see Programmable Operating Modes (Diagrams).

Examples

This section covers some examples for the supervision of pumping systems with the PID control algorithm.
The settings of the parameters being used are given in the tables below: the parameters highlighted in grey have no effect.

Example 1: Dry Run Detection

For most pumps, especially submersible bore-hole pumps, it must be assured that the pump is stopped in case of dry run. This is assured by the Dry Run Detection feature. How Does It Work?
Dry run detection is based on power/frequency monitoring. Stop (trip) due to dry run is initiated under the following conditions:

Table 63: MPL parameterization for Dry Run Detection

P359	MPL2: Digital output mode	DOUBLE ANALOG
P360	MPL2: Selecting variable A	A77: Output Power
P361	MPL2: Selecting variable B	A86: PID Feedback
P362	MPL2: Testing variable A	<
P363	MPL2: Testing variable B	<
P364	MPL2: Comparing value for Test A	Min. operating PWR **[*]**
P365	MPL2: Comparing value for Test B	Min. FBK value **[*]**
P366	MPL2: Function applied to the result of the 2 tests	(A) AND (B)
P366a	MPL2: Selecting variable C	D11: PID Out Max
P366b	MPL2: Function applied to the result of f(A,B) C	f(A,B) AND (C)
P367	MPL2: Output logic level	TRUE

NOTE It is recommended that a TIMEOUT be entered for Dry Run Detection. Enter a timeout for MPL2 output (see TIMERS MENU).

P368	MPL3: Digital output mode	DOUBLE ANALOG
P369	MPL3: Selecting variable A	A77: Output Power
P370	MPL3: Selecting variable B	A86: PID Feedback
P371	MPL3: Testing variable A	≥
P372	MPL3: Testing variable B	<
P373	MPL3: Comparing value for Test A	Min. operating PWR **[*]**
P374	MPL3: Comparing value for Test B	Min. FBK value **[*]**
P375	MPL3: Function applied to the result of the 2 tests	(A) AND (B)
P375a	MPL3: Selecting variable C	D51: MPL2
P375b	MPL3: Function applied to the result of f(A,B) C	f(A,B) OR (C)
P376	MPL3: Output logic level	TRUE

NOTE MPL3 detects when piping is clogged or faulty or when the delivery/pressure sensor is malfunctioning (e.g. the pump membrane is locked) when the sensor is located downstream of the mains.

P377	MPL4: Digital output mode	DOUBLE FULL
P378	MPL4: Selecting variable A	D51: MPL3
P379	MPL4: Selecting variable B	A86: PID Feedback
P380	MPL4: Testing variable A	
P381	MPL4: Testing variable B	≥
P382	MPL4: Comparing value for Test A	
P383	MPL4: Comparing value for Test B	Min. FBK value **[*]**
P384	MPL4: Function applied to the result of the 2 tests	(A) Set (B) Reset
P384a	MPL4: Selecting variable C	D0: Disabled
P384b	MPL4: Function applied to the result of f(A,B) C	
P385	MPL4: Output logic level	See steps 1. and 2. below

Virtual digital output MPL4 locks the system operation in two modes:

1. Virtually connecting the output to an external alarm input (**P385**=FALSE; **C164**=12: MPL4)
2. Disabling the PID (**P385**=TRUE; **C171**=12: MPL4)

On the other hand, when the malfunctioning signal is sent to the PLC supervisor, the same parameterization in MPL4 shall be entered in the digital output concerned.

NOTE

[*]
Min. Operating PWR = Min. power required for the pump delivery.
Min. FBK value = the min. feedback value shall be ≥ **P237** (minimum PID).

NOTE

When the Sleep Mode (see PID PARAMETERS MENU) and the Dry Run Detection mode are activated simultaneously, the delay time for the Dry Run Detection mode shall be shorter than the Sleep Mode time.

Example 2: Pipe Fill Function

The PIPE FILL function avoids water hammer in irrigation pipes. To avoid water hammer, pipes must be filled very slowly for air drainage. To do so, force a minimum rate reference, thus obtaining the minimum delivery of the pumping system. Once the min. rate is attained, the feedback starts increasing; when the filling pressure is attained, the system can start operating under normal conditions. Suppose that the feedback value of the pipe pressure is present at analog input AIN1.

Table 64: MPL parameterization for Pipe Fill function

P368	MPL3: Digital output mode	DOUBLE ANALOG
P369	MPL3: Selecting variable A	A79: AIN1
P370	MPL3: Selecting variable B	A79: AIN1
P371	MPL3: Testing variable A	<
P372	MPL3: Testing variable B	≥
P373	MPL3: Comparing value for Test A	Pressure value when the system is empty
P374	MPL3: Comparing value for Test B	Pressure value when the system is full
P375	MPL3: Function applied to the result of the 2 tests	(A) Set (B) Reset
P375a	MPL3: Selecting variable C	D0: Disabled
P375b	MPL3: Function applied to the result of f(A,B) C	
P376	MPL3: Output logic level	TRUE

P377	MPL4: Digital output mode	DIGITAL
P378	MPL4: Selecting variable A	D52: MPL3
P379	MPL4: Selecting variable B	
P380	MPL4: Testing variable A	
P381	MPL4: Testing variable B	
P382	MPL4: Comparing value for Test A	
P383	MPL4: Comparing value for Test B	
P384	MPL4: Function applied to the result of the 2 tests	
P384a	MPL4: Selecting variable C	D0: Disabled
P384b	MPL4: Function applied to the result of f(A,B) C	
P385	MPL4: Output logic level	TRUE

P009	Acceleration time 1	Ramp for normal operation **[*]**
P010	Deceleration time 1	Ramp for normal operation **[*]**
P011	Acceleration time 2	Ramp for PIPE FILL **[*]**
P012	Deceleration time 2	Ramp for PIPE FILL **[*]**
P080	Multispeed function	0: Preset Speed
P081	Output speed 1 (Mspd1)	Min. operating speed **[*]**
C182	MDI Multiprogramming enable	Enabled
C155	MDI for multispeed 0 selection	12: MPL4
C167	MDI for multiramp 0 selection	11: MPL3
C171	MDI for PID disable	11: MPL3

It is required to repeat MPL3 output to MPL4 output, because every MPL may be allocated to maximum 2 functions (**C182 = Enabled** – see DIGITAL INPUTS MENU). In that case, 3 functions are required, so an additional output is needed.

NOTE

[*]
Ramp for normal function = Ramp desired during normal operation.
Ramp for PIPE FILL = Ramp desired when filling the pipes.
Minimum operating speed = Min. speed required for the correct delivery of the pump.

30.3. List of Parameters P350 to P385

Table 65: List of Parameters P350 to P385

Parameter	FUNCTION	User Level	DEFAULT VALUES	MODBUS Address
P350	MPL1: Digital output mode	ADVANCED	0: DISABLE	950
P351	MPL1: Selecting variable A	ADVANCED	D0: DISABLE	951
P352	MPL1: Selecting variable B	ADVANCED	D0: DISABLE	952
P353	MPL1: Testing variable A	ADVANCED	0: >	953
P354	MPL1: Testing variable B	ADVANCED	0: >	954
P355	MPL1: Comparing value for Test A	ADVANCED	0	955
P356	MPL1: Comparing value for Test B	ADVANCED	0	956
P357	MPL1: Function applied to the result of the 2 tests	ADVANCED	0: (A) OR (B)	957
P357a	MPL1: Selecting variable C	ADVANCED	D0: DISABLE	932
P357b	MPL1: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	933
P358	MPL1: Output logic level	ADVANCED	1: TRUE	958
P359	MPL2: Digital output mode	ADVANCED	0: DISABLE	959
P360	MPL2: Selecting variable A	ADVANCED	D0: DISABLE	960
P361	MPL2: Selecting variable B	ADVANCED	D0: DISABLE	961
P362	MPL2: Testing variable A	ADVANCED	0: >	962
P363	MPL2: Testing variable B	ADVANCED	0: >	963
P364	MPL2: Comparing value for Test A	ADVANCED	0	964
P365	MPL2: Comparing value for Test B	ADVANCED	0	965
P366	MPL2: Function applied to the result of the 2 tests	ADVANCED	0: (A) OR (B)	966
P366a	MPL2: Selecting variable C	ADVANCED	D0: DISABLE	934
P366b	MPL2: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	935
P367	MPL2: Output logic level	ADVANCED	1: TRUE	967
P368	MPL3: Digital output mode	ADVANCED	0: DISABLE	968
P369	MPL3: Selecting variable A	ADVANCED	D0: DISABLE	969
P370	MPL3: Selecting variable B	ADVANCED	D0: DISABLE	970
P371	MPL3: Testing variable A	ADVANCED	0: >	971
P372	MPL3: Testing variable B	ADVANCED	0: >	972
P373	MPL3: Comparing value for Test A	ADVANCED	0	973
P374	MPL3: Comparing value for Test B	ADVANCED	0	974
P375	MPL3: Function applied to the result of the 2 tests	ADVANCED	0: (A) OR (B)	975
P375a	MPL3: Selecting variable C	ADVANCED	D0: DISABLE	936
P375b	MPL3: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	937
P376	MPL3: Output logic level	ADVANCED	1: TRUE	976
P377	MPL4: Digital output mode	ADVANCED	0: DISABLE	977
P378	MPL4: Selecting variable A	ADVANCED	D0: DISABLE	978
P379	MPL4: Selecting variable B	ADVANCED	D0: DISABLE	979
P380	MPL4: Testing variable A	ADVANCED	0: >	980
P381	MPL4: Testing variable B	ADVANCED	0: >	981
P382	MPL4: Comparing value for Test A	ADVANCED	0	982
P383	MPL4: Comparing value for Test B	ADVANCED	0	983
P384	MPL4: Function applied to the result of the 2 tests	ADVANCED	0: (A) OR (B)	984
P384a	MPL4: Selecting variable C	ADVANCED	D0: DISABLE	938
P384b	MPL4: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	939
P385	MPL4: Output logic level	ADVANCED	1: TRUE	985

P350 MPL1: Digital Output Mode

P350	**Range**	0 ÷ 8	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT
	Default	1	1: DIGITAL
	Level	ADVANCED	
	Address	950	
	Function	This parameter defines the operating mode of **virtual digital output 1**. The different operating modes are described at the beginning of this chapter.	

P351 MPL1: Selecting Variable A

P351	**Range**	0 ÷ 149	See Table 48
	Default	21	D0: Enable
	Level	ADVANCED	
	Address	951	
	Function	This parameter selects the digital signal used to calculate the value of **MPL1** digital output. It selects an analog variable used to calculate the value of **MPL1** digital output if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P352 MPL1: Selecting Variable B

P352	**Range**	0 ÷ 149	See Table 48
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	952	
	Function	This parameter selects the second digital signal used to calculate the value of **MPL1** digital output. It selects an analog variable used to calculate the value of **MPL1** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P353 MPL1: Testing Variable A

P353	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	953	
	Function	This parameter defines the test to be performed for the variable detected by **P351** using **P355** as a comparing value.	

P354 MPL1: Testing Variable B

P354	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	954	
	Function	This parameter defines the test to be performed for the variable detected by **P352** using **P356** as a comparing value**.**	

P355 MPL1: Comparing Value for Test A

P355	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A*, see Table 48
	Default	0	0
	Level	ADVANCED	
	Address	955	
	Function	This parameter defines the comparing value with the selected variable for test A.	

P356 MPL1: Comparing Value for Test B

P356	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B*, see Table 48
	Default	0	0
	Level	ADVANCED	
	Address	956	
	Function	This parameter defines the comparing value with the selected variable for test B.	

P357 MPL1: Function Applied to the Result of the 2 Tests

P357	**Range**	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	0	0: (A) OR (B)
	Level	ADVANCED	
	Address	957	
	Function	This parameter determines the logic function applied to the result of the tests allowing calculating the output value.	

P357a MPL1: Selecting Variable C

P357a	**Range**	0 ÷ 79	See Table 48
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	932	
	Function	This parameter selects the digital signal used to calculate the value of **MPL1** digital output. The digital signals that can be selected are given in Table 48.	

P357b MPL1: Function Applied to the Result of f(A,B) C

P357b	**Range**	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: f(A,B)\ OR (C) 7: f(A,B) OR (C\) 8: f(A,B)\ AND (C) 9: f(A,B) AND (C\) 10: f(A,B) RESET (C) SET RISING EDGE 11: f(A,B) SET (C) RESET FALLING EDGE 12: f(A,B) RESET (C) SET FALLING EDGE
	Default	0	0: f(A,B) OR (C)
	Level	ADVANCED	
	Address	933	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P358 MPL1: Output Logic Level

P358	**Range**	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ADVANCED	
	Address	958	
	Function	MPL1 digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P359 MPL2: Digital Output Mode

P359	**Range**	0 ÷ 8	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT
	Default	1	0: DISABLE
	Level	ADVANCED	
	Address	959	
	Function	This parameter defines the operating mode of **virtual digital output 2**. The different operating modes are described at the beginning of this chapter.	

P360 MPL2: Selecting Variable A

P360	**Range**	0 ÷ 149	See Table 48
	Default	33	D0: Disable
	Level	ADVANCED	
	Address	960	
	Function	This parameter selects the digital signal used to calculate the value of **MPL2** digital output. It selects an analog variable used to calculate the value of **MPL2** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P361 MPL2: Selecting Variable B

P361	**Range**	0 ÷ 149	See Table 48
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	961	
	Function	This parameter selects the second digital signal used to calculate the value of **MPL2** digital output. It selects an analog variable used to calculate the value of **MPL2** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P362 MPL2: Testing Variable A

P362	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	362	
	Function	This parameter defines the test to be performed for the variable detected by **P360** using **P364** as a comparing value**.**	

P363 MPL2: Testing Variable B

P363	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	963	
	Function	This parameter defines the test to be performed for the variable detected by **P361** using **P365** as a comparing value.	

P364 MPL2: Comparing Value for Test A

P364	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A,* see Table 48
	Default	0	0
	Level	ADVANCED	
	Address	964	
	Function	This parameter defines the comparing value with the selected variable for test A.	

P365 MPL2: Comparing Value for Test B

P365	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B*, see Table 48
	Default	0	0
	Level	ADVANCED	
	Address	965	
	Function	This parameter defines the comparing value with the selected variable for test B.	

P366 MPL2: Function Applied to the Result of the 2 Tests

P366	**Range**	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	966	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P366a MPL2: Selecting Variable C

P366a	**Range**	0 ÷ 79	See Table 48
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	934	
	Function	This parameter selects the digital signal used to calculate the value of **MPL2** digital output. The digital signals that can be selected are given in Table 48.	

P366b MPL2: Function Applied to the Result of f(A,B) C

P366b	**Range**	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	0	0: f(A,B) OR (C)
	Level	ADVANCED	
	Address	935	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P367 MPL2: Output Logic Level

P367	**Range**	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ADVANCED	
	Address	967	
	Function	MPL2 digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P368 MPL3: Digital Output Mode

P368	**Range**	0 ÷ 8	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT
	Default	1	0: DISABLE
	Level	ADVANCED	
	Address	968	
	Function	This parameter defines the operating mode of **virtual digital output 3**. The different operating modes are described at the beginning of this chapter.	

P369 MPL3: Selecting Variable A

P369	**Range**	0 ÷ 149	See Table 48
	Default	38	D0: Disable
	Level	ADVANCED	
	Address	969	
	Function	This parameter selects the digital signal used to calculate the value of **MPL3** digital output. It selects an analog variable used to calculate the value of **MPL3** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P370 MPL3: Selecting Variable B

P370	**Range**	0 ÷ 149	See Table 48
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	970	
	Function	This parameter selects the second digital signal used to calculate the value of **MPL3** digital output. It selects an analog variable used to calculate the value of digital input **MPL3** if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P371 MPL3: Testing Variable A

P371	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	971	
	Function	This parameter defines the test to be performed for the variable detected by **P369** using **P373** as a comparing value**.**	

P372 MPL3: Testing Variable B

P372	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	972	
	Function	This parameter defines the test to be performed for the variable detected by **P370** using **P374** as a comparing value.	

P373 MPL3: Comparing Value for Test A

P293	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A,* see Table 48
	Default	0	0
	Level	ADVANCED	
	Address	973	
	Function	This parameter defines the comparing value with the variable selected for test A.	

P374 MPL3: Comparing Value for Test B

P374	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B*, see Table 48
	Default	0	0
	Level	ADVANCED	
	Address	974	
	Function	This parameter defines the comparing value with the variable selected for test B.	

P375 MPL3: Function Applied to the Result of the 2 Tests

P375	**Range**	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	0	0: (A) OR (B)
	Level	ADVANCED	
	Address	975	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P375a MPL3: Selecting Variable C

P375a	**Range**	0 ÷ 79	See Table 48
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	936	
	Function	This parameter selects the digital signal used to calculate the value of **MPL3** digital output. The digital signals that can be selected are given in see Table 48.	

P375b MPL3: Function Applied to the Result of f(A,B) C

P375b	**Range**	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: f(A,B)\ OR (C) 7: f(A,B) OR (C\) 8: f(A,B)\ AND (C) 9: f(A,B) AND (C\) 10: f(A,B) RESET (C) SET RISING EDGE 11: f(A,B) SET (C) RESET FALLING EDGE 12: f(A,B) RESET (C) SET FALLING EDGE
	Default	0	0: f(A,B) OR (C)
	Level	ADVANCED	
	Address	937	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P376 MPL3: Output Logic Level

P376			
	Range	0–1	0: TRUE 1: FALSE
	Default	1	1: TRUE
	Level	ADVANCED	
	Address	976	
	Function	MPL3 digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P377 MPL4: Digital Output Mode

P377			
	Range	0 ÷ 8	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT
	Default	1	0: DISABLE
	Level	ADVANCED	
	Address	977	
	Function	This parameter defines the operating mode of **virtual digital output 4**. The different operating modes are described at the beginning of this chapter.	

P378 MPL4: Selecting Variable A

P378			
	Range	0 ÷ 149	See Table 48
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	978	
	Function	This parameter selects the digital signal used to calculate the value of **MPL4** digital output. It selects an analog variable used to calculate the value of **MPL4** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

P379 MPL4: Selecting Variable B

P379			
	Range	0 ÷ 149	See Table 48
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	979	
	Function	This parameter selects the second digital signal used to calculate the value of **MPL4** digital output. It selects an analog variable used to calculate the value of **MPL4** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 48.	

<u>**P380 MPL4: Testing Variable A**</u>

P380	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	980	
	Function	This parameter defines the test to be performed for the variable detected by **P378** using **P382** as a comparing value**.**	

<u>**P381 MPL4: Testing Variable B**</u>

P381	**Range**	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	981	
	Function	This parameter defines the test to be performed for the variable detected by **P379** using **P383** as a comparing value.	

<u>**P382 MPL4: Comparing Value for Test A**</u>

P382	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A*, see Table 48
	Default	0	0
	Level	ADVANCED	
	Address	982	
	Function	This parameter defines the comparing value with the selected variable for test A.	

<u>**P383 MPL4: Comparing Value for Test B**</u>

P383	**Range**	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B*, see Table 48
	Default	0	0
	Level	ADVANCED	
	Address	983	
	Function	This parameter defines the comparing value with the selected variable for test B.	

P384 MPL4: Function Applied to the Result of the 2 Tests

P384	**Range**	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	0	0: (A) OR (B)
	Level	ADVANCED	
	Address	984	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P384a MPL4: Selecting Variable C

P384a	**Range**	0 ÷79	See Table 48
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	938	
	Function	This parameter selects the digital signal used to calculate the value of **MPL4** digital output. The digital signals that can be selected are given in Table 48.	

P384b MPL4: Function Applied to the Result of f(A,B) C

P384b	**Range**	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: f(A,B)\ OR (C) 7: f(A,B) OR (C\) 8: f(A,B)\ AND (C) 9: f(A,B) AND (C\) 10: f(A,B) RESET (C) SET RISING EDGE 11: f(A,B) SET (C) RESET FALLING EDGE 12: f(A,B) RESET (C) SET FALLING EDGE
	Default	0	0: f(A,B) OR (C)
	Level	ADVANCED	
	Address	939	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P385 MPL4: Output Logic Level

P385			
	Range	0–1	0: TRUE 1: FALSE
	Default	1	1: TRUE
	Level	ADVANCED	
	Address	985	
	Function	MPL4 digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

NOTE

Although it is possible to program a digital output so that it reflects the drive status, this indication is not be considered “SIL rated” as per the safety standards the STO function relates to. The STO safety function is accomplished with a dedicated and redundant hardware circuit, assessed and certified with defined SIL and PL levels, whereas the control software and the outputs implementing hardware do not meet the requirements above.
For that reason, the output signals within safety functions of the system where the drive is installed must not be used.
For details on the STO function, consult the Safe Torque Off Function - Application Manual.

31. INPUTS FOR REFERENCES FROM OPTIONAL BOARD

This menu relates to ES847 I/O expansion board. It can be viewed only if **R023** (I/O board setting) = XAIN (see the EXPANSION BOARD CONFIGURATION MENU).
In addition to the analog inputs located on the control board, a current analog input and a voltage analog input can be acquired if ES847 is fitted.

31.1. Scaling Analog Inputs XAIN4, XAIN5

NOTE Please refer to the Sinus Penta's Motor Drives Accessories - User Manual for hardware details about analog inputs.

Two analog inputs (XAIN4, XAIN5) are located on ES847 control board.
XAIN4 is a current input and XAIN5 is a voltage input. They are both bipolar analog inputs (–10V ÷ +10V or –20mA ÷ +20mA).
For both analog inputs, parameters **P390** to **P399** allow setting the type of signal to be acquired, offset compensation (if any), scaling to obtain a speed reference or a torque reference, the signal filtering time constant.
Parameter **P393** sets the offset of the input analog signal (if **P393**=0 offset is zero), while parameter **P394** defines the filtering time constant (factory setting: **P394** = 100ms).
The voltage signal can be bipolar (–**10V** ÷ **+10V**) or unipolar (**0V** ÷ **+10V**).
The current signal can be bipolar (**–20mA** ÷ **+20mA**), unipolar (**0mA** ÷ **+20mA**) or can have a minimum offset (**4mA** ÷ **20mA**).
The user will set each analog input mode in parameters **P390**, **P395**.

Table 66: Analog input hardware mode

Type / Terminals	Name	Type	Parameter
Differential input / Pin 11,12	XAIN4	±10V Input	**P390**
Differential input / Pin 13,14	XAIN5	±20mA Input	**P395**

NOTE Configurations different from the ones stated in the table above are not allowed.

Scaling is obtained by setting the parameters relating to the **linear function for the conversion** from the value read by the analog input to the corresponding speed/torque reference value.
The **conversion function** is a **straight line** passing through **2 points** in **Cartesian coordinates** having the values read by the analog input in the X-axis, and the speed/torque reference values in the Y-axis. The speed/torque reference values are multiplied by the reference percent parameters.

Each point is detected through its **two coordinates**.

The ordinates of the two points are the following:
the value of **Speed_Min** (or **Trq_Min** for the torque reference) multiplied by the percentage set with **P391a/P396a** for the **first point**; the value of **Speed_Max** (or **Trq_Max** for the torque reference) multiplied by the percentage set with **P392a/P397a** for the **second point**.

Speed_Min depends on the selected motor: see parameter **C028** (motor 1), **C071** (motor 2), or **C114** (motor 3).
Trq_Min depends on the selected motor: see parameter **C047** (motor 1), **C090** (motor 2) or **C133** (motor 3).

Speed_Max depends on the selected motor: see parameter **C029** (motor 1), **C072** (motor 2) or **C115** (motor 3).
Trq_Max depends on the selected motor: see parameter **C048** (motor 1), **C091** (motor 2), or **C134** (motor 3).

The X-axis values of the two points depend on the analog input:

XAIN4 Input:
Parameter **P391** is the X-axis of the **first point;** parameter **P392** is the X-axis of the **second point.**

XAIN5 Input:
Parameter **P396** is the X-axis of the **first point;** parameter **P397** is the X-axis of the **second point.**

(see also Scaling Analog Inputs REF, AIN1, AIN2).

31.2. List of parameters P390 to P399

Table 67: List of Parameters P390 to P399

Parameter	FUNCTION	User Level	DEFAULT VALUE	MODBUS Address
P390	Type of signal over **XAIN4** input	ADVANCED	1:0÷10V	990
P391	Value of **XAIN4** input producing min. reference (X-axis)	ADVANCED	0.0V	991
P391a	Percentage of Speed_Min/Trq_Min producing min. reference (Y-axis related to **P391**)	ADVANCED	100.0%	704
P392	Value of **XAIN4** input producing max. reference (X-axis)	ADVANCED	10.0V	992
P392a	Percentage of Speed_Max/Trq_Max producing max. reference (Y-axis related to **P392**)	ADVANCED	100.0%	710
P393	Offset over **XAIN4** input	ADVANCED	0V	993
P394	Filtering time over **XAIN4** input	ADVANCED	100ms	994
P395	Type of signal over **XAIN5** input	ADVANCED	3: 4÷20mA	995
P396	Value of **XAIN5** input producing min. reference (X-axis)	ADVANCED	4.0mA	996
P396a	Percentage of Speed_Min/Trq_Min producing min. reference (Y-axis related to **P396**)	ADVANCED	100.0%	711
P397	Value of **XAIN5** input producing max. reference (X-axis)	ADVANCED	20.0mA	997
P397a	Percentage of Speed_Min/Trq_Min producing min. reference (Y-axis related to **P397**)	ADVANCED	100.0%	712
P398	Offset over **XAIN5** input	ADVANCED	0mA	998
P399	Filtering time over **XAIN5** input	ADVANCED	100 ms	999

P390 Type of Signal over XAIN4 Input

P390			
	Range	0 ÷ 2	0: ± 10 V 1: 0 ÷ 10 V 2: ABS ± 10 V
	Default	1	1:0÷10V
	Level	ADVANCED	
	Address	990	
	Function	This parameter selects the type of single–ended, analog signal over XAIN4 terminal in the terminal board. The signal can be a voltage signal, a unipolar signal, or a bipolar signal. **0:** ± 10 V Bipolar voltage input between –10V and +10V. The detected signal is saturated between these two values. **1**: 0 ÷ 10 V Unipolar voltage input between 0V and +10V. The detected signal is saturated between these two values. **2**: ABS ± 10 V as **0:** ± 10 V, but negative voltages are considered as positive voltages.	

P391 Value of XAIN4 Input Producing Min. Reference

P391			
	Range	–100 ÷ 100, if **P390** = 0 0 ÷ 100, if **P390** = 1 –100 ÷ 100, se **P390** = 2	–10.0 V ÷ 10.0 V, if **P390 =** 0: ± 10 V 0.0 V ÷ 10.0V, if **P390** = 1: 0 ÷ 10 V –10.0 V ÷ 10.0 V, if **P390 =** 2: ABS ± 10 V
	Default	0	0.0V
	Level	ADVANCED	
	Address	991	
	Function	This parameter selects the value for XAIN4 input signal for minimum reference, or better the reference set in **C028 xP391a** (Master mode) or in **C047xP391a** (Slave mode). If motor 2 is active, **C071** and **C090** will be used instead of **C028** and **C047**; if motor 3 is active, the values set in **C114** and **C133** will be used.	

P391a Percentage of Speed_Min/Trq_Min. Producing Min. Reference (Y-axis related to P391)

P391a			
	Range	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	704	
	Function	This parameter represents the min. speed percentage (or the min. torque percentage for a torque reference) to be used for the minimum reference set with **P391.**	

P392 Value of XAIN4 Input Producing Max. Reference (X-axis)

P392			
	Range	–100 ÷ 100, if **P390** = 0 0 ÷ 100, if **P390** = 3 –100 ÷ 100, if **P390** = 2	–10.0 V ÷ 10.0 V, if **P390 =** 0: ± 10 V 0.0 V ÷ 10.0V, if **P390** = 1: 0 ÷ 10 V –10.0 V ÷ 10.0 V, if **P390 =** 2: ABS ± 10V
	Default	100	+10.0V
	Level	ADVANCED	
	Address	992	
	Function	This parameter selects the value for XAIN4 input signal for maximum reference, or better the reference set in **C029xP392a** (Master mode) or in **C048xP392a** (Slave mode). If motor 2 is active, **C072** and **C091** will be used instead of **C029** and **C048**; if motor 3 is active, the values set in **C115** and **C134** will be used.	

P392a Percentage of Speed_Max/Trq_Max Producing Max. Reference (Y-axis related to P392)

P392a			
	Range	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	710	
	Function	This parameter represents the max. speed percentage (or the max. torque percentage for a torque reference) to be used for the maximum reference set with **P392.**	

P393 Offset over XAIN4 Input

P393			
	Range	–2000 ÷ 2000	–2.000 V ÷ +2.000 V
	Default	0	0.000 V
	Level	ADVANCED	
	Address	993	
	Function	This parameter selects the offset correction value of the XAIN4 analog signal that has been measured. The value set is added to the signal measured before saturation or conversion; its unit of measure is the same as the one of the signal selected for XAIN4 analog input.	

P394 Filtering Time over XAIN4 Input

P394			
	Range	0 ÷ +65000	0 ÷ +65000ms
	Default	100	100 ms
	Level	ADVANCED	
	Address	994	
	Function	This parameter selects the value of the filter time constant of the first command applied to the XAIN4 input signal when the signal saturation and conversion is over.	

P395 Type of Signal over XAIN5 Input

P395			
	Range	3 ÷ 6	3: ± 20 mA 4: 4 ÷ 20 mA 5: 0 ÷ 20 mA 6: ABS ± 20 mA
	Default	4	4: 4 ÷ 20 mA
	Level	ADVANCED	
	Address	995	
	Function	This parameter selects the type of differential analog signal over terminals X**AIN5+** and X**AIN5–** in the terminal board. The signal can be a current signal, a unipolar signal, or a bipolar signal. **3:** ±20 mA Bipolar current input between –20mA and +20mA. The detected signal is saturated between these two values. **4:** 4 ÷ 20 mA Unipolar current input with min. threshold, between +4 mA and +20mA. The detected signal is saturated between these two values. Before being saturated, if the detected signal is lower than 4 mA or greater than 20 mA, alarms **A069** or **A086** trip. **5:** 0 ÷ 20 mA Unipolar current input between +0 mA and +20mA. The detected signal is saturated between these two values. **6:** ABS ± 20 mA as **3**: ± 20 mA, but the negative currents are considered as the positive currents.	

P396 Value of XAIN5 Producing Min. Reference (X-axis

P396			
	Range	–200 ÷ 200, if **P395** = 3 +40 ÷ 200, if **P395** = 4 0 ÷ 200, if **P395** = 5 –200 ÷ 200, if **P395** = 6	–20.0 mA ÷ 20.0 mA, if **P395** = 3: ± 20 mA +4.0 mA ÷ 20.0 mA, if **P395** = 4: 4 ÷ 20 mA 0.0 mA ÷ 20.0 mA, if **P395** = 5: 0 ÷ 20 mA –20.0 mA ÷ 20.0 mA, if **P395** = 6: ABS ± 20 mA
	Default	40	+4.0mA
	Level	ADVANCED	
	Address	996	
	Function	This parameter selects the value for XAIN5 input signal for minimum reference, or better the reference set in **C028xP396a** (Master mode) or in **C047xP396a** (Slave mode). If motor 2 is active, **C071** and **C090** will be used instead of **C028** and **C047**; if motor 3 is active, the values set in **C114** and **C133** will be used.	

P396a Percentage of Speed_Min/Trq_Min Producing Min. Reference (Y-axis related to P396)

P396a			
	Range	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	711	
	Function	This parameter represents the min. speed percentage (or the min. torque percentage for a torque reference) to be used for the minimum reference set with **P396.**	

P397 Value of XAIN5 Input Producing Max. Reference (X-axis)

P397	**Range**	–200 ÷ 200, if **P395** = 3 +40 ÷ 200, if **P395** = 4 0 ÷ 200, if **P395** = 5 –200 ÷ 200, if **P395** = 6	–20.0 mA ÷ 20.0 mA, if **P395** = 3: ± 20 mA +4.0 mA ÷ 20.0 mA, if **P395** = 4: 4 ÷ 20 mA 0.0 mA ÷ 20.0 mA, if **P395** = 5: 0 ÷ 20 mA –20.0 mA ÷ 20.0 mA, if **P395** = 6: ABS ± 20 mA
	Default	200	+20.0mA
	Level	ADVANCED	
	Address	997	
	Function	This parameter selects the value for XAIN5 input signal for maximum reference, or better the reference set in **C029xP397a** (Master mode) or in **C048xP397a** (Slave mode). If motor 2 is active, **C072** and **C091** will be used instead of **C029** and **C048**; if motor 3 is active, the values set in **C115** and **C134** will be used.	

P397a Percentage of Speed_Max/Trq_Max Producing Max. Reference (Y-axis related to P397)

P397a	**Range**	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	712	
	Function	This parameter represents the max. speed percentage (or the max. torque percentage for a torque reference) to be used for the maximum reference set with **P397.**	

P398 Offset over XAIN5 Input

P398	**Range**	–2000 ÷ 2000	– 20.00 mA ÷ +20.00 mA
	Default	0	0 mA
	Level	ADVANCED	
	Address	998	
	Function	This parameter selects the offset correction value of XAIN5 analog signal that has been measured. The value set is added to the signal measured before saturation or conversion; its unit of measure is the same as the one of the signal selected for XAIN5 analog input.	

P399 Filtering Time over XAIN5 Input

P399	**Range**	0 ÷ +65000	0 ÷ +65000ms
	Default	100	100 ms
	Level	ADVANCED	
	Address	999	
	Function	This parameter selects the value of the filter time constant of the first command applied to XAIN5 input signal when the signal saturation and conversion is over.	

32. AUTOTUNE MENU

32.1. Overview

NOTE See the FIRST STARTUP section for tuning based on the control algorithm to be used.

NOTE At the end of the Autotune procedure, the system automatically saves the whole parameter set of the drive.

NOTE Autotune must be performed only after entering the motor ratings or the ratings of the encoder used as a speed feedback. Please refer to the MOTOR CONFIGURATION MENU and the ENCODER/FREQUENCY INPUTS MENU.

The selected motor may be tuned in order to obtain the machine ratings or the parameterization required for the correct functioning of the control algorithms. The user can also check the proper operation/wiring of the encoder used as a speed feedback.

The Autotune menu includes two programming inputs, **I073** and **I074**. Input **I073** allows enabling and selecting the type of autotune. Input **I074**, which can be programmed only if **I073** = [1: Motor Tune], describes the type of autotune which is performed. Because the values set in **I073** or **I074** cannot be changed once for all and are automatically reset after autotune, the **ENABLE-A ENABLE-B** signals must be disabled and the **ESC** key must be used to accept the new value.

32.1.1. MOTOR AUTOTUNE AND ADJUSTING LOOPS

Set **I073** as Motor Tune to enable autotune functions that can be selected with **I074**.

NOTE

For the correct operation of the tuning algorithms, enter the motor ratings and the ratings of the encoder used as a speed feedback.

If the carrier frequency is changed via parameters **C001** or **C002**, the current control loop and the flux control loop of the VTC or FOC regulator are to be adjusted again (see “VTC” Control Algorithm and “FOC” Control).

The autotune procedure computes the motor parameters and the regulators parameters regardless of the control algorithm selected via **C010**/**C053**/**C096**. Therefore, it is possible to perform the autotune procedure before selecting the type of motor control to be applied.

Please refer to the MOTOR CONFIGURATION MENU and the ENCODER/FREQUENCY INPUTS MENU.

Table 68: Programmable "Motor Tune" functions

Value of I074	Motor rotation	Tuning
[0: Motor Params]	no	Automatic estimation of motor parameters by means of measurements carried out on the motor and/or calculations made starting from its nameplate. Procedure required for the correct operation of IFD with slip compensation, VTC and FOC controls. The following parameters are computed (parameter names are given for motor M1 only): - Stator resistance **C022**, through automatic estimation - Leakage inductance **C023**, through automatic estimation - If **C021**=0, a first trial value for no-load current **C021** is computed based on the motor ratings (rated power in particular), otherwise, the value in **C021** is not changed. An accurate value for **C021** is required when using VTC and FOC control algorithms, so it is recommended that it is measured by means of a special test as detailed in the FIRST STARTUP section - Mutual inductance **C024**, based on motor ratings and no-load current - If **C025**=0, a first trial value for rotor time constant **C025,** otherwise the value in **C025** is not changed. Although a first trial value for the rotor time constant is computed, for the VTC and FOC control algorithms to work correctly, the rotor time constant should be calculated using one of the following two procedures.
[1: Control NO rot]	no	Automatic estimation of the rotor time constant and tuning of the current regulator for VTC and FOC controls and the flux regulator for FOC control. For the correct operation of the VTC and FOC algorithms, it is possible to perform this type of tuning if the motor shaft cannot rotate. During this tuning, current pulses are applied to the motor. The current amplitude of the current pulses is up to the rated current. Before performing this procedure, tune motor parameters through **I074** = [0: Motor Params]. The following parameters are computed: - VTC control: **P175t1** (proportional gain of the current control) and **P175u1** (integral time of the current control); - FOC control: **P155**, **P156** current and **P158**, **P159** flux regulators parameters - both controls: **C025** rotor time constant.
[2: Control YES rot]	yes	Automatic estimation of the rotor time constant and tuning of the current regulator for VTC and FOC controls and the flux regulator for FOC control. For the correct operation of the VTC and FOC algorithms, it is possible to perform this type of tuning if the motor shaft can rotate with no connected load. If the motor cannot rotate, perform procedure **I074** = [1: Control NO rot]. During this tuning, current pulses are first applied to the motor when the rotor is standstill (current pulse amplitude is up to the rated current). Later, the motor is started up 90% of the rated speed. Before performing this procedure, tune motor parameters through **I074** = [0: Motor Params]. The following parameters are computed: - VTC control: **P175t1** (proportional gain of the current control) and **P175u1** (integral time of the current control); - FOC control: **P155**, **P156** current and **P158**, **P159** flux regulators parameters; - both controls: **C025** rotor time constant.

NOTE When the rotor time constant estimation is completed and whenever its value is manually changed, parameters **P158** and **P159** are changed as well as a function of the rotor time constant value that has been set up.

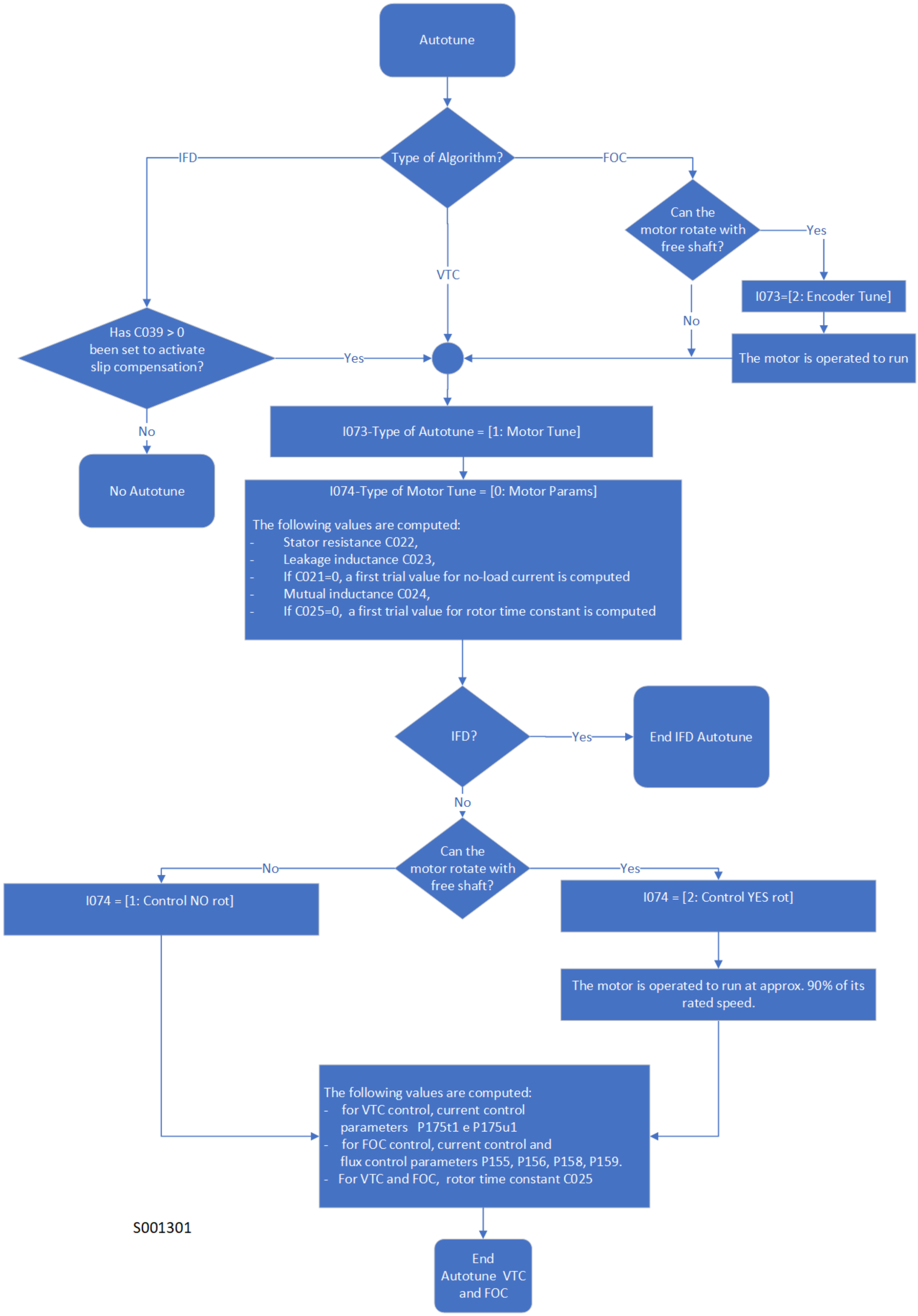


Figure 42: Flowchart for Autotune

32.1.2. CHECKING THE ENCODER OPERATION

Set **I073** as Encoder Tune to check the correct operation of the incremental encoder selected as a speed feedback (see the ENCODER/FREQUENCY INPUTS MENU) and to automatically set the correct direction of rotation.

NOTE

Before checking the correct operation of the encoder used as a speed feedback, **enter the motor ratings and the encoder ratings.**
Please refer to the MOTOR CONFIGURATION MENU and the ENCODER/FREQUENCY INPUTS MENU.

Once **I073** is set as Encoder Tune and the **ENABLE-A** and **ENABLE-B** terminals have been closed, the connected motor attains a speed of rotation of approx. 150 rpm; its speed of rotation is detected by the encoder, then the drive is disabled. The following messages can be displayed on the display/keypad:
A059 Encoder Fault
W31 Encoder OK

Then the following message is always displayed:
W32 OPEN ENABLE

If alarm **A059 Encoder Fault** trips: in the encoder input, the value measured by the drive does not match with the actual speed of rotation of the motor. Check that the encoder is properly set up (see the ENCODER/FREQUENCY INPUTS MENU) and wired; if the Encoder B input is used, check the Configuration of the DIP–switches located on **ES836**, **ES913** or **ES861** optional board (see the Sinus Penta’s Motor Drives Accessories - User Manual).

If **W31 Encoder OK** appears: the speed feedback from encoder is correct.

In addition, the autotune sets the sign of the encoder as feedback with parameter **C199**.

32.2. List of Inputs I073 - I074

Table 69: List of Inputs I073 - I074

Input	FUNCTION	User Level	MODBUS Address
I073	Type of autotune	BASIC	1460
I074	Type of motor tune	BASIC	1461

I073 Type of Autotune

I073	**Range**	0 ÷ 2	0: Disable 1: Motor Tune 2: Encoder Tune
	Default	This is not a programming parameter: the input is set to zero whenever the drive is powered on and whenever the command is executed.	
	Level	BASIC	
	Address	1460	
	Function	**I073** selects the type of tune to perform. If you select [1: Motor Tune]: **I074** sets different types of tune for current loops, flux loops and speed loops and for the estimation of the motor ratings (see Motor Autotune and Adjusting Loops). If you select [2: Encoder Tune]: you can check the correct operation of the encoder used as a speed feedback (see Checking the Encoder Operation).	

I074 Type of Motor Tune

I074	**Range**	0 ÷ 2	0: Motor Params 1: Control NO rot 2: Control YES rot
	Default	This is not a programming parameter: the input is set to zero whenever the drive is powered on and whenever the command is executed.	
	Level	BASIC	
	Address	1461	
	Function	**I074** selects the type of autotune to perform if **I073** = [1: Motor Tune] (see section Motor Autotune and Adjusting Loops).	

NOTE No changes can be made to **I073** and **I074** when the **ENABLE-A** and **ENABLE-B** signals are present. If you attempt to change these values when the **ENABLE-A** and **ENABLE-B** signals are present, **"W34 ILLEGAL DATA"** warning appears. Remove the **ENABLE-A** and **ENABLE-B** signals to change these values and activate them again to begin the selected autotune process.

NOTE If **SAVE/ENTER** is pressed to store the changes made to **I073** and **I074**, **"W17 SAVE IMPOSSIBLE"** warning appears. Use the **ESC** key instead.

33. CARRIER FREQUENCY MENU

33.1. Overview

The Carrier Frequency Menu makes it possible to set some of the PWM modulation characteristics based on the preset type of control.

33.1.1. Carrier Frequency Setting

It is possible to gain access to all the parameters included in the Carrier Frequency menu.
The user can set the minimum value and the maximum value of the switching carrier frequency and the number of pulses per period used to produce the output frequency when switching from min. carrier frequency to max. carrier frequency (synchronous modulation).

The silent modulation function can also be enabled (**C004**).

33.1.2. Example

Setting two levels of carrier frequency and the number of pulses used for synchronous modulation.
A lower value for carrier frequency ensures a better performance of the motor in terms of output torque but implies higher noise levels. Suppose that the connected motor has a rated speed equal to 1500rpm at 50Hz and that you need the best performance up to 200rpm and a “noiseless” carrier frequency at max. speed (3000rpm).
In this case, the max. speed of the drive will produce an output voltage with a frequency value equal to 100Hz; in proximity to this speed the carrier frequency should be at its maximum level. Suppose that a model implementing max. 16kHz carrier frequency is used.
Assign the following:
C001 = 1600Hz
C002 = 16000Hz
C003 ≥ (**C002**/100Hz) = (160 pulses per period)

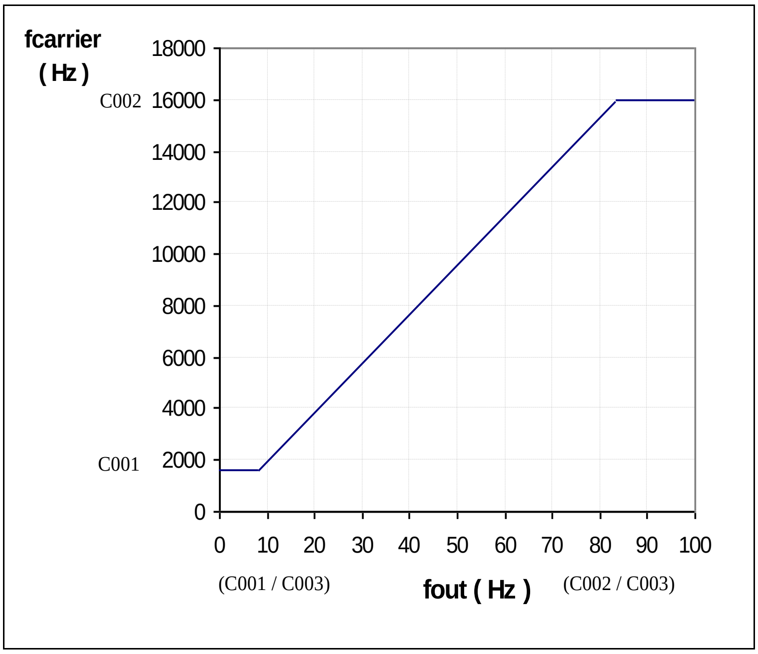


Figure 43: Carrier frequency (example)

Suppose that **C003** = 192np, so that **C002**/**C003** = 16000/192 = 83.33Hz. The max. carrier frequency is obtained with this output frequency. The min. frequency is kept constant until frequency **C001**/**C003** = 8.33 Hz is attained, corresponding to 250 rpm of the motor speed. In the output frequency range, ranging from 8.33 to 83.33Hz, synchronous modulation is obtained and the carrier frequency applied results from: f carrier = fout * **C003** [Hz].

33.1.3. Maximum Programmable Speed Value

The maximum preset carrier frequency value also limits the maximum speed value to be programmed:

Max. programmable speed → rated speed * (maximum output frequency/rated frequency)
where the maximum output frequency results from the following:

C002 ≤ 5000Hz fout_max = C002 / 10
5000Hz < C002 ≤ 8000Hz fout_max = 500
8000Hz < C002 fout_max = C002 / 16

C002 is the maximum carrier frequency and the divisor is the min. allowable number of pulses per period.

Table 70: Maximum value of the output frequency depending on the Penta model

Model	**Max. output frequency (Hz)** (*)
	2T/4T
0005 to 0014	599 (**)
0015 to 0129	599 (***)
0150 to 0402	500
0457 to 2076	400 (****)

(**) 1000Hz on demand, except for models 0008, 0010 and 0013 (625Hz on demand)
(***) 625Hz on demand, except for models 0040 (1000Hz on demand) and 0049 (800Hz on demand)
(****) 500Hz for models 0523, 0599, 0749, 0832, 0850, 0965 and 1129

Model	**Max. Output Frequency (Hz)** (*)
	5T/6T
0003 to 0069	500
0076 to 0600	400
0748 to 2076	200 (*****)

(*****) 400Hz for models 0750, 0828, 0960 and 1128

(*) NOTE The maximum output frequency is limited to the speed level programmed in parameters **C028, C029 [–32000 ÷ 32000]rpm.** This results in **Fout$_{max}$= (RPM$_{max}$*NPole)/120.**

EXAMPLE:
When using a 4-pole motor and 30,000rpm are required, F$_{out}$ will be 1000Hz, so the performance requirements are fulfilled.
On the other hand, if the same performance requirements are needed with an 8-pole system, 30,000rpm cannot be obtained, as F$_{out}$ is 2000Hz. As a result, when using an 8-pole motor, the maximum allowable programmable speed is 15,000rpm[RPM$_{outmax}$=(F$_{outmax}$*120)/(number of motor poles)].

33.2. List of Parameters C001 to C004

Table 71: List of Parameters C001 to C004

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
C001	Minimum carrier frequency	ENGINEERING	1001	See Table 81 and Table 85
C002	Maximum carrier frequency	ENGINEERING	1002	See Table 81 and Table 85
C003	Number of pulses	ENGINEERING	1003	1:[24]
C004	Silent modulation	ENGINEERING	1004	See Table 81 and Table 85

The default value and the max. value of carrier frequency (**C001** and **C002**) depend on the drive model.
To check those values, see Table 81 and Table 85.

CAUTION If the carrier frequency is changed via parameters **C001** or **C002**, it is advisable to adjust the current control loop and the flux control loop of the VTC or FOC regulator again (see “VTC” Control Algorithm and “FOC” Control Algorithm).

C001 Minimum Carrier Frequency

C001	**Range**	1600 ÷ 16000 *Depending on the drive model*	1600 ÷ 16000 Hz *Depending on the drive model* – See Table 81 and Table 85
	Default	See Table 81 and Table 85	
	Level	ENGINEERING	
	Address	1001	
	Function	This parameter represents the min. value of the modulation frequency being used.	

NOTE The minimum value in **C001** cannot exceed the maximum value in **C002**. If you want to increase the minimum value and **C001** and **C002** are set the same value, it is necessary to increase the maximum value in **C002** before proceeding.

C002 Maximum Carrier Frequency

C002	**Range**	1600 ÷ 16000 *Depending on the drive model*	1600 ÷ 16000 Hz *Depending on the drive model* – See Table 81 and Table 85.
	Default	See Table 81 and Table 85.	
	Level	ENGINEERING	
	Address	1002	
	Function	This parameter represents the max. value of the modulation frequency being used.	

NOTE The max. value set in **C002** cannot be lower than the min. value set in **C001**. Decrease the min. value in **C001** if you need to decrease the max. value and if **C001** equals **C002**.

NOTE The max. value in **C002** also determines the max. allowable speed value for the selected motor, in order to ensure a minimum number of pulses per period of frequency produced. This value is 16 for maximum carrier frequency (max. **C002** value) greater than 5kHz and 10 for lower maximum carrier frequency (see Table 81 and Table 85).
See also Maximum Programmable Speed Value.

C003 Pulse Number

C003	**Range**	0-5	0: [12] 1: [24] 2: [48] 3: [96] 4: [192] 5: [384]
	Default	1	1: [24]
	Level	ENGINEERING	
	Address	1003	
	Function	This parameter has effect only if **C001≠C002**. It represents the min. value of pulses per period obtained when modulation frequency changes (synchronous modulation).	

C004 Silent Modulation

C004	**Range**	0-1	0: [No]; 1: [Yes]
	Default	See Table 81 and Table 85	
	Level	ENGINEERING	
	Address	1004	
	Function	This parameter enables silent modulation. The electric noise due to the switching frequency is dampened.	

34. MOTOR CONFIGURATION MENU

34.1. Overview

The Sinus Penta allows configuring three different types of motors and three different types of control algorithms at the same time.

The three types of control algorithms are identified with the acronyms
- ✓ **IFD** (Voltage/Frequency Control);
- ✓ **VTC** (Vector Torque Control);
- ✓ **FOC** (Field Oriented Control).

The **Voltage/Frequency control** allows controlling the motor by producing voltage depending on frequency.
The **Vector Torque Control (sensorless)** processes the machine equations depending on the equivalent parameters of the asynchronous machine. It also allows separating torque control from flux control with no need to use a transducer.
The **Field Oriented Control** is a closed-loop control requiring a speed transducer to detect the position of the motor shaft instant by instant.

The parameter set for the selected motor is included in the Motor Control menu:
- ✓ Motor Control 1 Menu concerns motor 1;
- ✓ Motor Control 2 Menu concerns motor 2;
- ✓ Motor Control 3 Menu concerns motor 3.

Factory setting allows configuring only one motor. To access the Configuration menus of the other connected motors, simply enter the number of the selected motor in **C009** (Number of Configured Motors) in the Motor Control 1 Menu.
To select the connected motor, use digital inputs programmed with parameters **C173** and **C174**, Digital Input for Motor 2 Activation and Digital Input for Motor 3 Activation respectively (see also the DIGITAL INPUTS MENU).
The parameters included in the Motor Control Menus are detailed in the table below.

Table 72: Description of the parameters classified by motor

Parameter Contents	Motor Control 1	Motor Control 2	Motor Control 3
Mains rated voltage	**C008**	————————	————————
Control algorithm being used	**C010**	**C053**	**C096**
Type of reference being used (speed/torque) (see Torque Control (VTC and FOC Only)	**C011**	**C054**	**C097**
Availability of the speed feedback from encoder	**C012**	**C055**	**C098**
Electric ratings of the motor	**C015 ÷ C025**	**C058 ÷ C068**	**C101 ÷ C111**
Max. and min. required speed, field weakening speed, field weakening time constant, max. speed alarm threshold and enable	**C028 ÷ C031**	**C071 ÷ C074**	**C114 ÷ C117**
V/f pattern parameters	**C013 / C032 ÷ C038**	**C056 / C075 ÷ C081**	**C099 / C118 ÷ C124**
Slip compensation activation	**C039**	**C082**	**C125**
Drop in rated current voltage	**C040**	**C083**	**C126**
Fluxing ramp time	**C041**	**C084**	**C127**

The parameters that can be modified depend on the type of control that has been selected.

34.1.1. Electrical Specifications of the Connected Motor

This group of parameters can be divided into two subunits: the first subunit includes the motor ratings, the second subunit includes the parameters of the equivalent circuit of the asynchronous machine being used.

34.1.2. Motor Ratings

Table 73: Motor ratings

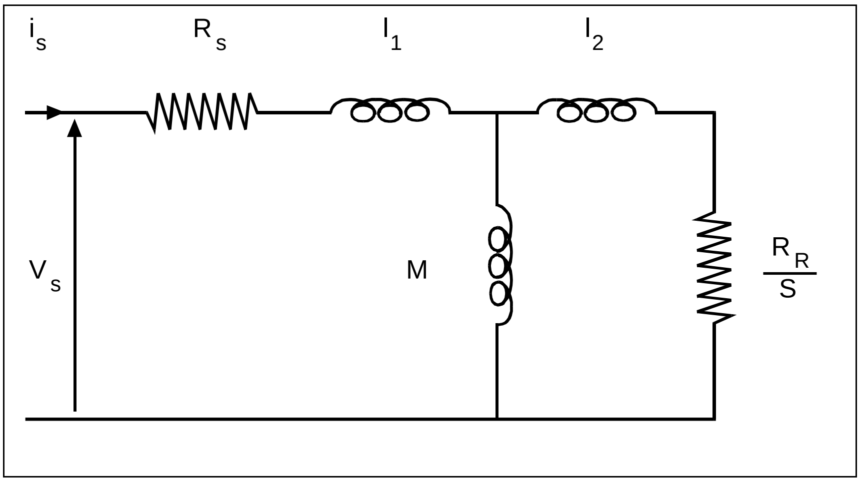
Motor Ratings	Motor 1	Motor 2	Motor 3
Rated frequency	**C015**	**C058**	**C101**
Rated rpm	**C016**	**C059**	**C102**
Rated power	**C017**	**C060**	**C103**
Rated current	**C018**	**C061**	**C104**
Rated voltage	**C019**	**C062**	**C105**
No-load power	**C020**	**C063**	**C106**
No-load current	**C021**	**C064**	**C107**

34.1.3. Parameters of the Equivalent Circuit of the Asynchronous Machine

Table 74: Parameters of the equivalent circuit of the asynchronous machine

Description	Motor 1	Motor 2	Motor 3
Stator resistance	**C022**	**C065**	**C108**
Leakage inductance	**C023**	**C066**	**C109**
Mutual inductance	**C024**	**C067**	**C110**
Rotor time constant	**C025**	**C068**	**C111**

Figure 44: Equivalent circuit of the asynchronous machine



Where:
Rs: Stator resistance (wires included)
Rr: Rotor resistance
l_1+l_2: Full leakage inductance
M: Mutual inductance (not required for control implementation)
S: Slip
τ rot. $\cong$ M / Rr rotor time constant.

Because the motor characteristics are generally unknown, the Sinus Penta is capable of automatically determining the motor characteristics (see the FIRST STARTUP section and the AUTOTUNE MENU).
However, some parameters may be manually adjusted to meet the requirements needed for special applications.

The parameters used for the different control algorithms are stated in the table below.

Table 75: Motor parameters used by control algorithms

Parameter	IFD	VTC	FOC
Stator resistance	ν	ν	ν
Leakage inductance	—	ν	—
Mutual inductance	—	ν	ν
Rotor time constant	—	ν	ν

ν Used ; — Not used

NOTE Because the value of the stator resistance is used for any type of control, always perform the autotune procedure with **I073** = [1: Motor Tune] and **I074** = [0: Motor Params].

34.1.4. V/F PATTERN (IFD ONLY)

This group of parameters which is included in the **Motor Control Menu** defines the V/f pattern trend of the drive when it is used as an IFD control algorithm. When setting the type of V/f pattern (e.g. **C013** for motor 1), the following curves can be used:

- Constant torque
- Quadratic
- Free setting

The diagram below illustrates three types of programmable curves compared to the theoretical V/f curve.
If **C013 = Constant Torque,** Preboost parameter **C034** allows changing the starting voltage value if compared to the theoretical V/f curve (this allows torque compensation for losses caused by the stator impedance and a greater torque at lower revs).
If **C013 = Quadratic,** the drive will follow a V/f pattern with a parabolic trend. You can set the starting voltage value (**C034**), the desired voltage drop if compared to the relevant constant torque (use **C032**) and the frequency allowing implementing this torque reduction (use **C033**).
If **C013 = Free Setting,** you can program the starting voltage (**C034 Preboost**), the increase in voltage (**C035 Boost 0**) at programmable frequency (**C035a Frequency for Boost0**) and the increase in voltage (**C036 Boost1**) at programmable frequency (**C037 Frequency for Boost1**).

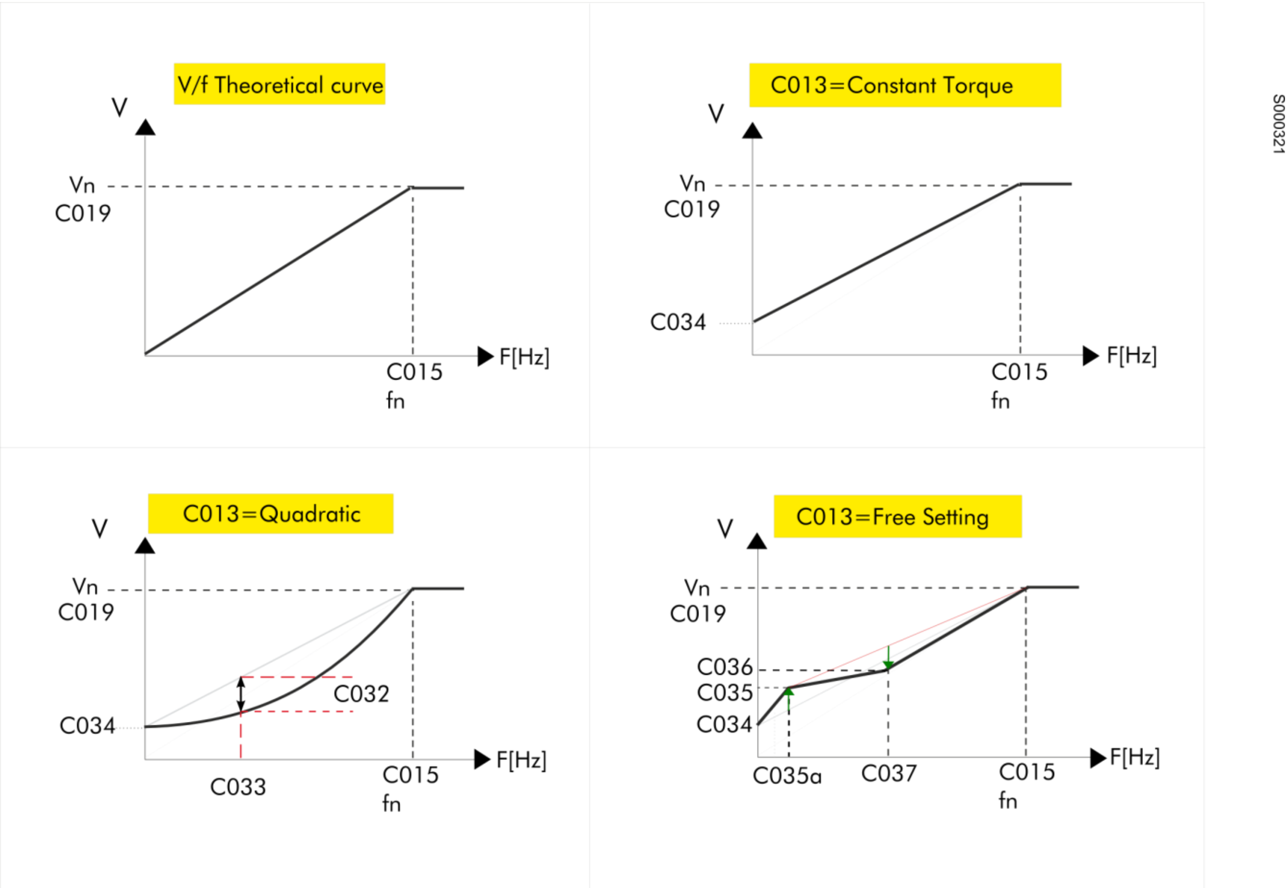


Figure 45: Types of programmable V/f curves

The voltage produced by the drive may be changed also by setting the **Automatic increase in torque curve** parameter (**C038 for motor 1)**.

For the description of the parameters used in the figure above, see table below.

Table 76: IFD control parameters for the connected motors

Parameter	Motor 1	Motor 2	Motor 3
Rated frequency: Rated frequency of the connected motor (current rating).	**C015**	**C058**	**C101**
Rated voltage: rated voltage of the connected motor (voltage rating).	**C019**	**C062**	**C105**
V/f curve type: Type of V/f curve applied.	**C013**	**C056**	**C099**
Torque reduction with quadratic curve: Torque reduction using V/f quadratic curve.	**C032**	**C075**	**C118**
Rated speed referring to torque reduction with quadratic curve: Speed actuating the torque reduction using a quadratic curve.	**C033**	**C076**	**C119**
Voltage preboost: Determines the voltage produced by the drive at min. output frequency fomin.	**C034**	**C077**	**C120**
Voltage Boost 0: Determines the voltage variations in respect to the nominal voltage at the frequency set up by the relevant parameter.	**C035**	**C078**	**C121**
Boost 0 application frequency: Determines the Boost 0 application frequency.	**C035a**	**C078a**	**C121a**
Voltage Boost 1: Determines the frequency for the application of the boost at preset frequency.	**C036**	**C079**	**C122**
Boost 1 application frequency: Determines the Boost 1 application frequency at preset frequency.	**C037**	**C080**	**C123**
Autoboost: Variable torque compensation expressed as a percentage of the rated motor voltage. The preset value expresses the voltage increase when the motor is running at rated torque.	**C038**	**C081**	**C124**

34.1.5. Example 1 - V/f Pattern Parameterization

Motor 1: the voltage/frequency pattern is to be programmed for an asynchronous motor (400V/50Hz) with a rated speed of 1500rpm up to 2000rpm.

Type of V/f curve	**C013**	=	Constant Torque
Rated frequency	**C015**	=	50 Hz
Rated motor rpm	**C016**	=	1500rpm
Rated voltage	**C019**	=	400 V
Preboost	**C034**	=	depending on the starting torque
Max. speed	**C029**	=	2000rpm

34.1.6. Example 2 - V/f Pattern Parameterization

The voltage/frequency pattern is to be programmed for an asynchronous motor (400 V / 50 Hz) having a rated power of 7.5 kW and a rated speed of 1420 rpm with a voltage compensation depending on the motor torque:

Type of V/f pattern	**C013**	=	Constant Torque
Rated frequency	**C015**	=	50 Hz
Motor rpm	**C016**	=	1420 rpm
Rated power	**C017**	=	7.5 kW
Rated voltage	**C019**	=	400 V
Preboost	**C034**	=	depending on the starting torque
Autoboost	**C038**	=	4%

Voltage compensation (AutoBoost) results from the formula below:
ΔV = **C019** x (**C038**/100) x (T/Tn)
Where T is the estimated motor torque and Tn is the rated motor torque.
Tn is calculated as follows:
Tn = (Pn x pole pairs/2πf = (**C017** x pole pairs)/(2π x **C015**)
"Pole pairs" is the integer number obtained by rounding down (60* **C015**/**C016**).

The programmable parameters relating to the AutoBoost functions are the following:
C038 (AutoBoost): variable torque compensation expressed as a percentage of the motor rated voltage (**C019**). The value set in **C038** is the voltage increase when the motor is running at its rated torque.
C017 (Pn): rated power of the connected motor.

34.1.7. Slip Compensation (IFD Only)

This function allows compensating the speed decrease of the asynchronous motor when the mechanical load increases (slip compensation). This is available for IFD control only.
The parameters relating to this function are included in the MOTOR CONFIGURATION MENU.

Table 77: Parameters setting Slip Compensation (IFD Control)

Parameter	Motor 1	Motor 2	Motor 3
Rated voltage: Rated voltage of the connected motor (voltage rating).	**C019**	**C062**	**C105**
No-load power: Power absorbed by the motor when no load is connected to the motor; it is expressed as a percentage of the motor rated power.	**C020**	**C063**	**C106**
Stator resistance: Determines the resistance of the stator phases used to compute the power consumption due to Joule effect.	**C022**	**C065**	**C108**
Activation of slip compensation: If other than zero, this parameter enables slip compensation and defines its relevant value.	**C039**	**C082**	**C125**

Once the drive output power has been estimated and the power losses due to the Joule effect and to the mechanical parts (depending on output voltage and no-load power) have been subtracted, mechanical power is obtained. Starting from mechanical power and the value set for slip compensation (**C039** for motor 1), you can obtain the increase of the output frequency limiting the error between the desired speed value and the actual speed value of the connected motor.

34.1.8. TORQUE CONTROL (VTC AND FOC ONLY)

VTC and FOC controls allow controlling the drive with a torque reference instead of a speed reference. To do so, set [1: Torque or 2: Torque with Speed Limit [FOC only] in the relevant parameter (**C011** for motor 1, **C054** for motor 2, **C097** for motor 3).

In this way, the main reference corresponds to the motor torque demand and may range from **C047** to **C048** (**Limits Menu**) for motor 1 (minimum and maximum torque expressed as a percentage of the motor rated torque). For motors 2 and 3, the parameters relating to min. and max. torque (**C090**, **C091** and **C133**, **C134**) are included in the Limits Menu 2 and Limits Menu 3.

For example, using a 0020 drive connected to a 15 kW motor, **C048** is factory-set to 120% of the motor rated torque. If the max. reference is applied (**C143** = REF), the torque reference will be 120%.

If a 7.5 kW motor is connected, **C048** may exceed 200%; torque values exceeding 200% may be obtained based on the value set in **C048**.

The motor rated torque results from the following formula:
$T=P/\omega$
where P is the rated power expressed in W and ω is the rated speed of rotation expressed in rad/s (1 rpm = $2\pi/60$ rad/s).

For example, a 15 kW motor at 1420 rpm has a nominal torque of:

$$T = \frac{15000}{1420 \cdot 2\pi/60} = 100.9 \text{ Nm}$$

The starting torque is:
rated torque * 120% = 121.1 Nm

34.1.9. Torque Follower Mode (VTC and FOC only)

If the torque reference mode is set, the VTC and FOC controls allow enabling the Torque Follower mode by activating parameter **C011c** (**C054c** for motor 2, **C097c** for motor 3). This allows the following:

- The inverter tracks the torque reference when the Enable input is closed, regardless of the Start input logics;
- No ramp is applied to the torque reference.

This mode is useful to get Master/Slave systems,where:

- A Master motor is driven by a drive in speed reference mode. This makes the instant torque demand value available externally to the drive (typically to an analog input).
- One or multiple Slave motors are driven by drives in torque reference mode and Torque Follower Mode, that get the torque reference from the Master, and that deliver the same torque as the Master's instant by instant.

Programming example of a Master/Slave system:
Master drive:
The Master drive will make the Torque Demand measure available to analog output AO1. The following are to be set in the ANALOG AND FREQUENCY OUTPUTS MENU (the parameters left at their default values are highlighted in gray):

P176	AO1: Representation Mode Selection	1: +/-10V
P177	AO1: Represented Variable Selected	64: Torque Dem. %
P178	AO1: Minimum Value of the Represented Variable	-200%
P179	AO1: Maxmum Value of the Represented Variable	200%
P182	AO1: Output Value Corresponding to the Minimum Value	-10.0V
P183	AO1: Output Value Corresponding to the Maximum Value	10.0V

Values in **P178**, **P179** relate to the rated torque. In order for the output voltage range (-10 ÷ +10V) to correspond to the whole available torque range, values in **P178**, **P179** are to be the same as the values set for the torque limits in the LIMITS MENU:

C048	Maximum Torque Limit Motor M1	-200%
C049	Maximum Torque Limit Brake M1	200%

Slave Drive:
Analog output AO1 in the Master drive is connected to analog input AIN1 in the Slave drive. The input voltage range is to be the same as the torque range.The following are to be set up in the INPUTS FOR REFERENCES MENU:

P055	Type of Reference for AIN1 Input	0: +/-10V
P059	Filter Constant for AIN1 Input	0

The remaining parameters are to be left to their default values. In the LIMITS MENU, the torque limit values are to be the same as the Master's:

C047	Minimum Torque for Motor 1	-200%
C048	Maximum Torque for Motor 1	200%

Set the following in the MOTOR CONFIGURATION MENU:

C011	Type of Reference for M1	1: Torque
C011c	Torque Follower Mode	1: Yes

34.1.10. FIELD WEAKENING (VTC AND FOC ONLY)

When operating in field weakening mode, the asynchronous motor runs at a higher speed than its rated speed.

In field weaking mode, it is required to limit mechanical power not to exceed the motor ratings. In FOC and VTC mode, the maximum motor torque is limited as detailed in the LIMITS MENU based on the external torque limit (defined in the CONTROL METHOD MENU) and on the torque limit defined by parameters **C047**/**C048/C049**.

Also, the field weakening mode requires limiting the maximum voltage required to the motor, mainly due to the back electromotive force, depending on the motor flux and the electric frequency. When in field weakening mode, the motor flux is to be properly reduced in order to limit output voltage.
Output voltage **M027** must be lower than the rated motor voltage (**C019**) not to exceed the motor ratings—at DC bus Vdc (**M029**) actually available—and not to introduce voltage harmonic distortion and current distortion. The phase-to-phase RMS voltage actually available is Vdc/√2.

Two field weakening modes are available for the FOC and VTC control modes, that may be activated also simultaneously:

- *"static" field weakening*: configured via parameter **C030** (field weakening speed).
If **C030** = "0: Disable", the static field weakening is disabled.
If **C030** > 0, the magnetization current is decreased in respect to the rated value set in **C021** with inversely proportional pattern to speed (1/n) at a speed higher than the rated speed (**C016**) scaled by **C030**. For example, a motor featuring rated speed **C016**=1480rpm and **C030**=100%, with rated current **C018** =100A and **C021** = 25%, up to 1480rpm, the magnetization current is **C018** * **C021** = 100A * 25% = 25A; at 3000rpm the magnetization current is reduced by **C018** * **C021** / 3000 * (**C016** * **C030**) = 12.3A

- *"automatic" field weakening*: configured via parameter **C030a** (field weakening time constant).
If **C030a** = "0: Disable", the automatic field weakening is disabled.
If **C030a** > 0, the magnetization current and flux **M017** are automatically decreased so that output voltage **M027** is lower than the rated motor voltage (**C019**) both at DC-link voltage divided by √2 and scaled by **C042**. In case the motor voltage exceeds the limits above, the automatic field weakening reduces the magnetization current until the output voltage equals the voltage limit.

The static field weakening is promptly activated based on a fixed magnetization current/speed relation, whilst the automatic field weakening dynamically adjusts the magnetization current with longer response time. When the operating conditions of the motor, e.g. the load torque, vary, the motor parameters depending on temperature and the DC-link voltage, the output voltage required to the motor and available to the motor vary accordingly. The automatic field weakening automatically adjusts the magnetization current to fit the motor operating conditions and enhancing output voltage.

NOTE In VTC mode, when the motor is stalled in field weakening mode, set **C030** = "0: Disable" to allow for the activation of the automatic field weakening only.

The static field weakening is inactive by default, while the automatic field weakening is enabled by default.

NOTE These two types of field weakening can coexist and can also be activated simultaneously.

The figures below show the magnetization current (Imag) pattern and the output voltage (Vout) pattern based on speed, with fixed load, for the static field weakening and the automatic field weakening. The figure on the left shows an example of static field weakening where the magnetization current is reduced when the motor rated rpm value is exceeded (rpm > **C016**). In the lower left corner, the field weakening effect on the output voltage is shown.
The figure on the right shows an example of automatic field weakening where the magnetization current is reduced when the output voltage reaches the voltage limit (**C019)**.

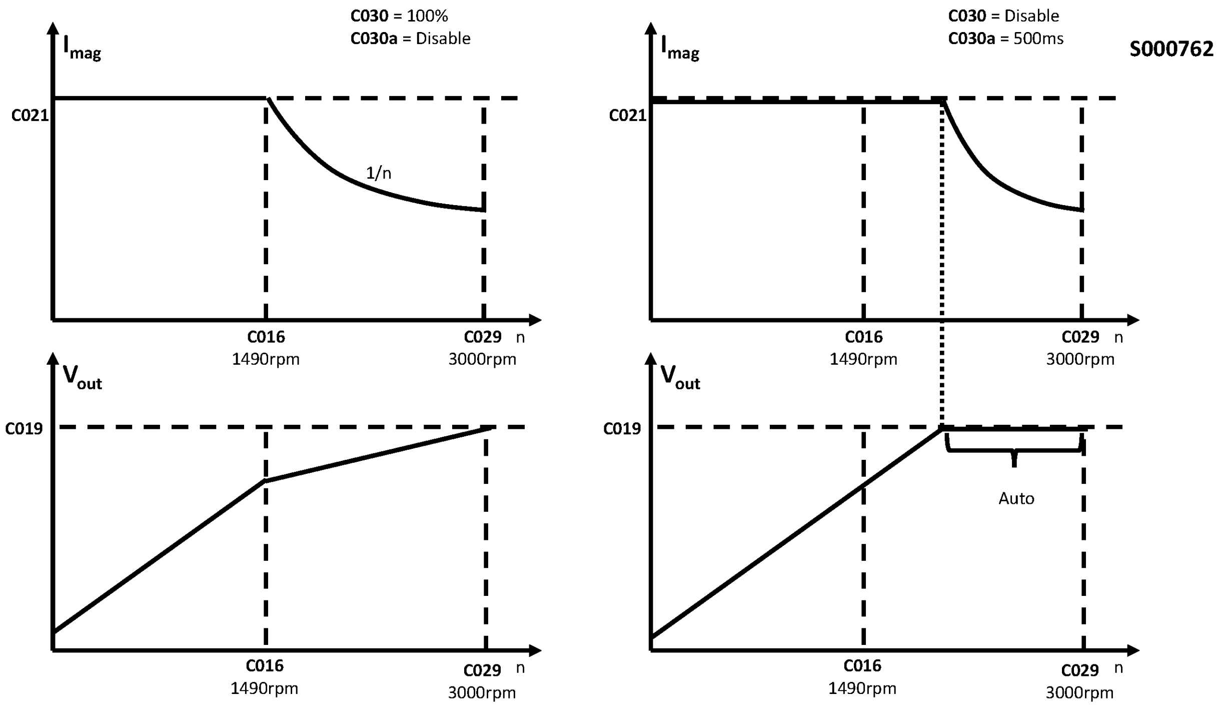


Figure 46: Comparing the static field weakening to the automatic field weakening

The parameters affecting field weakening operation are the following:

- Field Weakening Speed **C030**
- Field Weakening Time Constant **C030a**
- No-load Current **C021**
- Rotor Time Constant **C025**

The parameters above may be adjusted based on the following:

Failure	*What to do*
The motor is not capable of reaching the speed reference ("Limit St. Speed" displayed and the "Limit" LED comes ON on the display; "L" displayed on the 7-segment display)	Change one or more of the following parameters: A) Enable automatic field weakening by setting **C030a**>0. B) Decrease speed activating static field weakening **C030.** C) Decrease no-load current **C021**.
During acceleration ramps in field weakening mode, current limit activates (the "Limit" LED comes ON on the display and "H" is displayed on the 7-segment display). The motor is not capable of performing quick acceleration ramps in field weakening mode.	This means that field weakening is not responsive as required. Do the following: A) Enable automatic field weakening by setting **C030a**>0. If activated, this means that the time constant set in **C030a** is too long, so decrease **C030a** to increase responsiveness of the automatic field weakening mode. B) Decrease the speed value activating static field weakening **C030**. C) Decrease no-load current **C021**.
Too high current required to deliver motor torque (the "Limit" LED comes ON on the display and "H" is displayed on the 7-segment display), or the maximum deliverable torque in field weakening mode is too low.	This means that the magnetization current in field weakening mode is too low. Do the following: A) Increase **C030** in oder to start reducing the magnetization current as 1/n at higher speed, or disable the static field weakening (**C030** = "Disable"). When **C030a**>0, the automatic field weakening dynamically reduces the magnetization current, only if required. B) Increase no-load current **C021** in order to increase the motor flux.
In field weakening mode, output voltage **M027** is lower than the rated voltage and the DC-link voltage divided by √2.	This means that the magnetization current in field weaking mode is too low, so field weakening is excessive for the motor. This affects the maximum deliverable torque. Do the following: A) Increase **C030**, because the speed value causing the magnetization current to decrease is too low, or disable static field weakening by setting **C030**=Disable. B) Increase no-load current **C021**.
In field weakening mode, speed, torque or current oscillations occur.	This means that the automatic field weakening is too jerky. Do the following: A) Increase time constant **C030a**. B) Decrease the activation speed for the static field weakening **C030**, so that the automatic field weakening activates less frequently. C) Decrease no-load current **C021**, so that the automatic field weakening activates less frequently.
Output voltage **M027** required at high torque is lower than the no-load voltage (or at low torque), or is different than the expected torque based on the rated motor voltage.	This means that the motor flux is weak. This will affect the maximum deliverable torque. Do the following: A) Change rotor time constant **C025**. B) Disable the static field weakening by setting **C030** = "Disable" (or increase its value).

34.2. List of Parameters C008 to C128

Table 78: List of Parameters C008 to C128

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C008	Rated mains voltage	BASIC	1008	2:[380÷480V]
C009	N. of configured motors	ENGINEERING	1009	1

Parameter		FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C010	M1	Type of control algorithm	BASIC	1010	0: IFD
C053	M2		ENGINEERING	1053	
C096	M3			1096	
C011	M1	Type of reference	ADVANCED	1011	0: Speed (MASTER mode)
C054	M2		ENGINEERING	1054	
C097	M3			1097	
C011c	M1	Torque Follower mode	BASIC	1012 bit 0	0: No
C054c	M2		ENGINEERING	1055 bit 0	
C097c	M3			1098 bit 0	
C012	M1	Speed feedback from encoder	BASIC	1012 bit 1	0: No
C055	M2		ENGINEERING	1055 bit 1	
C098	M3			1098 bit 1	
C013	M1	Type of V/f curve	BASIC	1013	See Table 84 and Table 88
C056	M2		ENGINEERING	1056	
C099	M3			1099	
C014	M1	Phase rotation	ENGINEERING	1014	0: No
C057	M2			1057	
C100	M3			1100	
C015	M1	Rated motor frequency	BASIC	1015	50.0 Hz
C058	M2		ENGINEERING	1058	
C101	M3			1101	
C016	M1	Rated motor rpm	BASIC	1016	1420 rpm
C059	M2		ENGINEERING	1059	
C102	M3			1102	
C017	M1	Rated motor power	BASIC	1017	See Table 85 and Table 89
C060	M2		ENGINEERING	1060	
C103	M3			1103	
C018	M1	Rated motor current	BASIC	1018	See Table 85 and Table 89
C061	M2		ENGINEERING	1061	
C104	M3			1104	
C019	M1	Rated motor voltage	BASIC	1019	Depending on the drive voltage class
C062	M2		ENGINEERING	1062	
C105	M3			1105	
C020	M1	Motor no-load power	ADVANCED	1020	0.0%
C063	M2		ENGINEERING	1063	
C106	M3			1106	
C021	M1	Motor no-load current	ADVANCED	1021	0%
C064	M2		ENGINEERING	1064	
C107	M3			1107	
C022	M1	Motor stator resistance	ENGINEERING	1022	See Table 85 and Table 89
C065	M2			1065	
C108	M3			1108	
C023	M1	Leakage inductance	ENGINEERING	1023	See Table 85 and Table 89
C066	M2			1066	
C109	M3			1109	

Parameter		FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C024	M1	Mutual inductance	ADVANCED	1024	250.00 mH
C067	M2		ENGINEERING	1067	
C110	M3			1110	
C025	M1	Rotor time constant	ADVANCED	1025	0 ms
C068	M2		ENGINEERING	747	
C111	M3			1111	
C026	M1	Time constant of bus voltage low-pass filter	ENGINEERING	1026	0 ms
C069	M2			1069	
C112	M3			1112	
C028	M1	Min. motor speed	BASIC	1028	0 rpm
C071	M2		ENGINEERING	1071	
C114	M3			1114	
C029	M1	Max. motor speed	BASIC	1029	1500 rpm
C072	M2		ENGINEERING	1072	
C115	M3			1115	
C030	M1	Field weakening speed	ENGINEERING	1030	0: Disabled
C073	M2			1073	
C116	M3			1116	
C030a	M1	Field weakening time constant	ENGINEERING	1137	500 ms
C073a	M2			1138	
C116a	M3			1139	
C031	M1	Max. speed alarm	ADVANCED	1031	0: Disabled
C074	M2		ENGINEERING	1074	
C117	M3			1117	
C032	M1	Reduction in quadratic torque curve	ADVANCED	1032	30%
C075	M2		ENGINEERING	1075	
C118	M3			1118	
C033	M1	Rated revs referring to reduction in quadratic torque curve	ADVANCED	1033	20%
C076	M2		ENGINEERING	1076	
C119	M3			1119	
C034	M1	Voltage Preboost for IFD	BASIC	1034	See Table 83 and Table 87
C077	M2		ENGINEERING	1077	
C120	M3			1120	
C035	M1	Voltage Boost 0 at programmable frequency	ADVANCED	1035	See Table 83 and Table 87
C078	M2		ENGINEERING	1078	
C121	M3			1121	
C035a	M1	Frequency for Boost 0 application	ADVANCED	1052	5%
C078a	M2		ENGINEERING	1070	
C121a	M3			1113	
C036	M1	Voltage Boost 1 at programmable frequency	ADVANCED	1036	See Table 83 and Table 87
C079	M2		ENGINEERING	1079	
C122	M3			1122	
C037	M1	Frequency for Boost 1 application	ADVANCED	1037	See Table 83 and Table 87
C080	M2		ENGINEERING	1080	
C123	M3			1123	
C038	M1	Autoboost	ADVANCED	1038	See Table 83 and Table 87
C081	M2		ENGINEERING	1081	
C124	M3			1124	
C039	M1	Slip compensation	ADVANCED	1039	0: Disabled
C082	M2		ENGINEERING	1082	
C125	M3			1125	
C040	M1	Voltage drop at rated current	ADVANCED	1040	0: Disabled
C083	M2		ENGINEERING	1083	
C126	M3			1126	

Parameter		FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C041	M1	Fluxing ramp time	ENGINEERING	1041	See Table 82 and Table 86
C084	M2			1084	
C127	M3			1127	
C042	M1	Vout saturation percentage	ENGINEERING	1042	100%
C085	M2			1085	
C128	M3			1128	

C008 Rated Mains Voltage

C008	**Range**	0 ÷ 8	0: [200 ÷ 240] V 1: 2T Regen. 2: [380 ÷ 480] V 3: [481 ÷ 500] V 4: 4T Regen. 5: [500 ÷ 600] V 6: 5T Regen. 7: [600 ÷ 690] V 8: 6T Regen.
	Default	2	2: [380 ÷ 480] V
	Level	BASIC	
	Address	1008	
	Function	This parameter defines the rated voltage of the mains powering the drive, thus allowing obtaining voltage ranges to be used for the drive operation. The value set in this parameter depends on the **Drive voltage class.** To supply the drive via a non-stabilized DC source, the corresponding AC voltage range must be used (see Table 79). DO NOT USE xT Regen settings in this case.	

Table 79: Equivalence between AC mains range and DC range

AC Mains	DC range
200÷240 Vac	280÷338 Vdc
380÷480 Vac	530÷678 Vdc
481÷500 Vac	680÷705 Vdc
500÷600 Vac	705÷810 Vdc
600÷690 Vac	810÷970 Vdc

NOTE

Select xT Regen (where x relates to the voltage class of the drive) **if the drive is DC-supplied through a regenerative Sinus Penta or a different drive used to stabilize the DC bus to a higher level than the stabilization level obtained when rectifying the 3-phase mains.**

C009 N. of Configured Motors

C009	**Range**	1÷3	1÷3
	Default	1	1
	Level	ENGINEERING	
	Address	1009	
	Function	This parameter determines the number of motors to be configured. The active motor is selected through digital inputs programmed with **C173** and **C174** (see the DIGITAL INPUTS MENU). The programming parameters of the Motor Control 2 Menu can be accessed only if **C009** = 2 or 3; the programming parameters of the Motor Control 3 Menu can be accessed only if **C009** =3.	

C010 (C053, C096) Type of Control Algorithm

C010 (Motor 1) C053 (Motor 2) C096 (Motor 3)			
	Range	0 ÷ 2	0: IFD 1: VTC 2: FOC
	Default	0	0: IFD
	Level	BASIC (**C010**); ENGINEERING (**C053**, **C096**)	
	Address	1010, 1053, 1096	
	Function	This parameter sets the type of control algorithm to be used. Type of controls: 0: IFD V/f control 1: VTC Sensorless Vector Torque control 2: FOC Field Oriented Control The **V/f control (IFD)** allows controlling the motor by producing voltage depending on frequency. It is possible to configure several types of V/f patterns (see V/f Pattern (IFD Only)). The **Sensorless Vector Control (VTC)** and **Field Oriented Control (FOC)** are field-oriented control modes. The FOC is a closed-loop control, so a speed transducer is required to detect the position of the shaft of the connected motor. The VTC is a control mode w/out speed feedback, so no position/speed transducer is required: based on a dynamic model of an asynchronous motor, the algorithm estimates the speed and orientation of the motor flux. Both controllers guarantee segregation between the flux control and the torque control. In that way, the motor flux is adjusted based on the magnetization current, obtained from **No-load current C021** (**C064** for motor 2 and **C107** for motor 3). When the VTC or FOC controls are used, the connected motor can be controlled either via a torque reference or via a speed reference; in that case, the speed control loop, based on the error between reference speed and measured speed (FOC) or the estimated speed (VTC) is the external control loop for the torque controller. The equations used for VTC and FOC control algorithms require the following equivalent parameters of the asynchronous device: **stator resistance C022** (**C065** for motor 2, **C108** for motor 3), **mutual inductance C024** (**C067** for motor 2, **C110** for motor 3) and **rotor time constant C025** (**C068** for motor 2, **C111** for motor 3). As per VTC, the following value is required **leakage inductance C023** (**C066** for motor 2 and **C109** for motor 3).	

NOTE FOC control requires a speed transducer, such as an encoder feedback.

CAUTION It is not advisable to set VTC and FOC algorithms with a nominal current motor lower than 50% of the drive model, otherwise the control performance is not guaranteed.

C011 (C054, C097) Type of Reference (Master/Slave)

C011 (Motor 1) **C054 (Motor 2)** **C097 (Motor 3)**			
	Range	0 ÷ 2	0: Speed (MASTER mode) 1: Torque (SLAVE mode) 2: Torque with speed limit (SLAVE mode) (FOC only)
	Default	0	0: Speed (MASTER mode)
	Level	ADVANCED (**C011**); ENGINEERING (**C054**, **C097**)	
	Address	1011, 1054, 1097	
	Control	VTC and FOC	
	Function	This parameter defines the type of reference to be used. The torque control may be set up (see section Torque Control (VTC and FOC Only) as well). When the Torque control with speed limit mode is used, the drive will limit the motor rotation to the rpm set in parameter **C029 (C072, C115).** This function can be used to automatically toggle from the torque control mode to the speed control mode: when the torque control mode is implemented, the motor speed can reach any value included in the "AB" area (see figure below). If the limit speed is attained due to particular load conditions, the drive will automatically switch to the speed control ("BC" zone). The controlled torque is no longer maintained. If the torque returns to its setpoint value, the drive will automatically switch to the torque control again ("AB" zone).	

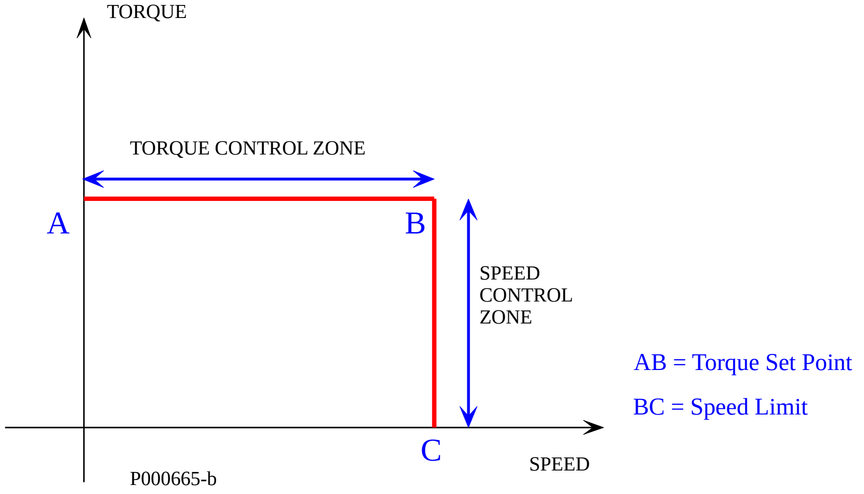


Figure 47: Torque control with speed limit

NOTE Mode 2 can be selected only if a FOC control is implemented.

C011c (C054c, C097c) Torque Follower Mode

C011c (mot. n.1) **C054c (mot. n.2)** **C097c (mot. n.3)**	**Range**	0 ÷ 1	0: No 1: Yes
	Default	0	0: No
	Level	BASIC (**C011c**); ENGINEERING (**C054c**, **C097c**)	
	Address	1012, 1055, 1098 bit 0	
	Control	VTC and FOC	
	Function	The Torque Follower mode is activated when this parameter is enabled,. If the drive is in torque reference mode (parameter **C011** = 1 or 2, or activation of the input set in **C170**), it will follow the torque reference without applying any ramp and without being dependent on the Start input logics. Just close the Enable input to let the drive track the given reference.	

C012 (C055, C098) Speed Feedback from Encoder

C012 (Motor 1) **C055 (Motor 2)** **C098 (Motor 3)**	**Range**	0 ÷ 1	0: No 1: Yes
	Default	0	0: No
	Level	BASIC (**C012**); ENGINEERING (**C055**, **C098**)	
	Address	1012, 1055, 1098 bit 1	
	Control	IFD and VTC	
	Function	This parameter enables the encoder: - IFD as a measure, - VTC as a speed feedback, - FOC as a speed feedback (in this case it is automatically set as "Yes"). It defines the encoder characteristics and whether Encoder A (MDI6 and MDI7 in the terminal board) or Encoder B (with optional board) is used as a speed feedback (see the ENCODER/FREQUENCY INPUTS MENU).	

NOTE

Parameters **C011c** and **C012** (and **C054**/**C054c** (motor 2) and **C097**/**C097c** (motor 3).) may have binary values only and they share the same Modbus address. The bit-parameter match is given in the Table 80.
It is important to consider this if the address is updated from an external interface system: before writing a new value, read the address value and change the bit concerned only, to avoid changing the other parameter as well.

These precautions are not necessary for the changes made via keypad or RemoteDrive.

Table 80: Coding of Parameters C011c (C054c, C097c) and C012 (C055, C098)

bit [15..2]	bit [1]	bit [0]
Not used	**C011c** (**C054c**, **C097c**)	**C012** (**C055**, **C098**)

C013 (C056, C099) Type of V/F Pattern

C013 (Motor 1) **C056 (Motor 2)** **C099 (Motor 3)**	**Range**	0 ÷ 2	0: Constant Torque 1: Quadratic 2: Free Setting
	Default	See Table 83 and Table 87	
	Level	BASIC (**C013**); ENGINEERING (**C056**, **C099**)	
	Address	1013, 1056, 1099	
	Control	IFD	
	Function	Allows selecting different types of V/f pattern. If **C013 (C056,C099) = Constant torque**, voltage at zero frequency can be selected (Preboost **C034** (**C077,C120**)). If **C013 (C056,C099) = Quadratic**, you can select voltage at zero frequency (preboost, **C034** (**C077,C120**)), max. voltage drop with respect to the theoretical V/f pattern, **C032** (**C075 C118**), and the frequency allowing implementing max. voltage drop, **C033** (**C076 C119**). If **C013 (C056,C099) = Free Setting**, you can set voltage at zero frequency (preboost, **C034**(**C077,C120**)); voltage increase to 20% of the rated frequency (Boost0, **C035** (**C078,C121**)); and voltage increase to a programmed frequency (Boost1, **C036** (**C079,C122**); frequency for Boost1, **C037** (**C080,C123**)).	

C014 (C057, C100) Phase Rotation

C014 (Motor 1) **C057 (Motor 2)** **C100 (Motor 3)**	**Range**	0÷1	0: [No]; 1: [Yes]
	Default	0	0: [No]
	Level	ENGINEERING	
	Address	1014, 1057,1100	
	Function	Allows reversing the mechanical rotation of the connected motor.	

DANGER!!! When activating **C014 (C057, C100)**, the mechanical rotation of the connected motor and its load is reversed accordingly.

C015 (C058, C101) Rated Motor Frequency

C015 (Motor 1) **C058 (Motor 2)** **C101 (Motor 3)**	**Range**	10 ÷ 10000	1.0 Hz ÷ 1000.0 Hz
		See upper limits in Table 70	
	Default	500	50.0 Hz
	Level	BASIC (**C015**); ENGINEERING (**C058**, **C101**)	
	Address	1015, 1058, 1101	
	Control	All	
	Function	This parameter defines the rated motor frequency (nameplate rating).	

C016 (C059, C102) Rated Motor Rpm

C016 (Motor 1) **C059 (Motor 2)** **C102 (Motor 3)**	**Range**	1 ÷ 32000	1 ÷ 32000 rpm
	Default	1420	1420 rpm
	Level	BASIC (**C016**); ENGINEERING (**C059**, **C102**)	
	Address	1016 , 1059, 1102	
	Function	This parameter defines the rated motor rpm (nameplate rating).	

C017 (C060,C103) Rated Motor Power

C017 (Motor 1) **C060 (Motor 2)** **C103 (Motor 3)**	**Range**	1 ÷ 32000	0.1 ÷ 3200.0 kW
		Upper limited to twice the default value	
	Default	See Table 84 and Table 88	
	Level	BASIC (**C017**); ENGINEERING (**C060**, **C103**)	
	Address	1017, 1060, 1103	
	Function	This parameter defines the rated motor power (nameplate rating).	

C018 (C061, C104) Rated Motor Current

C018 (Motor 1) **C061 (Motor 2)** **C104 (Motor 3)**	**Range**	1 ÷ 32000	0.1 ÷ 3200.0 A
		Upper limited to the values in **Inom** column in Table 81 and Table 85	
	Default	See Table 84 and Table 88	
	Level	BASIC (**C018**); ENGINEERING (**C061**, **C104**)	
	Address	1018 , 1061, 1104	
	Function	This parameter defines the rated motor current (nameplate rating).	

C019 (C062, C105) Rated Motor Voltage

C019 (Motor 1) **C062 (Motor 2)** **C105 (Motor 3)**	**Range**	50 ÷ 12000	5.0 ÷ 1200.0 V
	Default	2300 for 2T Class drives 4000 for 4T Class drives 5750 for 5T Class drives 6900 for 6T Class drives	230.0 V for 2T Class drives 400.0 V for 4T Class drives 575.0 V for 5T Class drives 690.0 V for 6T Class drives
	Level	BASIC (**C019**); ENGINEERING (**C062**, **C105**)	
	Address	1019 , 1062, 1105	
	Function	This parameter defines the rated motor voltage (nameplate rating).	

C020 (C063, C106) Motor No-Load Power

C020 (Motor 1) **C063 (Motor 2)** **C106 (Motor 3)**	**Range**	0 ÷ 1000	0.0 ÷ 100.0%
	Default	0	0.0%
	Level	ADVANCED (**C020**); ENGINEERING (**C063**, **C106**)	
	Address	1020 , 1063, 1106	
	Function	This parameter defines the power absorbed by the motor at rated voltage and rated rpm when no load is connected to the motor.	

C021 (C064,C107) Motor No-Load Current

C021 (Motor 1) **C064 (Motor 2)** **C107 (Motor 3)**	**Range**	1 ÷ 100	1 ÷ 100%
	Default	0	0%
	Level	ADVANCED (**C021**); ENGINEERING (**C064**, **C107**)	
	Address	1021, 1064, 1107	
	Function	This parameter defines the current absorbed by the motor at rated voltage and rated rpm when no load is connected to the motor. It is expressed as a percentage of the motor rated current **C018** (**C061**, **C104**). For a proper tuning of the current loops required for FOC control, enter a value other than zero. If the stator resistance is tuned (**I073** = [1: Motor Tune]); **1074** = [0: Motor Params]) and the no-load current parameter is zero, a value for a first attempt is assigned to this parameter, depending on power and pole pairs of the connected motor.	

C022 (C065, C108) Motor Stator Resistance

C022 (Motor 1) **C065 (Motor 2)** **C108 (Motor 3)**	**Range**	0 ÷ 32000	0.000 ÷ 32.000 Ω
	Default	See Table 84 and Table 88	
	Level	ENGINEERING	
	Address	1022, 1065, 1108	
	Function	This parameter defines the stator resistance Rs of the connected motor. • If a star connection is used, it matches with the value of the resistance of one phase (half the resistance measured between two terminals); • if a delta connection is used, it matches with 1/3 of the resistance of one phase. Autotune is always recommended.	

C023 (C066, C109) Motor Leakage Inductance

C023 (Motor 1) **C066 (Motor 2)** **C109 (Motor 3)**	**Range**	0 ÷ 32000	0.00 ÷ 320.00 mH
	Default	See Table 84 and Table 88	
	Level	ENGINEERING	
	Address	1023, 1066, 1109	
	Function	This parameter defines the global leakage inductance of the connected motor. • If a star connection is used, it matches with the value of the inductance of one phase; • if a delta connection is used, it matches with 1/3 of the inductance of one phase. Autotune is always recommended.	

NOTE With the Autotune function, calculate the value of the leakage inductance (**C023**). From the resulting value, manually subtract the value in mH of the output inductance (if any).

C024 (C067, C110) Mutual Inductance

C024 (Motor 1) **C067 (Motor 2)** **C110 (Motor 3)**	**Range**	0 ÷ 65000	0.00 ÷ 650.00 mH
	Default	25000	250.00 mH
	Level	ADVANCED (**C024**); ENGINEERING (**C067**, **C110**)	
	Address	1024, 1067, 1110	
	Function	This parameter defines the mutual inductance of the connected motor. The approximate value of the mutual inductance results from no-load current I_0 and from stator resistance R_{stat} according to the formula below: $M \cong (V_{mot} - R_{stat} \times I_0) / (2\pi f_{mot} \times I_0)$	

NOTE

Parameter **C024** (mutual inductance) is **automatically calculated** based on the preset no-load current value (**C021**) whenever parameters **I073** and **I074** are set as follows:
I073 = [1: Motor Tune]
I074 = [0: Motor Params]
whether current loop tuning is performed or not.

C025 (C068, C111) Rotor Time Constant

C025 (Motor 1) **C068 (Motor 2)** **C111 (Motor 3)**	**Range**	0 ÷ 5000	0 ÷ 5000msec
	Default	0	
	Level	ADVANCED (**C025**); ENGINEERING (**C068**, **C111**)	
	Address	1025, 747,, 1111	
	Control	VTC and FOC	
	Function	This parameter defines the rotor time constant of the connected motor. If the rotor time constant is not stated by the motor manufacturer, it can be obtained through the autotune function (see the FIRST STARTUP section and the AUTOTUNE MENU).	

NOTE

Whenever one of these parameters is written, the drive automatically computes and saves the parameters of PI flux regulator and FOC control: proportional constant for motor 1 **P158** (**P165** for motor 2, **P172** for motor 3) and integral time **P159** (**P166** for motor 2, **P173** for motor 3).

C026 (C069, C112) Time Constant of Bus Voltage Low-pass Filter

C026 (Motor 1) **C069 (Motor 2)** **C112 (Motor 3)**	**Range**	0 ÷ 32000	0.0 ÷ 3200.0 ms
	Default	0	0.0 ms
	Level	ENGINEERING	
	Address	1026, 1069, 1112	
	Function	This parameter defines the time constant of the low-pass filter of the bus voltage readout. Changing this value can avoid motor oscillations, especially when no load is connected to the motor.	

C028 (C071, C114) Min. Motor Speed

C028 (Motor 1) **C071 (Motor 2)** **C114 (Motor 3)**	**Range**	-32000 ÷ 32000 (*)	-32000 ÷ 32000 rpm (*)
	Default	0	0 rpm
	Level	BASIC (**C028**); ENGINEERING (**C071**, **C114**)	
	Address	1028, 1071, 1114	
	Function	This parameter defines the minimum speed of the connected motor. When references forming the global reference are at their min. relative value, the global reference equals the min. speed of the connected motor. *Example:* CONTROL METHOD MENU **C143** →[1: REF] Selection of reference 1 source **C144** →[2: AIN1] Selection of reference 2 source **C145** →[0: Disable] Selection of reference 3 source **C146** →[0: Disable] Selection of reference 4 source INPUTS FOR REFERENCES MENU **P050** →[0: ± 10V] Type of reference for REF input **P051** →[– 10V] Value of the min. reference for REF input **P052** →[+10V] Value of the max. reference for REF input **P055** →[0: ± 10V] Type of reference for AIN1 input **P056** →[– 5 V] Value of min. reference for AIN1 input **P057** →[+5 V]Value of max. reference for AIN1 input The speed reference is the min. speed set in **C028** (motor 1) when both REF input and AIN1 input values are lower than or equal to the minimum values set in **P051** and **P056** respectively.	

(*) NOTE The maximum allowable value (as an absolute value) for **C028** and **C029** (min. and max. motor speed) also depends on the preset **max. carrier frequency** (see Table 70). In any case it can be max. 4 times the rated speed of the connected motor.

NOTE The value set as the min. speed is used as the saturation of the global reference; the speed reference will never be lower than the value set as min. speed.

NOTE The min. speed is not respected only when the REV command or the CW/CCW command are sent after setting a value for max. speed exceeding the min. value (**C029**>**C028** for motor 1) and with the max. reference to the drive. The motor rpm will be –**C029**<**C028**.

C029 (C072, C115) Max. Motor Speed

C029 (Motor 1) **C072 (Motor 2)** **C115 (Motor 3)**	**Range**	0 ÷ 32000 (*see note in parameter **C028**)	0 ÷ 32000 rpm (*see note in parameter **C028**)
	Default	1500	1500 rpm
	Level	BASIC (**C029**); ENGINEERING (**C072**, **C115**)	
	Address	1029, 1072, 1115	
	Function	This parameter defines the maximum speed of the connected motor. When references forming the global reference are at their max. relative value, the global reference equals the max. speed of the connected motor. If **C011** (**C054**, **C097**) **= 2: Torque with speed limit**, this parameter is used to limit the motor rotation.	

NOTE In the CONTROL METHOD MENU, if an external speed/torque limit source (**C147**) is selected, the speed limit value set with this parameter is the upper limit, that can be reduced by adjusting the external source. Also, the ramp times set in the RAMPS MENU (**P009–P025**) are applied to this limit.

C030 (C073, C116) Field weakening Start Speed

C030 (mot. n.1) **C073 (mot. n.2)** **C116 (mot. n.3)**	**Range**	0 ÷ 200	0: Disabled ÷ 200%
	Default	0	0: Disabled
	Level	ENGINEERING	
	Address	1030, 1073, 1116	
	Control	VTC e FOC	
	Function	This parameter defines the speed value determining the motor field weakening based on 1/n (“static” *field weakening*). It is expressed as a percentage of the rated motor speed **C016** (**C059**, **C102**). With **C030 (C073, C116)**=0: Disabled, the motor field weakening never occurs based on law 1/n. For more details, see Field Weakening (VTC and FOC Only).	

C030a (C073a, C116a) Field Weakening Time Constant

C030a (mot. n.1) **C073a (mot. n.2)** **C116a (mot. n.3)**	**Range**	0 ÷ 32000	0: Disabled ÷ 32000ms
	Default	500	500ms
	Level	ENGINEERING	
	Address	1137, 1138, 1139	
	Control	VTC and FOC	
	Function	With **C030a (C073a, C116a)**=other than 0: Disabled, the motor field weakening follows a law optimizing the output voltage based on the available DC voltage (*“automatic” field weakening*). This parameter defines the trigger rate of the automatic field weakening regulator. For more details, see Field Weakening (VTC and FOC Only).	

C031 (C074, C117) Max. Speed Alarm

C031 (Motor 1) **C074 (Motor 2)** **C117 (Motor 3)**	**Range**	0 ÷ 32000	0: (Disabled) ÷ 32000 rpm
	Default	0	0: Disabled
	Level	ADVANCED (**C031**); ENGINEERING (**C074**, **C117**)	
	Address	1031, 1074, 1117	
	Function	If it is not set to zero, this parameter determines the speed value to be entered for the maximum speed alarm (**A076**).	

C032 (C075, C118) Reduction in Quadratic Torque Curve

C032 (Motor 1) C075 (Motor 2) C118 (Motor 3)	**Range**	0 ÷ 1000	0 ÷ 100.0%
	Default	300	30.0%
	Level	ADVANCED (**C032**); ENGINEERING (**C075**, **C118**)	
	Address	1032, 1075, 1118	
	Control	IFD	
	Function	If the V/f curve pattern **C013 (C056, C099) = Quadratic**, this parameter defines the maximum voltage reduction in terms of theoretical V/f pattern, which is implemented at the frequency programmed in **C033 (C076, C119)**.	

C033 (C076, C119) Max. Reduction Frequency for Quadratic Torque Pattern

C033 (Motor 1) C076 (Motor 2) C119 (Motor 3)	**Range**	1 ÷ 100	1 ÷ 100%
	Default	20	20%
	Level	ADVANCED (**C033**); ENGINEERING (**C076**, **C119**)	
	Address	1033, 1076, 1119	
	Control	IFD	
	Function	If the V/f curve pattern **C013 (C056, C099) = Quadratic**, this parameter defines the frequency implementing the max. torque reduction in terms of theoretical V/f pattern set in **C032 (C075, C120)**.	

C034 (C077, C120) Voltage Preboost for IFD

C034 (Motor 1) C077 (Motor 2) C120 (Motor 3)	**Range**	0 ÷ 50	0.0 ÷ 5.0 %
	Default	See Table 83 and Table 87	
	Level	BASIC (**C034**); ENGINEERING (**C077**, **C120**)	
	Address	1034, 1077, 1120	
	Control	IFD	
	Function	Torque compensation at minimum frequency produced by the drive. IFD control: determines the increase of the output voltage at 0Hz.	

C035 (C078, C121) Voltage Boost 0 at Programmable Frequency

C035 (Motor 1) C078 (Motor 2) C121 (Motor 3)	**Range**	–100 ÷ +100	–100 ÷ +100 %
	Default	See Table 83 and Table 87	
	Level	ADVANCED (**C035**); ENGINEERING (**C078**, **C121**)	
	Address	1035, 1078, 1121	
	Control	IFD	
	Function	Torque compensation at preset frequency (parameter **C035a** for motor 1, **C078a** for motor 2 and **C121a** for motor 3). This parameter defines the output voltage variation at preset frequency in respect to the frequency resulting from the constant V/f ratio (voltage/frequency constant). It is expressed as a percentage of the nominal motor voltage (**C019**, **C062**, **C105**).	

C035a (C078a, C121a) Frequency for Boost 0 Application

C035a (mot. n.1) **C078a (mot. n.2)** **C121a (mot. n.3)**	**Range**	0 ÷ 99	0 ÷ 99 %
	Default	5	5%
	Level	ADVANCED (**C035a**); ENGINEERING (**C078a**, **C121a**)	
	Address	1052, 1070, 1113	
	Control	IFD	
	Function	Frequency for the application of the boost preset with parameter **C035** for motor 1, **C078** for motor 2 and **C121** for motor 3. It is expressed as a percentage of the nominal motor frequency (**C015**, **C058**, **C101**).	

C036 (C079, C122) Voltage Boost 1 at Programmable Frequency

C036 (Motor 1) **C079 (Motor 2)** **C122 (Motor 3)**	**Range**	–100 ÷ +400	–100 ÷ +400 %
	Default	See Table 83 and Table 87	
	Level	ADVANCED (**C036**); ENGINEERING (**C079**, **C122**)	
	Address	1036, 1079, 1122	
	Control	IFD	
	Function	Torque compensation at preset frequency (parameter **C037** for motor 1, **C080** for motor 2 and **C123** for motor 3). Determines how output voltage varies at preset frequency with respect to voltage obtained with a constant V/f pattern (constant voltage frequency). It is expressed as a percentage of the nominal motor frequency (**C019**, **C062**, **C105**)	

C037 (C080, C123) Frequency for Boost 1 Application

C037 (Motor 1) **C080 (Motor 2)** **C123 (Motor 3)**	**Range**	6 ÷ 99	6 ÷ 99 %
	Default	See Table 83 and Table 87	
	Level	ADVANCED (**C037**); ENGINEERING (**C080**, **C123**)	
	Address	1037,1080,1123	
	Control	IFD	
	Function	Frequency for application of voltage Boost with parameter **C036** for motor 1, parameter **C079** for motor 2 and parameter **C122** for motor 3. This is expressed as a percentage of the motor rated frequency (**C015**, **C058**, **C101**).	

C038 (C081, C124) Autoboost

C038 (Motor 1) **C081 (Motor 2)** **C124 (Motor 3)**	**Range**	0 ÷ 10	0 ÷ 10 %
	Default	See Table 83 and Table 87	
	Level	ADVANCED (**C038**); ENGINEERING (**C081**, **C124**)	
	Address	1038, 1081, 1124	
	Control	IFD	
	Function	Variable torque compensation expressed as a percentage of the motor rated voltage. The preset value expresses the voltage increase when the motor is running at its rated torque.	

NOTE For optimum efficiency, it is recommended that Autotune **I074** = [0: Motor Params] is performed, as the stator resistance value (**C022, C065**, **C108)** is used for the Autoboost function.

C039 (C082,C125) Slip Compensation

C039 (Motor 1) C082 (Motor 2) C125 (Motor 3)			
	Range	0 ÷ 200	[0: Disabled] ÷ 200 %
	Default	0	[0: Disabled]
	Level	ADVANCED (**C039**); ENGINEERING (**C082**, **C125**)	
	Address	1039, 1082, 1125	
	Control	IFD	
	Function	This parameter represents the motor rated slip expressed as a value percent. If set to 0, this function is disabled.	

NOTE For optimum efficiency, it is recommended that Autotune **I074** = [0: Motor Params] is performed, as the stator resistance value (**C022, C065**, **C108**) is used for the Slip Compensation function.
The no-load power value is to be entered as well (**C020**, **C063**, **C106**).

C040 (C083, C126) Voltage Drop at Rated Current

C040 (Motor 1) C083 (Motor 2) C126 (Motor 3)			
	Range	0÷500	0÷50.0%
	Default	0	0:Disabled
	Level	ADVANCED (**C040**); ENGINEERING (**C083**, **C126**)	
	Address	1040, 1083, 1126	
	Control	IFD	
	Function	Defines the voltage increase required to compensate the voltage drop between the inverter and the motor due to the presence of a filter. The voltage increase is given by: DeltaV = (**C040**/100) * Vmot * Iout/Imot * fout/fmot, where Iout is the output current, fout is the output frequency, Vmot, Imot and fmot are the rated motor voltage, rated motor current and rated motor frequency respectively (parameters **C019**, **C018** and **C015**). Example: **C040 = 10%** Voltage drop at rated current **C013 = Constant Torque** Type of V/f pattern **C015 = 50 Hz** Rated frequency **C019= 380 V** Rated voltage **C018 = 50 A** Rated current If the drive output frequency is 25 Hz, it should deliver 190V. When the output current is 40A (**C018**) the voltage actually produced is Vout = 190 + ((10/100 * 380) * 40/50 * 25/50) = 190 + 15.2 = 205.2 V.	

C041 (C084,C127) Fluxing Ramp Time

C041 (Motor 1) C084 (Motor 2) C127 (Motor 3)			
	Range	40 ÷ 4000	40 ÷ 4000 msec
	Default	See Table 82 and Table 86	
	Level	ENGINEERING	
	Address	1041, 1084, 1127	
	Control	VTC and FOC	
	Function	This parameter indicates the time spent for motor fluxing.	

C042 (C085, C0128) Vout Saturation Percentage

C042 (Motor 1) **C085 (Motor 2)** **C128 (Motor 3)**	**Range**	10 ÷ 120	10 ÷ 120 %
	Default	100	100%
	Level	ENGINEERING	
	Address	1042, 1085, 1128	
	Function	This parameter sets the bus voltage value percent used to generate the output voltage of the drive. Changes made to this parameter affect the motor performance in terms of field weakening.	

34.3. Tables Including the Parameters Depending on the Drive Model

34.3.1. 2T/4T Voltage Classes

Table 81: Parameters depending on the Drive Model - 2T/4T Class / 1

SIZE	MODEL	DRIVE INOM [A]	DRIVE IMAX [A]	DRIVE IPEAK [A]	DEF CARRIER [kHz]	MAX CARRIER [kHz]	DEF Silent Modulation
					C001 C002	C001 C002	C004
S05	0005	10.5	11.5	14	5	16	YES
	0007	12.5	13.5	16	5	16	YES
	0008	15	16	19	5	10	YES
	0009	16.5	17.5	19	5	16	YES
	0010	17	19	23	5	10	YES
	0011	16.5	21	25	5	16	YES
	0013	19	21	25	5	10	YES
	0014	16.5	25	30	5	16	YES
	0015	23	25	30	5	10	YES
S05/S12	0016	27	30	36	3	10	YES
	0020	30	36	43	3	10	YES
S12	0017	30	32	37	3	10	YES
	0023	38	42	51	3	10	YES
	0025	41	48	58	3	10	YES
	0030	45	56	67	3	10	YES
	0033	51	56	68	3	10	YES
	0034	57	63	76	3	10	YES
	0036	60	72	86	3	10	YES
	0037	65	72	83	3	10	YES
S15	0040	72	80	88	3	16	YES
	0049	80	96	115	3	12.8	YES
S16	0041	75	91.5	110	6	16	YES
	0061	88	112.5	135	6	16	YES
S20	0060	88	112	134	3	10	YES
	0067	103	118	142	3	10	YES
	0074	120	144	173	3	10	YES
	0086	145	155	186	3	10	YES
S21	0068	105	132	158	6	16	YES
	0075	133	145.5	175	6	16	YES
	0087	145	158	189	6	16	YES
	0112	170	217	261	6	16	YES
S30	0113	180	200	240	2	10	YES
	0129	195	215	258	2	10	YES
	0150	215	270	324	2	8	YES
	0162	240	290	324	2	8	YES
S31	0130	206	255	306	6	16	YES
	0151	236	270	324	6	16	YES
	0163	246	309	371	6	16	YES
	0178	300	369	443	6	16	YES
S41	0180	300	340	408	2	6	NO
	0202	345	420	504	2	6	NO
	0217	375	460	552	2	6	NO
	0260	445	560	672	2	6	NO

SIZE	MODEL	DRIVE INOM [A]	DRIVE IMAX [A]	DRIVE IPEAK [A]	DEF CARRIER [kHz]	MAX CARRIER [kHz]	DEF Silent Modulation
					C001 C002	C001 C002	C004
S51	0313	480	600	720	2	5	NO
	0367	550	680	792	2	5	NO
	0402	680	850	1020	2	5	NO
S60	0457	720	880	1056	2	4	NO
	0524	800	960	1152	2	4	NO
S60P	0598P	900	1100	1152	2	4	NO
S65	0598	900	1100	1320	2	4	NO
	0748	1000	1300	1560	2	4	NO
	0831	1200	1440	1728	2	4	NO
S75	0964	1480	1780	2136	2	4	NO
	1130	1700	2040	2448	2	4	NO
	1296	2100	2520	3024	2	4	NO
S90	1800	2600	3100	3720	2	4	NO
	2076	3000	3600	4000	2	4	NO
2xS41	0523	800	960	960	2	5	NO
2xS51	0599	900	1100	1100	2	5	NO
	0749	1000	1300	1300	2	5	NO
	0832	1200	1440	1440	2	5	NO
3xS51	0850	1340	1600	1600	2	5	NO
	0965	1480	1780	1780	2	5	NO
	1129	1700	2040	2040	2	5	NO

Table 82: Parameters depending on the Drive Model - 2T/4T Class / 2

SIZE	MODEL	DEF TFLUX [ms]	DEF ILIM DEC [%Inom]	DEF DCB RAMP [ms]	DEF Acc. Time [sec]	DEF Dec. Time [sec]	S – Acc/Dec DEF	Fire Mode Ramps DEF [sec]	UNIT Acc. / Dec. DEF [sec]	Dec. Ramp Ext. DEF
	M1	C041	C045	C222	P009 P012 P015 P018	P010 P013 P016 P019	P022 P023 P024 P025	P032 P033	P014 P020	C210
	M2	C084	C088	C223						
	M3	C127	C131	C224						
S05	0005	300	150	50	10	10	50	10	0.1	0.2
	0007	300	150	50	10	10	50	10	0.1	0.2
	0008	300	150	50	10	10	50	10	0.1	0.2
	0009	300	150	50	10	10	50	10	0.1	0.2
	0010	300	150	50	10	10	50	10	0.1	0.2
	0011	300	150	50	10	10	50	10	0.1	0.2
	0013	300	150	50	10	10	50	10	0.1	0.2
	0014	300	150	50	10	10	50	10	0.1	0.2
	0015	300	150	50	10	10	50	10	0.1	0.2
S05/S12	0016	300	150	50	10	10	50	10	0.1	0.2
	0020	300	150	50	10	10	50	10	0.1	0.2
S12	0017	300	150	50	10	10	50	10	0.1	0.2
	0023	300	150	50	10	10	50	10	0.1	0.2
	0025	300	150	50	10	10	50	10	0.1	0.2
	0030	300	150	50	10	10	50	10	0.1	0.2
	0033	300	150	50	10	10	50	10	0.1	0.2
	0034	300	150	70	10	10	50	10	0.1	0.2
	0036	300	150	70	10	10	50	10	0.1	0.2
	0037	300	150	70	10	10	50	10	0.1	0.2
S15	0040	300	150	70	10	10	50	10	0.1	0.2
	0049	300	150	80	10	10	50	10	0.1	0.2
S16	0041	300	150	70	10	10	50	10	0.1	0.2
	0061	300	150	80	10	10	50	10	0.1	0.2
S20	0060	300	150	80	10	10	50	10	0.1	0.2
	0067	300	150	100	10	10	50	10	0.1	0.2
	0074	300	150	100	10	10	50	10	0.1	0.2
	0086	300	150	150	10	10	50	10	0.1	0.2
S21	0068	300	150	100	10	10	50	10	0.1	0.2
	0075	300	150	100	10	10	50	10	0.1	0.2
	0087	300	150	150	10	10	50	10	0.1	0.2
	0112	300	150	150	10	10	50	10	0.1	0.2
S30	0113	300	150	150	10	10	50	10	0.1	0.2
	0129	300	150	150	10	10	50	10	0.1	0.2
	0150	300	150	200	10	10	50	10	0.1	0.2
	0162	300	150	200	10	10	50	10	0.1	0.2
S31	0130	300	150	150	10	10	50	10	0.1	0.2
	0151	300	150	200	10	10	50	10	0.1	0.2
	0163	300	150	200	10	10	50	10	0.1	0.2
	0178	450	150	220	10	10	50	10	0.1	0.2
S41	0180	450	100	250	100	100	1	100	1	2
	0202	450	100	250	100	100	1	100	1	2
	0217	450	100	250	100	100	1	100	1	2
	0260	450	100	250	100	100	1	100	1	2

SIZE	MODEL	DEF TFLUX [ms]	DEF ILIM DEC [%Inom]	DEF DCB RAMP [ms]	DEF Acc. Time [sec]	DEF Dec. Time [sec]	S – Acc/Dec DEF	Fire Mode Ramps DEF [sec]	UNIT Acc. / Dec. DEF [sec]	Dec. Ramp Ext. DEF
	M1	**C041**	**C045**	**C222**	**P009 P012 P015 P018**	**P010 P013 P016 P019**	**P022 P023 P024 P025**	**P032 P033**	**P014 P020**	**C210**
	M2	**C084**	**C088**	**C223**						
	M3	**C127**	**C131**	**C224**						
S51	0313	450	100	250	100	100	1	100	1	2
	0367	450	100	250	100	100	1	100	1	2
	0402	450	100	250	100	100	1	100	1	2
S60	0457	450	100	250	100	100	1	100	1	2
	0524	450	100	250	100	100	1	100	1	2
S60P	0598P	450	100	250	100	100	1	100	1	2
S65	0598	450	100	250	100	100	1	100	1	2
	0748	450	100	250	100	100	1	100	1	2
	0831	450	100	250	100	100	1	100	1	2
S75	0964	450	100	250	100	100	1	100	1	2
	1130	450	100	250	100	100	1	100	1	2
	1296	450	100	250	100	100	1	100	1	2
S90	1800	450	100	250	100	100	1	100	1	2
	2076	450	100	250	100	100	1	100	1	2
2xS41	0523	450	100	250	100	100	1	100	1	2
2xS51	0599	450	100	250	100	100	1	100	1	2
	0749	450	100	250	100	100	1	100	1	2
	0832	450	100	250	100	100	1	100	1	2
3xS51	0850	450	100	250	100	100	1	100	1	2
	0965	450	100	250	100	100	1	100	1	2
	1129	450	100	250	100	100	1	100	1	2

Table 83: Parameters depending on the Drive Model - 2T/4T Class / 3

SIZE	MODEL	DEF V/f Pattern	DEF PREBOOST [%Vmot]	BOOST @ 5% fmot and BOOST DEF [%Vmot]	Frequency for BOOST DEF [%fmot]	DEF Auto BOOST [%Vmot]
	M1	**C013**	**C034**	**C035/C036**	**C037**	**C038**
	M2	**C056**	**C077**	**C078/C079**	**C080**	**C081**
	M3	**C099**	**C120**	**C121/C122**	**C123**	**C124**
S05	0005	0:CONST	1.0	0	50	1
	0007	0:CONST	1.0	0	50	1
	0008	0:CONST	1.0	0	50	1
	0009	0:CONST	1.0	0	50	1
	0010	0:CONST	1.0	0	50	1
	0011	0:CONST	1.0	0	50	1
	0013	0:CONST	1.0	0	50	1
	0014	0:CONST	1.0	0	50	1
	0015	0:CONST	1.0	0	50	1
S05/S12	0016	0:CONST	1.0	0	50	1
	0020	0:CONST	1.0	0	50	1
S12	0017	0:CONST	1.0	0	50	1
	0023	0:CONST	1.0	0	50	1
	0025	0:CONST	1.0	0	50	1
	0030	0:CONST	1.0	0	50	1
	0033	0:CONST	1.0	0	50	1
	0034	0:CONST	1.0	0	50	1
	0036	0:CONST	1.0	0	50	1
	0037	0:CONST	1.0	0	50	1
S15	0040	0:CONST	1.0	0	50	1
	0049	0:CONST	1.0	0	50	1
S16	0041	0:CONST	1.0	0	50	1
	0061	0:CONST	1.0	0	50	1
S20	0060	0:CONST	1.0	0	50	1
	0067	0:CONST	1.0	0	50	1
	0074	0:CONST	1.0	0	50	1
	0086	0:CONST	1.0	0	50	1
S21	0068	0:CONST	1.0	0	50	1
	0075	0:CONST	1.0	0	50	1
	0087	0:CONST	1.0	0	50	1
	0112	0:CONST	1.0	0	50	1
S30	0113	0:CONST	0.5	0	50	1
	0129	0:CONST	0.5	0	50	1
	0150	0:CONST	0.5	0	50	1
	0162	0:CONST	0.5	0	50	1
S31	0130	0:CONST	0.5	0	50	1
	0151	0:CONST	0.5	0	50	1
	0163	0:CONST	0.5	0	50	1
	0178	0:CONST	0.5	0	50	1
S41	0180	2:FREE	0.2	–20	20	0
	0202	2:FREE	0.2	–20	20	0
	0217	2:FREE	0.2	–20	20	0
	0260	2:FREE	0.2	–20	20	0

SIZE	MODEL	DEF V/f Pattern	DEF PREBOOST [%Vmot]	BOOST @ 5% fmot and BOOST DEF [%Vmot]	Frequency for BOOST DEF [%fmot]	DEF Auto BOOST [%Vmot]
	M1	**C013**	**C034**	**C035/C036**	**C037**	**C038**
	M2	**C056**	**C077**	**C078/C079**	**C080**	**C081**
	M3	**C099**	**C120**	**C121/C122**	**C123**	**C124**
S51	0313	2:FREE	0.2	–20	20	0
	0367	2:FREE	0.2	–20	20	0
	0402	2:FREE	0.2	–20	20	0
S60	0457	2:FREE	0.2	–20	20	0
	0524	2:FREE	0.2	–20	20	0
S60P	0598P	2:FREE	0.2	–20	20	0
S65	0598	2:FREE	0.2	–20	20	0
	0748	2:FREE	0.2	–20	20	0
	0831	2:FREE	0.2	–20	20	0
S75	0964	2:FREE	0.2	–20	20	0
	1130	2:FREE	0.2	–20	20	0
	1296	2:FREE	0.2	–20	20	0
S90	1800	2:FREE	0.2	–20	20	0
	2076	2:FREE	0.2	–20	20	0
2xS41	0523	2:FREE	0.2	–20	20	0
2xS51	0599	2:FREE	0.2	–20	20	0
	0749	2:FREE	0.2	–20	20	0
	0800	2:FREE	0.2	–20	20	0
	0832	2:FREE	0.2	–20	20	0
3xS51	0850	2:FREE	0.2	–20	20	0
	0965	2:FREE	0.2	–20	20	0
	1129	2:FREE	0.2	–20	20	0

Table 84: Parameters depending on the Drive Model and Voltage Class - 2T/4T Class / 4

SIZE	MODEL	2T DEF Pmot [kW]	2T DEF Imot [A]	2T DEF Rstat [Ω]	2T DEF Ldisp [mH]	4T DEF Pmot [kW]	4T DEF Imot [A]	4T DEF Rstat [Ω]	4T DEF Ldisp [mH]
	M1	C017	C018	C022	C023	C017	C018	C022	C023
	M2	C060	C061	C065	C066	C060	C061	C065	C066
	M3	C103	C104	C108	C109	C103	C104	C108	C109
S05	0005	---	---	---	---	3	6.4	2.500	30.00
	0007	1.8	7.3	1.155	14.43	4	8.4	2.000	25.00
	0008	2.2	8.5	1.000	12.00	---	---	---	---
	0009	---	---	---	---	4.5	9	1.600	16.00
	0010	3	11.2	0.800	7.50	---	---	---	---
	0011	---	---	---	---	5.5	11.2	1.300	12.00
	0013	3.7	13.2	0.650	6.00	---	---	---	---
	0014	---	---	---	---	7.5	14.8	1.000	8.00
	0015	4	16.6	0.600	5.00	---	---	---	---
S05/S12	0016	4.5	15.7	0.462	3.46	9.2	17.9	0.800	6.00
	0020	5.5	19.5	0.346	2.89	11	21.0	0.600	5.00
S12	0017	---	---	---	---	9.2	21	0.800	6.00
	0023	7.5	25.7	0.300	2.50	---	---	---	---
	0025	---	---	---	---	15	29	0.400	3.00
	0030	---	---	---	---	18.5	35	0.300	2.50
	0033	11	36	0.200	1.50	---	---	---	---
	0034	---	---	---	---	22	41	0.250	2.00
	0036	---	---	---	---	25	46	0.250	2.00
	0037	15	50	0.100	1.15	---	---	---	---
S15	0040	15	50	0.115	1.15	25	46	0.200	2.00
	0049	18.5	61	0.087	1.15	30	55	0.150	2.00
S16	0041	18.5	61	0.087	1.15	30	55	0.200	2.00
	0061	22	71	0.069	1.15	37	67	0.120	2.00
S20	0060	22	71	0.069	1.15	37	67	0.120	2.00
	0067	25	80	0.058	0.69	45	80	0.100	1.20
	0074	30	96	0.046	0.69	50	87	0.080	1.20
	0086	32	103	0.035	0.58	55	98	0.060	1.00
S21	0068	25	80	0.058	0.69	45	80	0.100	1.20
	0075	30	96	0.046	0.69	50	87	0.080	1.20
	0087	32	103	0.035	0.58	55	98	0.060	1.00
	0112	45	135	0.023	0.58	75	133	0.040	1.00
S30	0113	45	135	0.023	0.58	75	133	0.040	1.00
	0129	50	150	0.023	0.58	80	144	0.040	1.00
	0150	55	170	0.017	0.58	90	159	0.030	1.00
	0162	65	195	0.012	0.58	110	191	0.020	1.00
S31	0130	55	170	0.017	0.58	90	159	0.040	1.00
	0151	55	170	0.017	0.58	100	173	0.030	1.00
	0163	65	195	0.012	0.58	110	191	0.020	1.00
	0178	75	231	0.010	0.52	132	228	0.018	0.9
S41	0180	75	231	0.010	0.52	132	228	0.018	0.9
	0202	80	250	0.010	0.52	160	273	0.018	0.9
	0217	110	332	0.009	0.46	185	321	0.015	0.8
	0260	110	332	0.007	0.35	220	375	0.012	0.6

		2T				4T			
SIZE	**MODEL**	**Pmot DEF [kW]**	**Imot DEF [A]**	**Rstat DEF [Ω]**	**Ldisp DEF [mH]**	**Pmot DEF [kW]**	**Imot DEF [A]**	**Rstat DEF [Ω]**	**Ldisp DEF [mH]**
	M1	**C017**	**C018**	**C022**	**C023**	**C017**	**C018**	**C022**	**C023**
	M2	**C060**	**C061**	**C065**	**C066**	**C060**	**C061**	**C065**	**C066**
	M3	**C103**	**C104**	**C108**	**C109**	**C103**	**C104**	**C108**	**C109**
S51	0313	132	390	0.006	0.28	250	375	0.012	0.50
	0367	150	458	0.005	0.23	280	480	0.010	0.40
	0402	160	475	0.005	0.17	355	589	0.010	0.30
S60	0457	200	593	0.005	0.14	315	528	0.008	0.25
	0524	220	661	0.004	0.12	355	589	0.007	0.20
S60P	0598P	250	732	0.003	0.12	400	680	0.006	0.20
S65	0598	250	732	0.003	0.12	400	680	0.006	0.20
	0748	280	840	0.002	0.09	500	841	0.003	0.15
	0831	330	985	0.001	0.06	560	939	0.002	0.10
S75	0964	400	1183	0.001	0.05	710	1200	0.002	0.09
	1130	450	1330	0.001	0.05	800	1334	0.001	0.09
	1296	560	1633	0.001	0.05	1000	1650	0.001	0.09
S90	1800	---	---	---	---	1200	2050	0.001	0.06
	2076	---	---	---	---	1400	2400	0.001	0.05
2xS41	0523	---	---	---	---	355	589	0.007	0.20
2xS51	0599	---	---	---	---	400	680	0.006	0.20
	0749	---	---	---	---	500	841	0.003	0.15
	0832	---	---	---	---	560	939	0.002	0.10
3xS51	0850	---	---	---	---	630	1080	0.002	0.09
	0965	---	---	---	---	710	1200	0.002	0.09
	1129	---	---	---	---	800	1334	0.001	0.09

34.3.2. 5T/6T Voltage Classes

Table 85: Parameters depending on the Drive Model - 5T/6T Class / 1

SIZE	MODEL	DRIVE INOM [A]	DRIVE IMAX [A]	DRIVE IPEAK [A]	DEF CARRIER [kHz]	MAX CARRIER [kHz]	DEF Silent Modulation
					C001 C002	C001 C002	C004
S12/S14	0003	7	8.5	10	3	5	YES
	0004	9	11	13	3	5	YES
	0006	11	13.5	16	3	5	YES
	0012	13	16	19	3	5	YES
	0018	17	21	25	3	5	YES
S14	0019	21	25	30	3	5	YES
	0021	25	30	36	3	5	YES
	0022	33	40	48	3	5	YES
	0024	40	48	58	3	5	YES
	0032	52	63	76	3	5	YES
S22	0042	60	72	86	3	5	YES
	0051	80	96	115	3	5	YES
	0062	85	110	132	3	5	YES
	0069	105	135	162	3	5	YES
S32	0076	125	165	198	2	4	YES
	0088	150	200	240	2	4	YES
	0131	190	250	300	2	4	YES
	0164	230	300	360	2	4	YES
	0172	265	345	414	2	4	YES
S42	0181	305	380	420	2	4	NO
	0201	330	420	420	2	4	NO
	0218	360	465	560	2	4	NO
	0259	400	560	560	2	4	NO
S52	0290	450	600	720	2	4	NO
	0314	500	665	798	2	4	NO
	0368	560	720	850	2	4	NO
	0401	640	850	850	2	4	NO
S65	0457	720	880	1056	2	4	NO
	0524	800	960	1152	2	4	NO
	0598	900	1100	1320	2	4	NO
	0748	1000	1300	1440	2	2	NO
S70	0831	1200	1440	1440	2	2	NO
S75	0964	1480	1780	2136	2	2	NO
	1130	1700	2040	2448	2	2	NO
S80	1296	2100	2520	2520	2	2	NO
S90	1800	2600	3100	3600	2	2	NO
	2076	3000	3600	3600	2	2	NO
2xS42	0459	720	880	880	2	4	NO
2xS52	0526	800	960	960	2	4	NO
	0600	900	1100	1100	2	4	NO
	0750	1000	1300	1300	2	4	NO
	0828	1200	1440	1440	2	4	NO
3xS52	0960	1480	1780	1780	2	4	NO
	1128	1700	2040	2040	2	4	NO

Table 86: Parameters depending on the Drive Model - 5T/6T Class / 2

SIZE	MODEL	DEF TFLUX [ms]	DEF ILIM DEC [%Inom]	DEF DCB RAMP [ms]	DEF Acc. Time [sec]	DEF Dec. Time [sec]	S – Acc/Dec DEF	Fire Mode Ramps DEF [sec]	Unit Of Meas. Acc. / Dec. DEF [sec]	Dec. Ramp Ext. DEF
	M1	C041	C045	C222	P009 P012 P015 P018	P010 P013 P016 P019	P022 P023 P024 P025	P032 P033	P014 P020	C210
	M2	C084	C088	C223						
	M3	C127	C131	C224						
S12/S14	0003	300	150	50	10	10	50	10	0.1	0.2
	0004	300	150	50	10	10	50	10	0.1	0.2
	0006	300	150	50	10	10	50	10	0.1	0.2
	0012	300	150	50	10	10	50	10	0.1	0.2
	0018	300	150	50	10	10	50	10	0.1	0.2
S14	0019	300	150	50	10	10	50	10	0.1	0.2
	0021	300	150	50	10	10	50	10	0.1	0.2
	0022	300	150	50	10	10	50	10	0.1	0.2
	0024	300	150	50	10	10	50	10	0.1	0.2
	0032	300	150	50	10	10	50	10	0.1	0.2
S22	0042	300	150	80	10	10	50	10	0.1	0.2
	0051	300	150	80	10	10	50	10	0.1	0.2
	0062	300	150	80	10	10	50	10	0.1	0.2
	0069	300	150	100	10	10	50	10	0.1	0.2
S32	0076	300	150	100	10	10	50	10	0.1	0.2
	0088	300	150	150	10	10	50	10	0.1	0.2
	0131	300	150	150	10	10	50	10	0.1	0.2
	0164	300	150	200	10	10	50	10	0.1	0.2
	0172	300	150	200	10	10	50	10	0.1	0.2
S42	0181	450	100	200	100	100	1	100	1	2
	0201	450	100	220	100	100	1	100	1	2
	0218	450	100	250	100	100	1	100	1	2
	0259	450	100	250	100	100	1	100	1	2
S52	0290	450	100	250	100	100	1	100	1	2
	0314	450	100	250	100	100	1	100	1	2
	0368	450	100	250	100	100	1	100	1	2
	0401	450	100	250	100	100	1	100	1	2
S65	0457	450	100	250	100	100	1	100	1	2
	0524	450	100	250	100	100	1	100	1	2
	0598	450	100	250	100	100	1	100	1	2
	0748	450	100	250	100	100	1	100	1	2
S70	0831	450	100	250	100	100	1	100	1	2
S75	0964	450	100	250	100	100	1	100	1	2
	1130	450	100	250	100	100	1	100	1	2
S80	1296	450	100	250	100	100	1	100	1	2
S90	1800	450	100	250	100	100	1	100	1	2
	2076	450	100	250	100	100	1	100	1	2
2xS42	0459	450	100	250	100	100	1	100	1	2
2xS52	0526	450	100	250	100	100	1	100	1	2
	0600	450	100	250	100	100	1	100	1	2
	0750	450	100	250	100	100	1	100	1	2
	0828	450	100	250	100	100	1	100	1	2
3xS52	0960	450	100	250	100	100	1	100	1	2
	1128	450	100	250	100	100	1	100	1	2

Table 87: Parameters depending on the Drive Model - 5T/6T Class / 3

SIZE	MODEL	DEF V/f Pattern	DEF PREBOOST [%Vmot]	BOOST @ 5% fmot and BOOST DEF [%Vmot]	Frequency for BOOST DEF [%fmot]	DEF Auto BOOST [%Vmot]
	M1	**C013**	**C034**	**C035/C036**	**C037**	**C038**
	M2	**C056**	**C077**	**C078/C079**	**C080**	**C081**
	M3	**C099**	**C120**	**C121/C122**	**C123**	**C124**
S12/S14	0003	0:CONST	1.0	0	50	1
	0004	0:CONST	1.0	0	50	1
	0006	0:CONST	1.0	0	50	1
	0012	0:CONST	1.0	0	50	1
	0018	0:CONST	1.0	0	50	1
S14	0019	0:CONST	1.0	0	50	1
	0021	0:CONST	1.0	0	50	1
	0022	0:CONST	1.0	0	50	1
	0024	0:CONST	1.0	0	50	1
	0032	0:CONST	1.0	0	50	1
S22	0042	0:CONST	1.0	0	50	1
	0051	0:CONST	1.0	0	50	1
	0062	0:CONST	1.0	0	50	1
	0069	0:CONST	1.0	0	50	1
S32	0076	0:CONST	1.0	0	50	1
	0088	0:CONST	1.0	0	50	1
	0131	0:CONST	0.5	0	50	1
	0164	0:CONST	0.5	0	50	1
S42	0181	2:FREE	0.2	–20	20	0
	0201	2:FREE	0.2	–20	20	0
	0218	2:FREE	0.2	–20	20	0
	0259	2:FREE	0.2	–20	20	0
S52	0290	2:FREE	0.2	–20	20	0
	0314	2:FREE	0.2	–20	20	0
	0368	2:FREE	0.2	–20	20	0
	0401	2:FREE	0.2	–20	20	0
S65	0457	2:FREE	0.2	–20	20	0
	0524	2:FREE	0.2	–20	20	0
	0598	2:FREE	0.2	–20	20	0
	0748	2:FREE	0.2	–20	20	0
S70	0831	2:FREE	0.2	–20	20	0
S75	0964	2:FREE	0.2	–20	20	0
	1130	2:FREE	0.2	–20	20	0
S80	1296	2:FREE	0.2	–20	20	0
S90	1800	2:FREE	0.2	–20	20	0
	2076	2:FREE	0.2	–20	20	0
2xS42	0459	2:FREE	0.2	–20	20	0
2xS52	0526	2:FREE	0.2	–20	20	0
	0600	2:FREE	0.2	–20	20	0
	0750	2:FREE	0.2	–20	20	0
	0828	2:FREE	0.2	–20	20	0
3xS52	0960	2:FREE	0.2	–20	20	0
	1128	2:FREE	0.2	–20	20	0

Table 88: Parameters depending on the Drive Model and Voltage Class - 5T/6T Class / 4

		5T				6T			
SIZE	**MODEL**	**DEF Pmot [kW]**	**DEF Imot [A]**	**DEF Rstat [Ω]**	**DEF Ldisp [mH]**	**DEF Pmot [kW]**	**DEF Imot [A]**	**DEF Rstat [Ω]**	**DEF Ldisp [mH]**
	M1	**C017**	**C018**	**C022**	**C023**	**C017**	**C018**	**C022**	**C023**
	M2	**C060**	**C061**	**C065**	**C066**	**C060**	**C061**	**C065**	**C066**
	M3	**C103**	**C104**	**C108**	**C109**	**C103**	**C104**	**C108**	**C109**
S12/S14	0003	3.0	4.4	3.608	43.30	4.0	4.8	4.330	51.96
	0004	4.0	5.7	3.608	43.30	4.0	4.8	4.330	51.96
	0006	5.5	7.6	2.887	36.08	7.5	8.4	3.464	43.30
	0012	7.5	10.0	1.732	15.88	7.5	8.4	2.078	19.05
	0018	9.2	12.5	1.155	8.66	11.0	12.1	1.386	10.39
S14	0019	11.0	14.0	1.155	8.66	11.0	12.1	1.386	10.39
	0021	15.0	20.0	0.866	7.22	15.0	16.8	1.039	8.66
	0022	18.5	25.0	0.866	7.22	22.0	23.0	1.039	8.66
	0024	22.0	28.0	0.577	4.33	22.0	23.0	0.693	5.20
	0032	30.0	39.0	0.433	3.61	37.0	39.0	0.520	4.33
S22	0042	37	47	0.217	2.89	37	39	0.260	3.46
	0051	45	55	0.173	2.89	55	56	0.208	3.46
	0062	55	70	0.173	2.89	55	55.8	0.208	3.46
	0069	55	70	0.144	1.73	75	78.1	0.173	2.08
S32	0076	75	95	0.115	1.73	90	94.4	0.139	2.08
	0088	110	135	0.087	1.44	110	112.6	0.104	1.73
	0131	110	135	0.058	1.44	160	158	0.069	1.73
	0164	132	168	0.029	1.44	185	185	0.035	1.73
S42	0181	185	225	0.026	1.44	220	220	0.031	1.73
	0201	200	240	0.026	1.30	250	250	0.031	1.56
	0218	220	275	0.022	1.15	315	310	0.026	1.39
	0259	280	336	0.017	0.87	355	341	0.021	1.04
S52	0290	300	358	0.017	0.72	400	390	0.020	0.86
	0314	330	395	0.017	0.72	450	440	0.020	0.86
	0368	355	420	0.014	0.57	500	480	0.017	0.69
	0401	400	473	0.014	0.43	560	544	0.017	0.51
S65	0457	500	585	0.012	0.36	560	544	0.014	0.43
	0524	560	630	0.010	0.29	630	626	0.012	0.35
	0598	630	720	0.009	0.29	710	696	0.010	0.35
	0748	710	800	0.004	0.22	900	858	0.005	0.26
S70	0831	800	900	0.003	0.14	1000	954	0.003	0.17
S75	0964	1000	1450	0.003	0.13	1220	1187	0.003	0.16
	1130	1170	1360	0.001	0.13	1400	1360	0.001	0.16
S80	1296	1340	1560	0.001	0.13	1610	1560	0.001	0.16
S90	1800	1750	2050	0.001	0.08	2100	2100	0.001	0.10
	2076	2000	2400	0.001	0.07	2400	2400	0.001	0.08
2xS42	0459	500	626	0.012	0.36	630	626	0.014	0.43
2xS52	0526	500	696	0.010	0.29	710	696	0.012	0.35
	0600	630	773	0.009	0.29	800	773	0.010	0.35
	0750	710	800	0.004	0.22	900	858	0.005	0.26
	0828	710	800	0.003	0.14	1000	954	0.003	0.17
3xS52	0960	1000	1145	0.003	0.13	1200	1187	0.003	0.16
	1128	1000	1360	0.001	0.13	1400	1360	0.002	0.16

35. LIMITS MENU

35.1. Overview

The **Limits Menu** defines the current/torque limits applied to the control functions (IFD, VTC or FOC controls) selected for the three connected motors.

For **IFD** control, **current** limits are used. Three limit current levels are available, which are expressed as a percentage of the motor rated current:
1) Current limit while accelerating;
2) Current limit at constant rpm;
3) Current limit while decelerating.

Two special parameters are also available; one sets the decrease of the limit current value when the motor runs at constant power (field weakening), while the other parameter disables the frequency decrease in case of acceleration current limit (this is useful for inertial loads).

If a **VTC** control or a **FOC** control is used, limits are expressed as a percentage of the rated motor **torque**.
In Speed Control, values set in the two parameters **C048** Maximum Torque motor and **C049** Maximum Torque brake represent the limits for saturation of the control torque demand; **C047** has no effect.

In Speed Control, when in field weakening mode, such as when the system operates at a higher speed than the rated motor speed set in **C016**, the torque limits are reduced following a 1/speed law at speeds exceeding the rated speed, to limit the maximum mechanical power required to the motor, as shown in Figure 48.

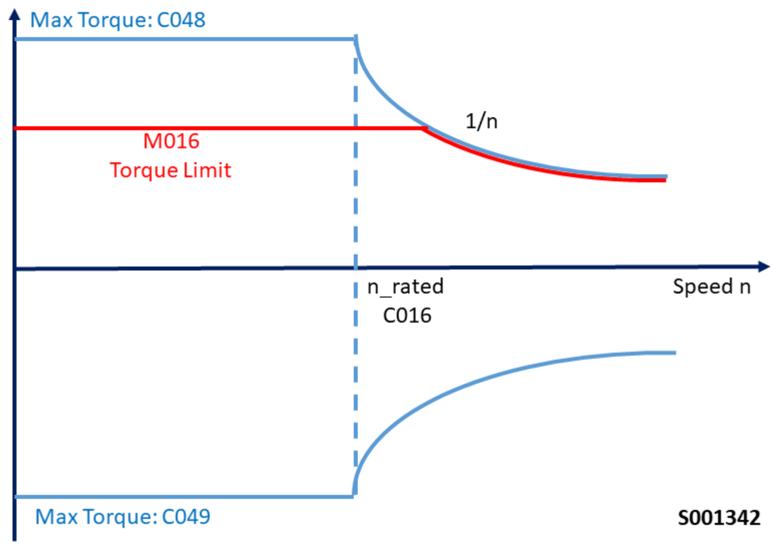


Figure 48: Torque limit for VTC and FOC controls including field weakening mode

In Torque Control, the maximum and minimum torque limits (**C047** and **C048**) represent the range of the source used for limitation. **C049** has no effect.
The torque ramp times set in the RAMPS MENU will be applied to the preset limit torque reference.

In Torque Control, when in field weakening mode, torque limits are reduced following a 1/speed law at speeds exceeding the rated speed, to limit the maximum mechanical power required to the motor.
External torque limit possibly programmed via **C147** is not re-scaled to 1/speed, but is saturated between the two limits defined above, as shown in Figure 49.

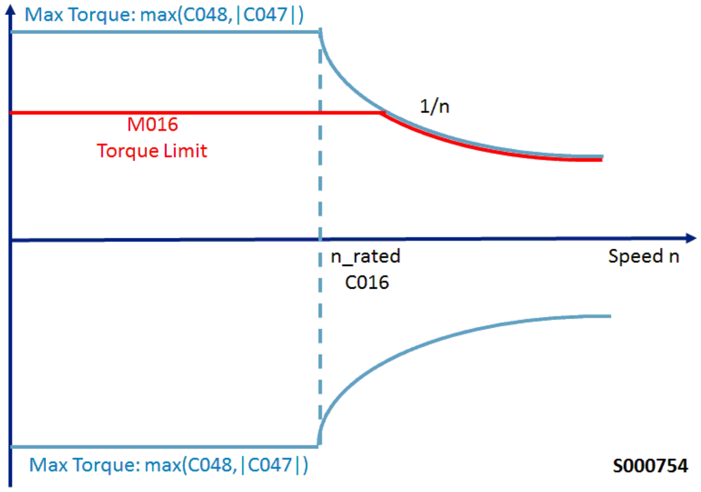


Figure 49: Torque reference limit for VTC and FOC controls including field weakening mode

The Ipeak current load is available (see Table 81 and Table 85) for a maximum time of 3 seconds and only if the preset carrier frequency is lower than/equal to the default frequency value (see Table 81 and Table 85). When operating with synchronous modulation, the current peak value dynamically decreases when the output frequency increases.
Manually enabling/disabling that function can be done only when using the **IFD** control with current limit parameters **C043/C044/C045**.
When using the **VTC** or **FOC** control, the system will automatically handle the maximum current value that can be used also based on the torque limit configured with **C047/C048/C049**.

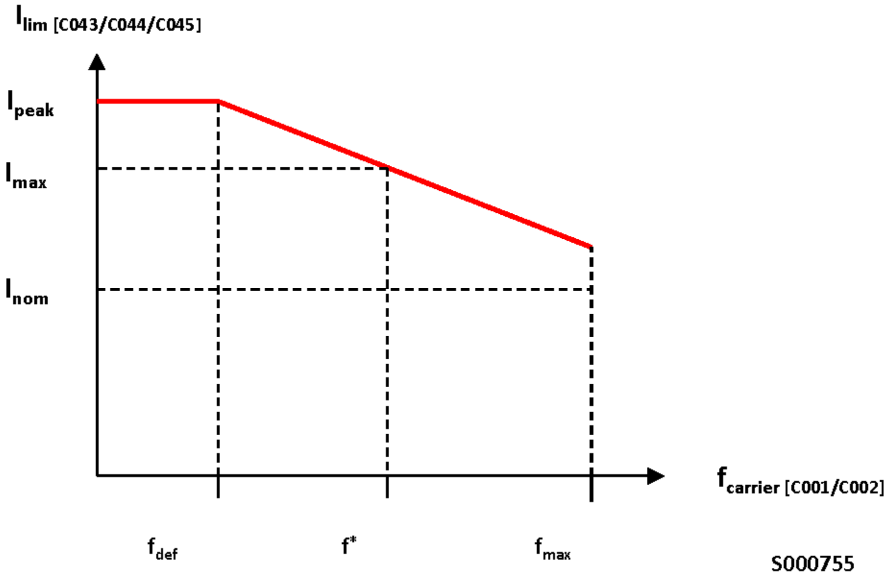


Figure 50: Current limit reduction based on carrier frequency: models with Ipeak

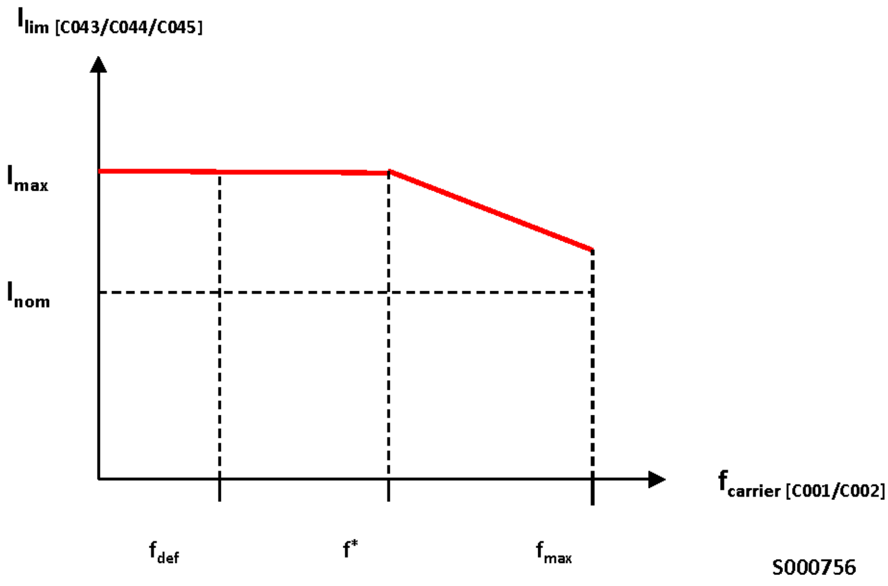


Figure 51: Current limit reduction based on carrier frequency: models without Ipeak

f_{def}: default carrier frequency
f*: maximum carrier frequency to obtain Imax
f_{max}: maximum programmable carrier frequency

CAUTION

The pictures above show the Imax/Ipeak current limit based on carrier frequency.
Please refer to the Sinus Penta's Installation Guide for the maximum carrier values recommended based on Inom rated current.

35.2. List of Parameters C043 to C135

Table 89: List of Parameters C043 to C135

Parameter		FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C043	**M1**	Current limit while accelerating	BASIC	1043	150%
C086	**M2**		ENGINEERING	1086	
C129	**M3**			1129	
C044	**M1**	Current limit at constant rpm	BASIC	1044	150%
C087	**M2**		ENGINEERING	1087	
C130	**M3**			1130	
C045	**M1**	Current limit while decelerating	BASIC	1045	See Table 82 and Table 86
C088	**M2**		ENGINEERING	1088	
C131	**M3**			1131	
C046	**M1**	Current limit decrease in field weakening	ADVANCED	1046	0: Disabled
C089	**M2**		ENGINEERING	1089	
C132	**M3**			1132	
C047	**M1**	Minimum Limit torque Motor	ADVANCED	1047	0.0%
C090	**M2**		ENGINEERING	1090	
C133	**M3**			1133	
C048	**M1**	Maximum Limit torque Motor	BASIC	1048	120.0%
C091	**M2**		ENGINEERING	1091	
C134	**M3**			1134	
C049	**M1**	Maximum Limit torque Brake	BASIC	1068	120.0%
C092	**M2**		ENGINEERING	1092	
C135	**M3**			1135	
C050	**M1**	Frequency decrease during acceleration limit	ADVANCED	1050	0: Enabled
C093	**M2**		ENGINEERING	1093	
C136	**M3**			1136	

C043 (C086, C129) Current Limit While accelerating

C043 (Motor 1) **C086 (Motor 2)** **C129 (Motor 3)**	**Range**	0 ÷ 400 (*)	0: Disabled 1.0% ÷ minimum between Ipeak/Imot and 400%
	Default	150	150%
	Level	BASIC (**C043**); ENGINEERING (**C086**, **C129**)	
	Address	1043, 1086, 1129	
	Control	IFD	
	Function	This parameter defines the current limit while accelerating; it is expressed as a percentage of the rated current of the selected motor. No limit is applied if this parameter is set to 0: Disabled.	

(*) *The maximum allowable value depends on the drive model.*

C044 (C087, C130) Current Limit at Constant Rpm

C044 (Motor 1) **C087 (Motor 2)** **C130 (Motor 3)**	**Range**	0 ÷ 400 (*)	0: Disabled 1.0% ÷ minimum between Ipeak/Imot and 400%
	Default	150	150%
	Level	BASIC (**C044**); ENGINEERING (**C087**, **C130**)	
	Address	1044, 1087, 1130	
	Control	IFD	
	Function	This parameter defines the current limit at constant rpm; it is expressed as a percentage of the rated current of the selected motor. No limit is applied if this parameter is set to 0: Disabled.	

(*) *The maximum allowable value depends on the drive model.*

C045 (C088, C131) Current Limit while Decelerating

C045 (Motor 1) **C088 (Motor 2)** **C131 (Motor 3)**	**Range**	0 ÷ 400 (*)	0: Disabled 1.0% ÷ minimum between Ipeak/Imot and 400%
	Default	See Table 82 and Table 86	
	Level	BASIC (**C045**); ENGINEERING (**C088**, **C131**)	
	Address	1045, 1088, 1131	
	Control	IFD	
	Function	This parameter defines the current limit while decelerating; it is expressed as a percentage of the rated current of the selected motor. No limit is applied if this parameter is set to 0: Disabled.	

(*) *The maximum allowable value depends on the drive model.*

C046 (C089, C132) Current Limit Decrease in Field weakening

C046 (Motor 1) **C089 (Motor 2)** **C132 (Motor 3)**	**Range**	0 ÷ 1	0: Disabled 1: Enabled
	Default	0	0: Disabled
	Level	ADVANCED (**C046**); ENGINEERING (**C089**, **C132**)	
	Address	1046, 1089, 1132	
	Control	IFD	
	Function	This parameter enables the current limit decrease function in field weakening. The current limit is multiplied by the ratio between the motor rated torque and the frequency forced to the drive: limit = current limit being used * (Fmot/ Fout).	

C047 (C090, C133) Minimum Limit torque Motor

C047 (Motor 1) **C090 (Motor 2)** **C133 (Motor 3)**	**Range**	–5000 ÷ 5000	–500.0% ÷ +500.0%
	Default	0	0.0%
	Level	ADVANCED (**C047**); ENGINEERING (**C090**, **C133**)	
	Address	1047, 1090, 1133	
	Control	VTC and FOC	
	Function	This parameter sets the min. limit of the torque demanded by the control being used. Torque is expressed as a percentage of the rated torque of the selected motor. It is active only if **C011** (**C054** / **C097**) is set to torque control.	

NOTE

If an external torque limit is set (**C147** in the CONTROL METHOD MENU), the values set in the parameters above represent the range of the source used for limitation; they can be reduced by adjusting the external source; the torque ramp times set in the RAMPS MENU will be applied to the preset limit torque reference (**P026–P027**).

C048 (C091, C134) Maximum Limit torque Motor

C048 (Motor 1) **C091 (Motor 2)** **C134 (Motor 3)**	**Range**	–5000 ÷ 5000 / 0 ÷ 5000	–500.0% ÷ +500.0% / 0 ÷ +500.0%
	Default	1200	120.0%
	Level	BASIC (**C048**); ENGINEERING (**C091**, **C134**)	
	Address	1048, 1091, 1134	
	Control	VTC and FOC	
	Function	This parameter sets the max. limit of the torque demanded by the control being used. Torque is expressed as a percentage of the rated torque of the selected motor. If **C011** (**C054** / **C097**) is set to torque control, its range is between + and – 500% and it works together with **C047** for the overall calculation of the settable limit. If **C011** (**C054** / **C097**) is set to speed control, its range is between 0 and +500% and it acts as a motor torque limit when the motor is working in the 1st or 3rd quadrant (motor operation).	

C049 (C092, C135) Maximum Limit torque Brake

C049 (Motor 1) **C092 (Motor 2)** **C135 (Motor 3)**	**Range**	0 ÷ 5000	0 ÷ +500.0%
	Default	1200	120.0%
	Level	BASIC (**C049**); ENGINEERING (**C092**, **C135**)	
	Address	1068, 1092, 1135	
	Control	VTC e FOC	
	Function	It acts as a motor torque limit when the motor is working in the 2nd or 4th quadrant (brake operation). Torque is expressed as a percentage of the rated torque of the selected motor. It is active only if **C011** (**C054** / **C097**) is set to speed control.	

NOTE

If an external torque limit is set (**C147** in the CONTROL METHOD MENU), the values set in the parameters above represent the range of the source used for limitation; in addition, the torque ramp times set in the RAMPS MENU will be applied to the preset limit torque reference (**P026–P027**).

C050 (C093, C136) Frequency Decrease during Acceleration Limit

C050 (Motor 1) C093 (Motor 2) C136 (Motor 3)	**Range**	0 ÷ 1	0: Enabled 1: Disabled
	Default	0	0: Enabled
	Level	ADVANCED (**C050**); ENGINEERING (**C093**, **C136**)	
	Address	1050, 1093, 1136	
	Control	IFD	
	Function	This parameter enables output frequency decrease during acceleration limit.	

NOTE Setting “1:Disabled” is recommended for high inertia loads. When high inertia loads are connected to the drive, the frequency decrease can lead to strong regeneration and DC-bus voltage oscillations.

36. CONTROL METHOD MENU

36.1. Overview

NOTE Please refer to the Sinus Penta's Installation Guide for the hardware description of digital inputs (COMMANDS) and analog inputs (REFERENCES).
See also the INPUTS FOR REFERENCES MENU and the DIGITAL INPUTS MENU.

The drive is factory set to receive digital commands via the terminal board; the main speed reference is sent from the REF analog input, and no external limit for torque limitation is enabled.

The parameters in this menu allow selecting the following:

- The source of the **drive commands** (digital inputs) from **three signal sources** (through parameters **C140, C141, C142**) which are logically matched so as to obtain an active **M031** command set. For each of these 3 **parameters** you can select the source of the command signals from **4 different sources**;
- The source of the **speed reference** (or torque reference) from **4 different sources** (that can be selected with parameters **C143, C144, C145, C146)** that **can be summed up together.**

For each of these **4 parameters**, you can select the source of the reference signals from **9 different sources**;

- The source of the **torque / speed limit** reference (through parameter **C147**, allowing selecting the reference source from **9 different sources**).

Therefore, you can select and enable different **command sources** (hardware or virtual sources), different speed (or torque) **references** (hardware or virtual sources) and enable an external torque **limit**.
The drive **commands** may be sent from:

- The hardware terminal board (terminal board on the control board), which is logically separated into terminal board A and terminal board B;
- The keypad;
- The virtual remote terminal board: through serial link with MODBUS communications protocol;
- The virtual remote terminal board: through Fieldbus (optional board).

Multiple terminal boards may also be enabled (up to 3 terminal boards with parameters **C140, C141, C142**); in this case, the drive will apply logic functions **OR** or **AND** to the different terminals to obtain the activated terminal board (see Command Sources).

The following **references** and torque limit signals may be sent:

- Three analog inputs acquired to the hardware terminal board (REF, AIN1, AIN2), plus two analog inputs (XAIN4, XAIN5) acquired to the hardware terminal board located on ES847 optional board;
- FIN frequency input;
- Encoder input;
- Keypad;
- Serial link with MODBUS communications protocol;
- Fieldbus (optional board);
- Up/Down from MDI (Up and Down digital inputs).

Multiple reference sources may be enabled at the same time (up to 4 reference sources with parameters **C143, C144, C145, C146**); in this case, the drive will consider the sum of all active reference as the main reference.

Finally, a dynamic selection between two command sources and two reference sources is allowed when using the digital input configured as Source Selection (see **C179**); otherwise, the inputs configured as Command Selection and Reference Selection (**C179a** and **C179b**) can be used.

36.1.1. Command Sources

The drive commands may be sent from the following sources:

0: Disabled
1: Terminal board A
2: Serial link (with MODBUS protocol)
3: Fieldbus (fieldbus on optional board)
4: Terminal board B
5: Keypad (remotable display/keypad)

The factory-setting enables only Terminal Board A (**C140**=1 and **C141**=1) as a command source (see also the DIGITAL INPUTS MENU). Both Terminal board A and B refer to the same terminal board located on the control board, but allow switching between one set of START, STOP, REVERSE commands sent to three terminals to a different set of commands sent to three different terminals.

Most commands may be delayed (when enabled or disabled): refer to the TIMERS MENU.

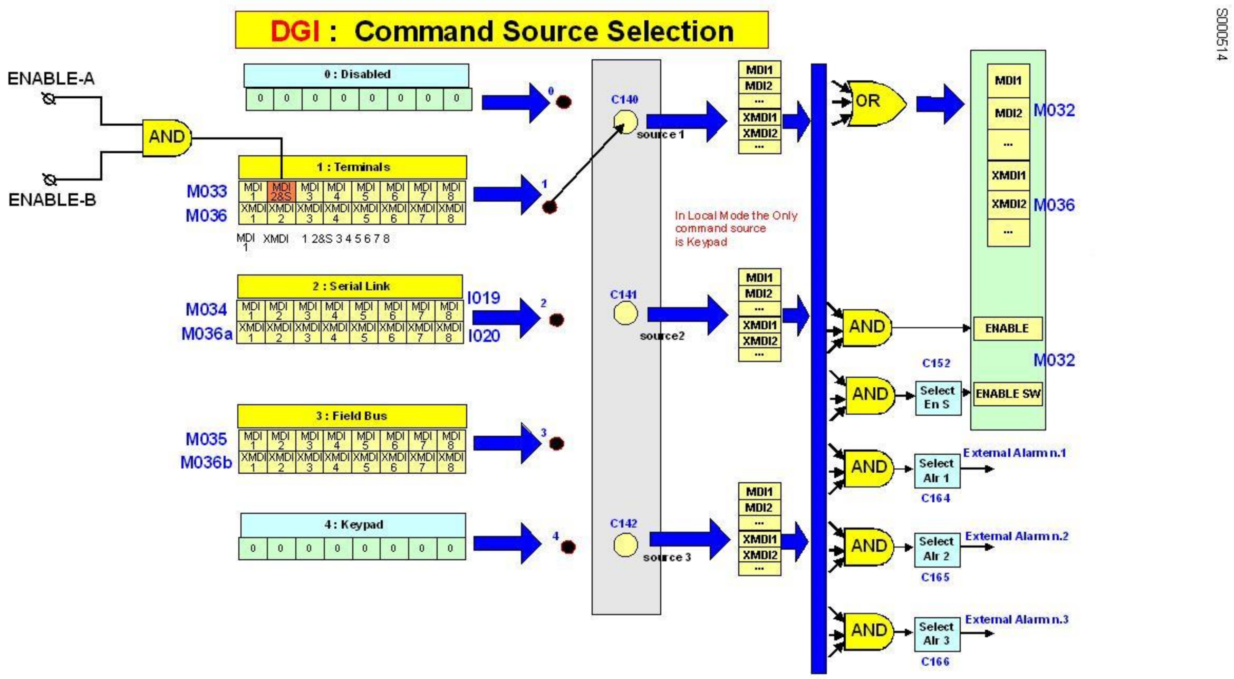


Figure 52: Selecting the command sources

If the keypad is not selected as a command source or, when the keypad is selected, if the the **STOP** input function is also enabled (**C150**≠0), more than one command source may be enabled at a time by programming parameters **C140**, **C141**, **C142** accordingly. The logic function for the different command sources is as follows:

Source programmed in:	Enable Conditions:	
	If: **C179** (Source Selection) = 0: Disable and (logic AND) **C179a** (Command Selection) = 0: Disable	If: **C179** = MDIx input or (logic OR) **C179a** = MDIx input
C140	Always active	Active if MDIx = 0
C141	Always active	Active if MDIx = 1
C142	Always active	Always active

Table 90: Enable conditions of the command sources

- **AND** for the terminals allocated to the **ENABLE** functions (**MDI2&S inputs** on physical terminals**, MDI2** via serial command or fieldbus), **ENABLE-SW, External Alarms n.1, n.2, n.3**.
- **OR** for all other terminals**.**

NOTE If the keypad is enabled as a command source, the **START**, **STOP**, **RESET**, **LOC/REM, FWD/REV** functions are enabled (to disable **LOC/REM** and **FWD/REV** see parameter **P269**). The keypad is ignored for the processing of logic functions (AND/OR) of the other command sources that are enabled at that moment.

NOTE As the **ENABLE-A** and **ENABLE-B** commands of the **<u>physical terminal board</u>** are a hardware safety device (they enable the drive) they are always active, even when none of parameters **C140, C141** or **C142** selects the terminal board (=1).
If the STO function is to be adopted, the control mode and the control circuit of these signals must be accomplished as per the Safe Torque Off Function - Application Manual**.**
That manual also includes a detailed validation procedure of the control configuration of the STO function to be executed upon first start-up and also periodically at yearly intervals.

NOTE The commands for the **External Alarm n.1, n.2, n.3** functions are always considered for the drive terminal board only**.**

NOTE The ***LOCAL mode,*** that can be enabled with the **LOC/REM** key from the keypad or with the **LOCAL** command function from the terminal board (see **C180**), forces the keypad as the only command source, thus ignoring the values set in parameters **C140**, **C141**, **C142**.
In this case, the following functions remain enabled on the hardware terminal board: **External Alarm n.,1 n.2, n.3 (C164, C165, C166)**, **Motor Sel. n.2 (C173)**, **Motor Sel. n.3 (C174)**, **SLAVE (C170)**, **Source Selection (C179**, **C179a**, **C179b), LOCAL (C180)** and the **ENABLE-A** and **ENABLE-B** functions, always enabled on terminals **MDI2** and **S**.
The **ENABLE-SW** and **DISABLE** functions are enabled in LOCAL mode if at least one of parameters **C140**, **C141**, **C142** is set to 1 (terminal board).

NOTE If **C179** (Source Selection) and **C179a** (Command Selection) are disabled, it is not possible to enable the Source Keypad together with a different source for **C140** e **C141**. This is to avoid conflicts in managing the Start and Stop inputs on the terminals (or other sources) or on the keypad.
However, there is one exception: if the Stop function is enabled programming **C150**, the conflict can be solved because terminal inputs can be managed through the keypad.

NOTE If **C140** or **C141** are enabled through the terminals, it is not possible to enable the Source Keypad for **C142,** irrespective of the settings for **C179**/**C179a**. This is because **C142** is always considered OR and, again, it may cause conflicts in the management through terminals or keypad.
Also in this case, it is possible to enable **C142** through the keypad by programming **C150**.

Table 91: Remote command inputs from serial link

MODBUS Address	Input Code	User Level	Description	Range
1406	**I019**	BASIC	Remote, virtual terminal board from serial link	Bit input: 0÷1 for 8 bits corresponding to MDI1÷ MDI8
1407	**I020**	BASIC	Auxiliary, virtual terminal board from serial link	Bit input: 0÷1 for 8 bits corresponding to XMDI1÷ XMDI8

Example:

If **C140** = 3 (Fieldbus) and **C141** = 2 (Serial link), the **ENABLE** command is sent by closing terminals **ENABLE-A** and **ENABLE-B** on the <u>terminal board</u> and (AND) by forcing bit **MDI2** from the <u>serial link</u> on input **I019** (MODBUS address: 1406) **and** bit **MDI2** from <u>Fieldbus</u> (see the FIELDBUS CONFIGURATION MENU).
The **START** command may also be sent (OR) by forcing bit **MDI1** from <u>serial link</u> on input **I019 or** by forcing bit **MDI1** from <u>Fieldbus</u> for the relevant variable.

36.1.2. SPEED/TORQUE REFERENCE SOURCES

The "**main reference**" is the value at constant speed to be attained by the controlled variable (speed or torque) (**M000**, **M007**) "required" from the drive.
This reference is acquired by the drive only if the **START** command and the **ENABLE-A** and **ENABLE-B** commands are active; otherwise, it is ignored.
When the main reference is acquired by the drive (**START**, **ENABLE-A** and **ENABLE-B** are active), it becomes the input signal controlled by the "time ramp" functions that generate the speed/torque reference setpoint for the connected motor.

The speed or torque references may come from the following command sources:

- **Source disabled;**
- **REF** (*single–ended analog input from terminal board*);
- **AIN1** (*differential analog input from terminal board*);
- **AIN2** (*differential analog input from terminal board*);
- **FIN** (*frequency input from terminal board; see also the ENCODER/FREQUENCY INPUTS MENU);*
- **Serial link** (*with MODBUS protocol*);
- **Fieldbus** (*fieldbus in optional board*);
- **Keypad** (*remotable display/keypad*);
- **Encoder** (*in terminal board MDI6–ECHA, MDI7–ECHB or optional board*);
- **Up Down from MDI** *(Up/down from digital inputs, see **C161** and **C162**)*
- **XAIN4** (*auxiliary, differential voltage analog input from ES847 terminal board)*
- **XAIN5** (*auxiliary, differential current analog input from ES847 terminal board)*

The activation logic function for the different reference sources is as follows:

Source programmed in:	Enable conditions:	
	If: **C179** (Source Selection) = 0: Disable and (logic AND) **C179b** (Reference Selection) = 0: Disable	If: **C179** = MDIx input or (logic OR) **C179b** = MDIx input
C143	Always active	Active if MDIx = 0
C144	Always active	Active if MDIx = 1
C145	Always active	Always active
C146	Always active	Always active

Table 92: Enable conditions of the reference sources

As per factory-setting, only one source is enabled (**C143**=1, **C144**=2, **C145**=0 and **C146**=0). Because the digital input for source selection is programmed (**C179=6: MDI6**, see Digital Inputs Menu), if this input is inactive, only the REF item is selected (please refer to the INPUTS FOR REFERENCES MENU).
If multiple reference sources are enabled, by programming also **C144**, **C145**, or **C146**, the actual calculated reference is **the algebraic sum of all the active references** (see How to Manage the Reference Sources).

REF, AIN1 and AIN2

The sources called REF, AIN1 and AIN2 come from the analog inputs in the terminal board and generate a reference resulting from the setting of the relevant parameters (from **P050** to **P064**). See the INPUTS FOR REFERENCES MENU for the scaling, offset compensation and filtering of the reference obtained. The inputs may be used as voltage or current inputs depending on the setting and the position of the relevant DIP-switches (see the Sinus Penta's Installation Guide).

FIN

The ***FIN*** source is a frequency input on terminal **MDI6 (FINA)** or **MD18 (FINB)** and it generates a reference determined by the setting of the relevant parameters (from **P071** to **P072**), allowing proper scaling (see the INPUTS FOR REFERENCES MENU and the ENCODER/FREQUENCY INPUTS MENU).

SERIAL LINK

The ***Serial Link*** source is an input located on the MODBUS link: the reference value must be written by the user to the addresses below:

Table 93: Reference inputs from serial link

MODBUS Address	Input Code	User Level	Reference	Description	Range	Unit of measure
1412	**I025**	BASIC	Speed	Speed reference/limit (integer portion)	Min. speed ÷ Max. speed	RPM
1413	**I026**	BASIC	Speed	Speed reference/limit (decimal portion)	–99 ÷ 99	RPM/100
1416	**I029**	BASIC	Torque	Torque reference/limit	Min. torque ÷ Max. torque	Tenths %

NOTE

I025 is

- the speed reference if at least one among parameters **C143**..**146** is set to 5:Serial Link and the type of reference of the active motor (parameters **C011** / **C054** / **C097**) is set to 0:Speed;
- the speed limit if **C147**=5:Serial Link and the type of reference of the active motor is set to 2:Torque with Speed Limit.

The range of this reference depends on the active Minimum Speed value and Maximum Speed value as set in parameters **C028** and **C029** (for motor 1, and relevant parameters for motor 2 and motor 3).
If **C029** ≤ **C028**, then **Min. speed** = **C029**, **Max. speed** = **C028**.
If **C029** ≥ **C028**, then **Min. speed** = **C028**, **Max. speed** = **C029**.

NOTE

I026 is the decimal portion of the speed reference in RPM and has effect in **FOC** motor control mode only.

NOTE

I029 is

- the torque reference if at least one among parameters **C143**..**146** is set to 5:Serial Link and the type of reference of the active motor (parameters **C011** / **C054** / **C097**) is set to 1:Torque or 2:Torque with Speed Limit;
- The torque limit if **C147**=5:Serial Link.

I029 is expressed as a percentage of the rated motor torque.
Reference range:
If **C047** ≤ **C048**, then **Min. torque** = **C047**, **Max. torque = C048**.
If **C047** ≥ **C048**, then **Min. torque** = **C048**, **Max. torque** = **C047**.
In case of torque limit, its minimum value is internally set =0 if the minimum torque limit is <0.

FIELDBUS

For a description of the **Fieldbus** source, see the FIELDBUS CONFIGURATION MENU.

KEYPAD

NOTE

The keypad is a special reference source. The keypad reference may be changed with the ▲ and ▼ keys only if this reference is on a Keypad page displaying a reference in line 4.
If the keypad is enabled, a **variation** to the active reference may be added through an algebraic sum (calculated by processing the other reference sources that are activated at that moment).
The reference variation method can be selected with parameters **P067**, **P068**, **P069**, and **C163**.
This function is the same as the **UP** and **DOWN** functions from the terminal board (see the DIGITAL INPUTS MENU**: C161** and **C162 and P068÷P069** in the INPUTS FOR REFERENCES MENU).

NOTE

The ***LOCAL mode,*** that can be enabled with the **LOC/REM** key on the keypad or with the **LOCAL** command function from terminal board (see **C180**), forces the keypad to become the only command and reference source, thus ignoring the values set in parameters **C143**, **C144**, **C145, C146**.

ENCODER

The ***Encoder*** source is an encoder input: it can come from the terminal board (terminals **MDI6**, **MDI7**) in Encoder A, or from the optional Encoder B board (see the ENCODER/FREQUENCY INPUTS MENU). It generates a reference resulting from the correct setting of the relevant parameters (**P073**, **P074**), allowing the relevant scaling (see the INPUTS FOR REFERENCES MENU).

UP/DOWN from digital inputs

To enable the **UP/DOWN from digital inputs** also set the relevant Up and Down inputs (see the DIGITAL INPUTS MENU).

XAIN4 and XAIN5

XAIN4 and XAIN5 come from the analog inputs in the terminal board of ES847 and generate a reference determined by the settings of the relevant parameters (**P390** to **P399**), allowing proper scaling, offset compensation and filtering (see the INPUTS FOR REFERENCES FROM OPTIONAL BOARD).

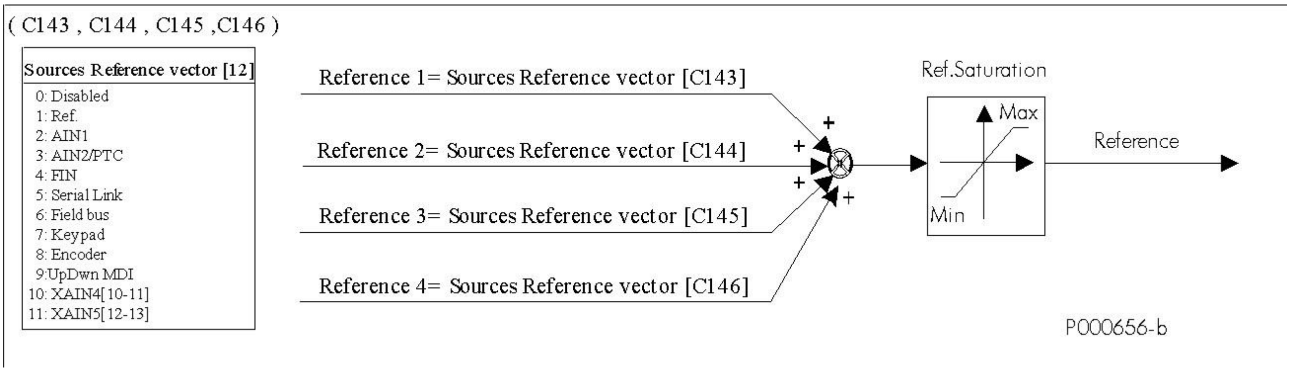


Figure 53: Selecting the source references

36.1.3. ALTERNATIVE COMMAND AND REFERENCE SOURCES

A digital input can be set as a selector between 2 alternative command and reference sources.

Example:

C179 MDI To select sources = **MDI6**
C140 To select command source number 1 = **Keypad**
C141 To select command source number 2 = **Fieldbus**
C143 To select reference source number 1 = **AIN1**
C144 To select reference source number 2 = **Fieldbus**

If **MD16** (in the drive terminal board) set as a selector is open, the drive will consider number 1 as reference and command sources (that is **C140 = Keypad** and **C143 = AIN1**); if it is closed, number 2 will be considered (**C141 = Fieldbus** and **C144 = Fieldbus**). See also How to Manage the Reference Sources.

If references sources 3 and 4 (**C145 and C146**) are not set to Disable, the reference sent for these sources shall be a sum of the source selected by MD16 vector.

Please refer to **C179** in the DIGITAL INPUTS MENU**.**

36.1.4. TORQUE LIMIT SOURCE

The source of the Torque Limit can be selected with parameter **C147**.
The Torque limit function is a limit of the absolute value of the torque required from the drive.
(– Torque limit) <= torque <= (+ Torque limit)

The torque limit references may be selected from the following:

0. **Source disabled**
1. **REF** (*single–ended analog input from terminal board*);
2. **AIN1** (*differential analog input from terminal board*);
3. **AIN2** (*differential analog input from terminal board; see also the ENCODER/FREQUENCY INPUTS MENU);*
4. **FIN** (*frequency input from terminal board*);
5. **Serial link** (*with MODBUS protocol*);
6. **Fieldbus** (*fieldbus on optional board*);
7. **Keypad** (*remotable display/keypad*);
8. **Encoder** (*in terminal board MDI6–ECHA , MDI7–ECHB or optional board*);
9. **Up Down from MDI** *(Up/down from digital inputs, see **C161 and C162***)
10. **XAIN4** (*auxiliary, differential voltage analog input from ES847 terminal board)*
11. **XAIN5** (*auxiliary, differential current analog input from ES847 terminal board)*

NOTE

If the reference source is disabled, the torque limit results from the max. absolute torque determined by the drive size and the motor size.
In speed control, the maximum motoring torque is given by **C048** only, while the maximum braking torque is given by **C049** only (for motor 1 and by similar parameters for motors 2 and 3).
In torque control, the max. absolute torque is the max. value ranging between the absolute values of **C047** and **C048** (motor 1, and relevant parameters for motor 2 and motor 3).
Max. absolute torque = Max(| **C047** |, | **C048** |)

Factory setting is **C147**=0: the reference source is disabled and the torque limit is given by the max. absolute torque.

36.1.5. REMOTE/LOCAL MODE

According to factory-setting, switching over from the **Remote** mode to the **Local** mode can only be made when the drive is disabled. The reference and command sources for the **Remote** mode depend on the settings of parameters **C140** to **C147** in the CONTROL METHOD MENU and on the settings of parameters **C285** to **C287** in the PID CONFIGURATION MENU. When switching over from the Remote mode to the Local mode, the command and reference can be sent via keypad only. This is true for the switch over from the **Local** to the **Remote** mode as well.
Parameter **C148** allows customizing the Loc/Rem function so that it can be performed even when the drive is running. Parameter **C148** also allows setting whether the same running condition and the same reference must be maintained when switching over from the Remote to the Local mode.

NOTE

For more details on the Loc/Rem function, see LOC/REM Key (Keypad Pages) and DIGITAL INPUTS MENU**.**

36.2. How to Manage the Reference Sources

This section covers how to manage the reference sources.
Two examples are given along with the table including the configuration of the parameters to be used.

Example 1: The Speed Reference is the algebraic sum of two references
Analog inputs REF and AIN1 (that are supposed to be 0-10V voltage inputs) are to be used as speed references. The main reference will be the sum of the two references being used. The end result may vary based on the parameters concerned.

P050	Type of Reference for REF Input	3: 0-10V
P051	Value of REF Input producing Min. Reference	0.0V
P051a	Percentage of Ref_Min producing Min. Reference	100.0%
P052	Value of REF Input producing Max. Reference	10.0V
P052a	Percentage of Ref_Max producing Max. Reference	100.0%
P055	Type of Signal over AIN1 input	3: 0-10V
P056	Value of AIN1 Input producing Min. Reference	0.0V
P056a	Percentage of Ref_Min producing Min. Reference	100.0%
P057	Value of AIN1 input producing Max. Reference	10.0V
P057a	Percentage of Ref_Max producing Max. Reference	100.0%
C028	Min. Motor Speed	0rpm
C029	Max. Motor Speed	1500rpm
C143	Selection of Reference 1	1: REF
C144	Selection of Reference 2	2: AIN1
C179	MDI for Source Selection	0: Disable

C179=0: Disable ensures that the main reference is the sum of the references being used. If a digital input for Source selection were used, either one reference would be selected as the main reference based on the input status.
Both REF and AIN1 references are programmed in order to meet the following requirements:

- at 0V, they are expected to generate 100% of the minimum motor speed reference (**C028**), i.e. 0rpm
- at 10V, they are expected to generate 100% of the maximum motor speed reference (**C029**), i.e. 1500rpm

The main reference will be their sum and will start from 0rpm (when both references are at 0V) and its maximum value would be 3000rpm (when both references are at 10V), but it will be limited to 1500, as set by **C029**, as soon as the sum of the two references exceeds 1500rpm.

Suppose that the parameters below are to be programmed (only the parameters changing with respect to the example above are given):

C028	Min. Motor Speed	50rpm

As the minimum motor speed is set to 50rpm, each of the two references, at 0V, will generate a reference equating 100% of 50rpm, i.e. 50rpm. The minimum value of the main reference, that is the sum of the two references, will then equating 100rpm if the two references are at 0V.
If the main reference shall start from 50rpm, that is it can generate the minimum motor speed, the following parameters shall be set accordingly:

P051a	Percentage of Ref_Min producing Min. Reference	50.0%
P056a	Percentage of Ref_Min producing Min. Reference	50.0%

In that way, either references at 0V will generate 50% of 50rpm, i.e. 25rpm. Their sum will be worth 50rpm at a minimum, as required.

If the whole resolution of the references is to be exploited, so that:

- at 0V, for both references, the minimum speed is 50rpm
- at 10V, for both references, the maximum speed is 1500rpm

then the following shall be programmed:

P052a	Percentage of Ref_Max producing Max. Reference	50.0%
P057a	Percentage of Ref_Max producing Max. Reference	50.0%

In that way, each reference will range from 25 to 750rpm and their sum will range from 50 and 1500rpm, as required.

Example 2: Speed references alternatively selected

The two REF analog inputs are to be used as alternative speed references. The following parameters shall be programmed accordingly:

P050	Type of Reference for REF Input	3: 0-10V
P051	Value of REF Input producing Min. Reference	0.0V
P051a	Percentage of Ref_Min producing Min. Reference	100.0%
P052	Value of REF Input producing Max. Reference	10.0V
P052a	Percentage of Ref_Max producing Max. Reference	100.0%
P055	Type of Signal over AIN1 input	3: 0-10V
P056	Value of AIN1 Input producing Min. Reference	0.0V
P056a	Percentage of Ref_Min producing Min. Reference	100.0%
P057	Value of AIN1 input producing Max. Reference	10.0V
P057a	Percentage of Ref_Max producing Max. Reference	100.0%
C143	Selection of Reference 1	1: REF
C144	Selection of Reference 2	2: AIN1
C179	MDI for Source Selection	6: MDI6

As MDI6 input is selected as reference source selection (**C179**), the references selected via **C143** and **C144** are selected as the main reference depending on the input status. When the input is inactive, REF will be the main reference; when the input is active, AIN1 will be the actual reference.

36.3. List of Parameters C140 to C148

Table 94: List of Parameters C140 to C148

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
C140	Command digital input 1	ADVANCED	1140	1:Terminal Board
C141	Command digital input 2	ADVANCED	1141	1:Terminal Board
C142	Command digital input 3	ENGINEERING	1142	0
C143	Reference input 1	ADVANCED	1143	1: REF
C144	Reference input 2	ADVANCED	1144	2: AIN1
C145	Reference input 3	ENGINEERING	1145	0
C146	Reference input 4	ENGINEERING	1146	0
C147	Limit input	ENGINEERING	1147	0
C148	Switch over from Remote to Local command	ENGINEERING	1148	0: StandBy or Fluxing

NOTE The programming range of parameters **C140**, **C141**, **C142** depends on the setting of parameter **C150** and vice versa (see the detailed description of the parameters above).

C140 (C141, C142) Command Source Selection 1 (2, 3)

C140 (C141, C142)	**Range**	0 ÷ 5	0: Disabled, 1: Terminal Board, 2: Serial Link, 3: Fieldbus, 4: Terminal Board B, 5: Keypad
	Default	**C140** ÷ **C141**= 1 **C142** = 0	**C140** ÷ **C141**= 1: Terminal Board **C142** = 0: Disabled
	Level	**C140** ÷ **C141** ADVANCED; **C142** ENGINEERING	
	Address	1140 (1141,1142)	
	Function	Selection of the drive command source.	

NOTE Setting one of the three command sources to 5: Keypad and one or more of the other command sources to different values from 5: Keypad is made possible only if:

1. STOP or STOP B digital inputs are set up (**C150** ≠ 0 or **C150a** ≠ 0) to enable using the pushbuttons or
2. the source selection function is selected (**C179** ≠ 0).

NOTE If the digital input for source selection or command selection (parameter **C179** and **C179a** in the Digital Inputs Menu) is set to a value other than 0: Disabled, parameter **C142** (Command Source Selection 3) is always considered as OR bit by bit to the selected source. The ENABLE input (MDI2), however, is considered as AND to the selected source.

C143 (C144, C145, C146) Reference 1 (2, 3, 4) Selection

C143 (C144, C145, C146)	**Range**	0 ÷ 9 0 ÷ 11 if ES847 is in	0: Disabled 1: REF 2: AIN1 3: AIN2 4: Frequency input 5: Serial Link 6: Fieldbus 7: Keypad 8: Encoder 9: UpDown from MDI 10: XAIN4 11: XAIN5
	Default	**C143** = 1, **C144** = 2 **C145** ÷ **C146** = 0	**C143** = 1: REF, **C144** = 2: AIN1 **C145** ÷ **C146** = 0 : Disabled
	Level	**C143** ÷ **C144** ADVANCED; **C145** ÷ **C146** ENGINEERING	
	Address	1143 (1144, 1145, 1146)	
	Function	This parameter selects the sources for the speed (or torque) reference. The reference resulting from the sum of the selected sources represents the drive speed or torque reference. If the PID action has been set as reference **C294 = Reference**, the drive speed or torque references shall only be given by the PID output and not by the sources set in **C143 ÷ C146**. Reference sources 10 and 11 can be selected only after setting XAIN in parameter **R023**.	

C147 Limit Selection

C147	**Range**	0 ÷ 9 0 ÷ 11 if ES847 is in	0: Disabled 1: REF 2: AIN1 3: AIN2 4: Frequency input 5: Serial Link 6: Fieldbus 7: Keypad 8: Encoder 9: UpDown from MDI 10: XAIN4 11: XAIN5
	Default	0	0: Disabled
	Level	ENGINEERING	
	Address	1147	
	Control	VTC and FOC if Torque Limit; FOC if Speed Limit	
	Function	If a speed control with VTC or FOC control algorithms is used, an external torque limit can be used: parameter **C147** selects the Torque Limit source. The torque ramp times set in **P026–P027** will be applied to the torque limit reference source that has been selected. The external torque limit may be disabled by closing the digital input set with **C187**. With FOC control algorithm and **C011**=[2:Torque w/Speed Limit] parameter **C147** selects the Speed Limit source which will act between the values indicated by parameters **C028** and **C029** (for motor 1 and by similar parameters for motors 2 and 3). This selection is not available with VTC control algorithm. Limiting sources 10 and 11 can be selected only after setting XAIN in parameter **R023**.	

NOTE

If the reference source is disabled, the torque limit results from the max. absolute torque determined by the drive size and the motor size.
In speed control, the maximum motoring torque is given by **C048** only, while the maximum braking torque is given by **C049** only (for motor 1 and by similar parameters for motors 2 and 3).
In torque control, the max. absolute torque is the max. value ranging between the absolute values of **C047** and **C048** (motor 1, and relevant parameters for motor 2 and motor 3).
Max. absolute torque = Max(| **C047** |, | **C048** |)

Factory-setting : the reference source is disabled (**C147**=0), so the torque limit depends on the max. absolute torque (see also the INPUTS FOR REFERENCES MENU).

C148 Switch over from Remote to Local Command

C148	**Range**	0 ÷ 3	0: StandBy + Fluxing 1: Drive Running / No Bumpless 2: Drive Running / Commands Bumpless 3: Drive Running / All Bumpless
	Default	0	0: StandBy or Fluxing
	Level	ENGINEERING	
	Address	1148	
	Function	The drive factory-setting (0: StandBy or Fluxing) allows switching over from Remote to Local mode (and vice versa) only when the drive is not running. Different settings allowed by parameter **C148** are detailed below; switching from Remote to Local mode (and vice versa) can be performed even when the drive is running: • **No Bumpless** → When switching from Remote to Local mode, a “zero”[*] speed or torque reference is sent to the drive; the **START** button must be pressed to start the drive. • **Commands Bumpless** → When switching from Remote to Local mode, a “zero”[*] speed or torque reference is sent to the drive, but the running conditions are the same as in Remote mode. For example, if the motor is running in Remote mode, the drive still runs even in Local mode and the reference can be changed with the **INC/DEC** key, starting from “zero”. • **All Bumpless** → When switching from Remote to Local mode, the drive maintains the same speed/torque reference and the same running condition as in Remote mode. For example, if the motor is running at 1000 rpm in Remote mode, the drive still runs even in Local mode with a reference of 1000 rpm that can be changed with the **INC/DEC** key, starting from “zero”. [*] Or to the smallest value compatible with **C028/C029** or **C047/C048**.	

NOTE

Parameter **C148** affects parameters **C140** to **C147** and **C285** to **C287** (see PID CONFIGURATION MENU) when the PID controller is enabled.

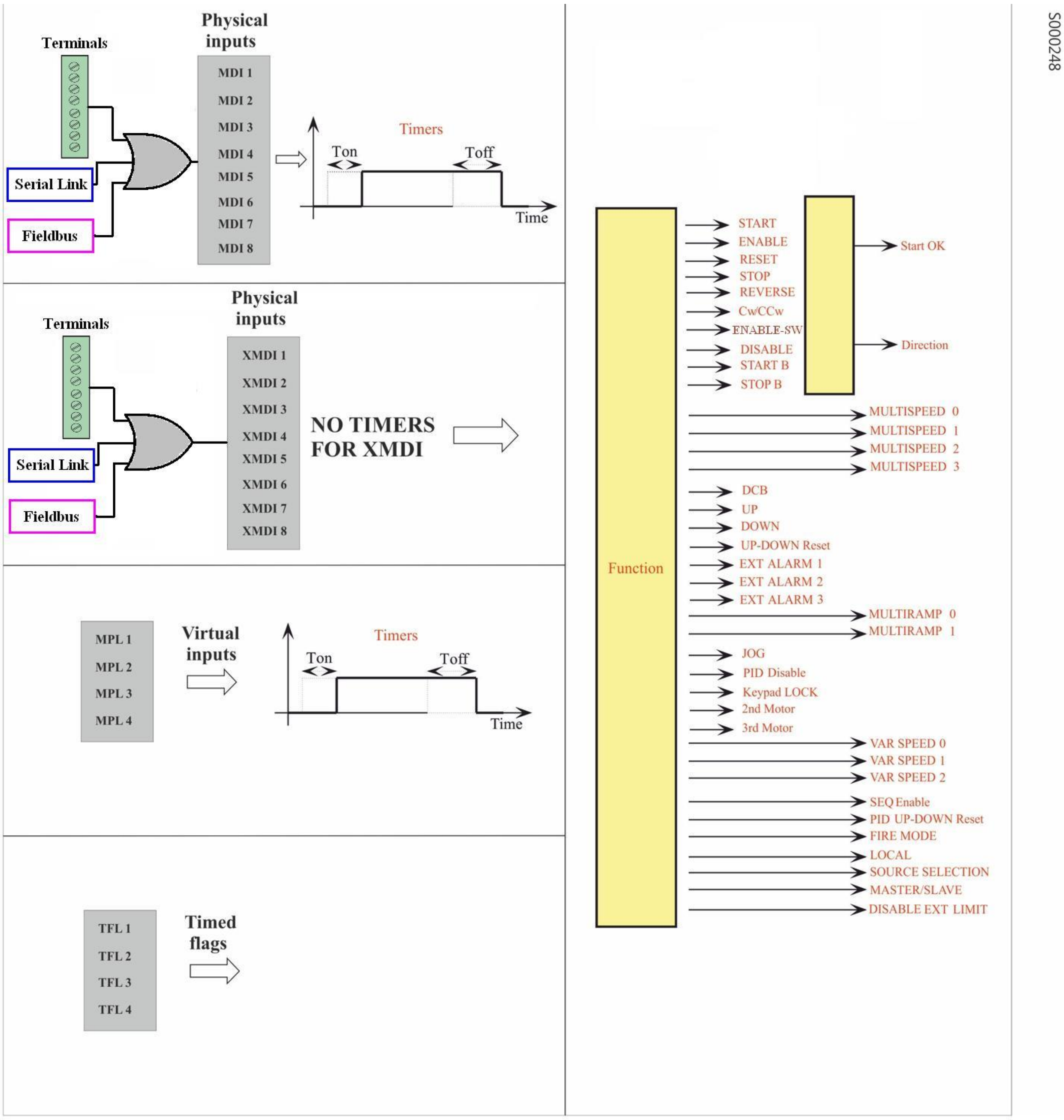
37. DIGITAL INPUTS MENU

37.1. Overview

NOTE Please refer to the Sinus Penta's Installation Guide for the hardware description of the digital inputs.

The parameters contained in this menu assign particular digital control functions to each digital input in the terminal board. Each parameter has a particular function, which is assigned to a given terminal on the terminal board.

Figure 54: Inputs that can be selected to implement control functions



The full processing of the digital inputs also includes the selection of other remote/virtual terminal boards (see the CONTROL METHOD MENU) and the possibility of delaying input digital signal enable/disable by means of software timers (see the TIMERS MENU).

The digital input status is displayed in measures **M031**, **M032**, **M033**, **M034**, **M035**.
Measure **M033** shows the **current** status of the 8 inputs in the local hardware terminals in the drive board. The input called **MDI2&S** (“**S**” on the display keypad) is active only if both physical inputs **ENABLE-A** and **ENABLE-B** are active.
The symbol □ displays the logic levels for terminals **M033** for inactive inputs; the active inputs are marked with ■.

Measures **M034** and **M035** show the tatus of the terminal boards that can be activated via serial link and fieldbus respectively.

Measure **M032** shows the **current** status of the virtual terminal board obtained by processing all active terminal boards. It includes 10 signals, with two additional signals with respect to the local hardware terminal board:

- Inputs **MDI1** to **MDI8** are obtained with the **logic OR** of the input signals for all active terminals;
- The **ENABLE** function is obtained with the logic **AND** of the input signals for terminal **MDI2&S** (physical terminal board) and terminals **MDI2** (serial link and fieldbus) in all active terminal boards, unless parameter **C154a** is active.
- The **ENABLE–SW** function is obtained with the logic **AND** of the terminals selected for this function in all active terminal boards.

Measure **M031** is similar to **M032**, but it displays the status of the terminal board obtained after delaying the input signals of M032 using special timers.
The drive uses this terminal board to acquire digital commands.

Some functions cannot be programmed, but they are assigned to special terminals:

Table 95: Unprogrammable function

Function	Terminal
ENABLE	MDI2

Some terminals in the local hardware terminal board can also be used for different functions:

Table 96: Terminals used for other inputs

Terminal	Description
MDI6	ECHA: channel A of **encoder A** in the terminal board or FINA: frequency input
MDI7	ECHB: channel B of **encoder A** in the terminal board
MDI8	FINB: frequency input

37.1.1. START

The **START** function may be assigned to a digital input (MDI1..8); to an auxiliary digital input (XMDI1..8); to a virtual auxiliary digital output (MPL1..4) or to a timed flag (TFL1..4). The input programming is set via parameter **C149**.
To enable the Start input, set the control modes via terminal board (factory setting). The **START** command can also be sent from the display/keypad. The programmed input Enable/Disable can be delayed via special timers.
The **START** input function is assigned to MDI1 terminal by default, but it can be assigned to other terminals as well. The same terminal programmed as **START** may be allocated to different functions as well.
The motor stop mode (**C185**) can be programmed. When removing the **START** command, the following motor stop modes can activate:
the motor stops following a deceleration ramp or starts idling; the motor is fluxed (VTC, FOC) only when the **START** command is shut down and the **ENABLE** is not active (**C184**).
When **START** is **active** (and when the **ENABLE** function is active as well), the **RUN** command is enabled: the speed (or torque) *setpoint* increases proportionally to the preset ramp until it reaches the active *reference*. (IFD control: in order to enable the RUN command, the main speed reference must be other than zero).
When **START** is **inactive** (also when the **ENABLE** is active), the **RUN** command is disabled: the reference is set to zero and the speed (or torque) setpoint decreases down to zero depending on the preset deceleration ramp.

NOTE

The way the **START** enables or disables the **RUN** command also depends on the setup of other functions, in particular the **STOP**, **REVERSE** and **JOG** functions (see parameters **C150**, **C151**, **C169**).
If the **REVERSE** (**C151**≠0) function is enabled, it can enable/disable the **RUN** command. However, if the **START** and **REVERSE** commands are both active, the **RUN** command is disabled.
*In this case, **START** is interpreted as FORWARD and **REVERSE** as REVERSE. When both Start and Reverse are active, the system cannot interpret the query to be FORWARD or REVERSE.*
If the **JOG** function is enabled (**C169**≠0), it can enable/disable the **RUN** command, but only if the **RUN** command has not been previously enabled by other functions.
If the **STOP** function is enabled (**C150**≠0), the **RUN** command may be enabled/disabled only by pressing the relevant "key": see the description of the **STOP** function (**C150**).

NOTE

If only the keypad is enabled as the command source, press the **START** key located on the keypad to enable the drive **RUN** and press the **STOP** key to disable the drive **RUN**.

NOTE

If **C185** = Free Wheel when removing the **START** command, the drive will not carry out the deceleration ramp and will be put on stand-by.

37.1.2. ENABLE (TERMINALS 15:MDI2 AND S)

The **ENABLE** function is assigned to terminals **ENABLE-A (MDI2)** and **ENABLE-B (S)** (the series-connection of those inputs activates the **MDI2&S** input as displayed in **M033**) and **enables the drive operation**. It cannot be set to other terminals, whereas the same terminal may be assigned to different functions.

In order to enable the drive operation:
- **ENABLE-A** and **ENABLE-B** inputs must be active. In that way, **MDI2&S** displayed in measure **M033** will be active;
- **MDI2** input must be active on all active terminal boards (serial link and fieldbus – CONTROL METHOD MENU), unless parameter **C154a** is active.

The **ENABLE** function is detailed in the figure below. The command sources programmed in parameters **C140**, **C141**, **C142** are to be considered only when activated. See Table 90.

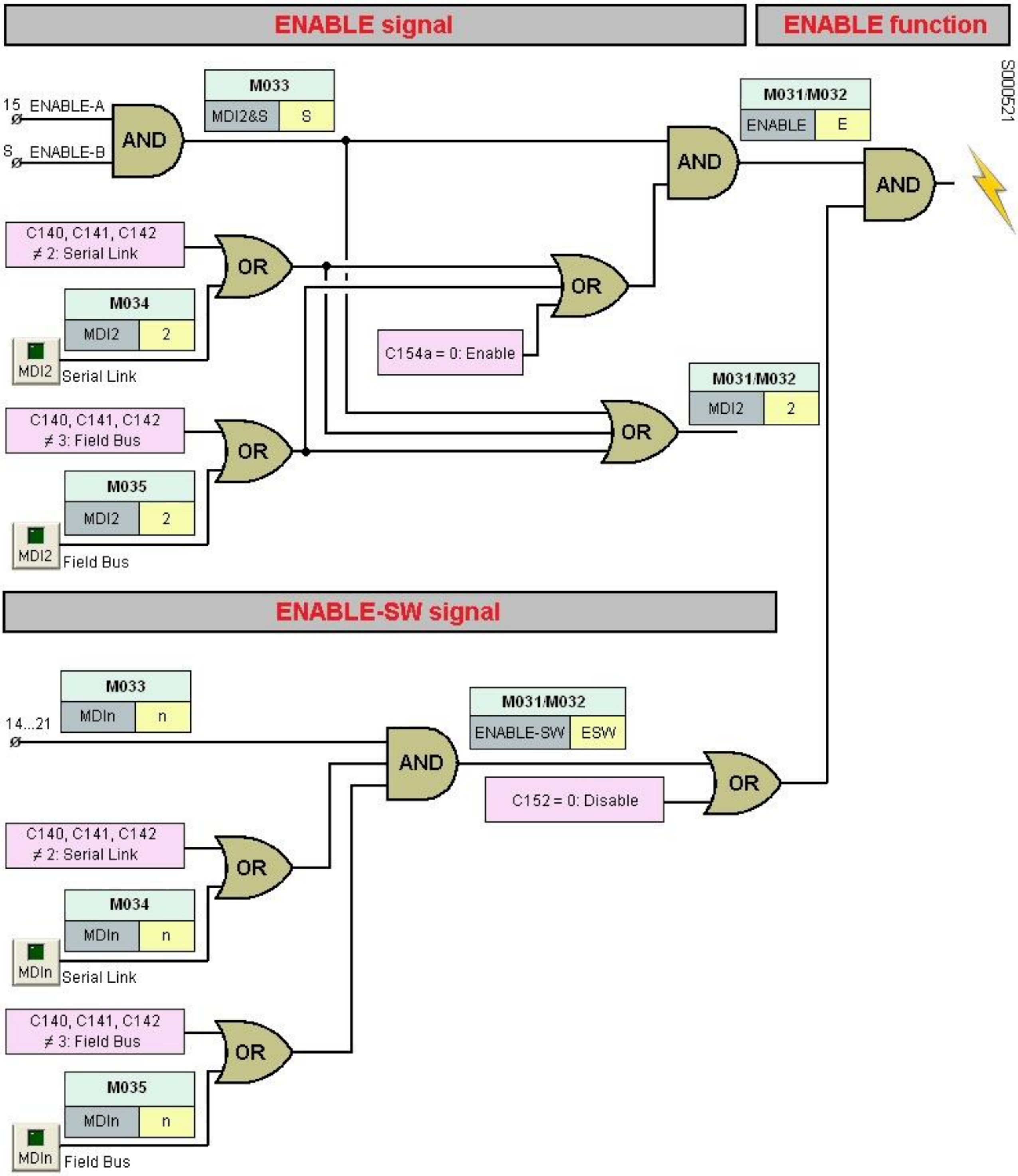


Figure 55: The ENABLE Function

NOTE

If the STO function is to be adopted, the control mode and the control circuit of the **ENABLE-A** and **ENABLE-B** signals must be accomplished as per the Safe Torque Off Function - Application Manual**.**
That manual also includes a detailed validation procedure of the control configuration of the STO function to be executed upon first start-up and also periodically at yearly intervals.

If the **ENABLE** input is disabled, the drive output voltage is always set to zero, so the connected motor starts **idling** (the motor idles and stops due to friction or the mechanical load).

In case of pulled loads (e.g. hoisting applications), when the motor is idling, the mechanical load could cause the motor to run at uncontrolled speed!

If the **ENABLE** input is disabled when the drive is controlling the motor, it is closed with a delay time depending on the drive model. This **ENABLE** delay starts from the instant when the input is disabled irrespective of the enable delay (if any) set through a software timer in **MDI2**.

The operating mode and the logic used by the **ENABLE** input to enable/disable the drive also depends on the programming of the **DISABLE** and **ENABLE-SW** functions described below.

If the **IFD** control is used, the drive enabling also depends on the **START** input and the current value of the active reference: if the **START** command is active but the reference is lower than the preset threshold, the drive operation is disabled. To enable this operating mode with other types of control, parameters **P065** and **P066** must be set accordingly.
The drive may also be disabled by the **PID** regulator (see parameter **P255)**.

DANGER!!!

The deactivation of the **ENABLE-SW** signal, the activation of the **DISABLE** signal, the deactivation of **MDI2** inputs from serial link or fieldbus DO NOT GUARANTEE that the Safe Torque Off – STO function is removed from the motor connected to the drive.
Safety stop conditions are guaranteed only when at least one of the two **ENABLE-A** and **ENABLE-B** inputs are opened.
For more details, consult the Safe Torque Off Function - Application Manual.

CAUTION

If the **MDI2** inputs are disabled for one of the active terminal boards, the drive is instantly disabled and the motor starts idling! If so, the mechanical load could cause uncontrolled acceleration/slowing down of the connected motor!

CAUTION

If the physical **ENABLE-A** or **ENABLE-B** inputs are opened, the drive is disabled and the motor starts idling! If this is the case, the mechanical load can cause uncontrolled acceleration/slowing down of the connected motor.

CAUTION

If a protection/alarm trips, the drive disables and the motor starts idling!

	NOTE	If software timers are enabled for digital inputs, the timer for the **MDI2** input delays the signal enabling. The **ENABLE** signal is always instantly disabled (*for the **ENABLE** function, Toff in **MDI2** is ignored).*
	NOTE	The activation of the **ENABLE** command enables the alarms controlling the configuration consistency of certain parameters.
	NOTE	When the **ENABLE** function is active, C parameters cannot be changed (factory-setting). If **P003** Condition required for changing C parameters = Standby+Fluxing, the parameters may be changed even if the drive is enabled but the motor is not running.
	NOTE	When the **ENABLE** function is active for VTC and FOC controls, the motor is fluxed by the drive. Motor fluxing is allowed only if the **START** contact is shut down and **C184** = Yes.
	NOTE	If set accordingly, safety parameter **C181** prevents the drive from starting if the **ENABLE** function is already active when the drive is powered on.

37.1.3. RESET

The **RESET** function is assigned to input terminal **MDI3** as factory default. It resets the alarms to unlock the drive operation.
If a protection trips, the drive locks, the **motor starts idling** (the motor idles and stops due to friction or the mechanical load) and an alarm message is displayed (see also the AUTORESET MENU and the ALARMS AND WARNINGS section).

Reset procedure
To unlock the drive, activate the **RESET** input for an instant, or press the **RESET** key from the keypad. When the drive unlocks and the cause responsible for the alarm has disappeared, “Inverter ok” comes up on the screen, otherwise, the alarm persists and cannot be reset.
If set up accordingly, safety parameter **C181** permits to deactivate and reactivate the **ENABLE** function to restart the drive once the cause responsible for the alarm has disappeared.

	NOTE	Factory setting does not reset alarms at power off. Alarms are stored and displayed at next power on and the drive is locked. A manual reset is then required to unlock the drive (see the AUTORESET MENU).
	CAUTION	If an alarm trips, see the ALARMS AND WARNINGS section and reset the equipment after detecting the cause responsible for the alarm.
	DANGER!!!	Electrical shock hazard exists on output terminals (U, V, W) and resistive braking module terminals (+, –, B) even when the drive is disabled.

37.2. Factory-setting of the Digital Inputs

Table 97: Terminal board: Factory-setting

Function	Terminal	Description
START	14: MDI1	Enables the drive RUN
ENABLE	15: MDI2&S	Enables the drive
RESET	16: MDI3	Resets the alarms tripped
MULTISPEED 0	17: MDI4	Bit 0 for Multispeed selection
MULTISPEED 1	18: MDI5	Bit 1 for Multispeed selection
Source Sel	19: MDI6	Source Selection
Loc/Rem	20: MDI7	Local / Remote Control Selection
CW/CCW	21: MDI8	Reference reversal

37.3. List of Parameters C149 to C188c and I006

The parameters ranging from **C149** to **C180** and from **C186** to **C188c** (one for each command function) activate single functions and set the terminal for each enabling/disabling function.
Parameter **C181** enables a safe **START** mode.
Parameter **C182** enables multiple programming (if compatible) to the same terminal. Max. two functions can be programmed to the same input.

Table 98: List of Parameters C149 to C188c and I006

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
I006	Function selection for MDI control	ADVANCED	1393	-
C149	START Input	ADVANCED	1149	MDI1
C149a	START Input B	ADVANCED	1297	none
C150	STOP Input	ADVANCED	1150	none
C150a	STOP B Input	ADVANCED	1298	none
C151	REVERSE Input	ADVANCED	1151	none
C151a	REVERSE B Input	ADVANCED	1299	none
C152	ENABLE-SW Input	ADVANCED	1152	none
C153	DISABLE Input	ADVANCED	1153	none
C154	RESET Alarms Input	ADVANCED	1281	MDI3
C154a	ENABLE from Terminal Board Only	ADVANCED	1154 bit 1	NO
C155	MULTISPEED 0 Input	ADVANCED	1155	MDI4
C156	MULTISPEED 1 Input	ADVANCED	1156	MDI5
C157	MULTISPEED 2 Input	ADVANCED	1157	none
C158	MULTISPEED 3 Input	ADVANCED	1158	none
C159	CW/CCW Input	ADVANCED	1159	MDI8
C160	DCB Input	ADVANCED	1160	none
C161	UP Input	ADVANCED	1161	none
C162	DOWN Input	ADVANCED	1162	none
C163	RESET UP/DOWN Input	ADVANCED	1163	none
C164	External alarm 1 Input	ADVANCED	1164	none
C164a	External alarm 1 trip delay	ADVANCED	1305	immediate
C165	External alarm 2 Input	ADVANCED	1165	none
C165a	External alarm 2 trip delay	ADVANCED	1306	immediate
C166	External alarm 3 Input	ADVANCED	1166	none
C166a	External alarm 3 trip delay	ADVANCED	1307	immediate
C167	MultiRamp 0 Input	ENGINEERING	1167	none
C168	MultiRamp 1 Input	ENGINEERING	1168	none
C169	JOG Input	ADVANCED	1169	none
C169a	Input for Selection of Speed Regulator Parameters	ADVANCED	1233	none

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
C170	SLAVE Input	ADVANCED	1170	none
C171	PID DISABLE Input	ADVANCED	1171	none
C171a	Input for PID control selection	ENGINEERING	1188	none
C172	KEYPAD LOCK Input	ADVANCED	1172	none
C173	MOTOR 2 SEL. Input	ENGINEERING	1173	none
C174	MOTOR 3 SEL. Input	ENGINEERING	1174	none
C175	SPEED VAR. 0 Input	ENGINEERING	1175	none
C176	SPEED VAR. 1 Input	ENGINEERING	1176	none
C177	SPEED VAR. 2 Input	ENGINEERING	1177	none
C178	PID RESET UP/DOWN input	ADVANCED	1178	none
C179	SOURCE SELECTION Input	ADVANCED	1179	MDI6
C179a	COMMAND SELECTION Input	ADVANCED	1238	none
C179b	REFERENCE SELECTION Input	ADVANCED	1239	none
C180	LOC/REM Input	ADVANCED	1180	MDI7
C180a	Type of LOC/REM contact	ADVANCED	1303	pushbutton+storage
C181	Safety Start enable	ADVANCED	1181	inactive
C182	Multiprogramming enable	ENGINEERING	1182	inactive
C183	Max. fluxing time before drive Disable	ADVANCED	1183	disabled
C184	Fluxing at activation only with START closed	ADVANCED	1184	no
C184a	Disable external torque limit during fluxing	ENGINEERING	1200	No
C185	Stop Mode	ADVANCED	1185	deceleration ramp
C186	Fire Mode enabling Input	ENGINEERING	1186	None
C187	Torque Limit Source Ref. Disabling Input	ADVANCED	1187	none
C187a	Multitorque 0 Input	ADVANCED	1094	None
C187b	Multitorque 1 Input	ADVANCED	1095	None
C188a	PID Multireference 1 Input	ENGINEERING	1365	none
C188b	PID Multireference 2 Input	ENGINEERING	1366	none
C188c	PID Multireference 3 Input	ENGINEERING	1367	none

NOTE If a parameter is set to zero, its function is disabled, otherwise the parameter value stands for the MDIx input assigned to the function.

NOTE Auxiliary digital inputs XMDI (values from 17 to 24 in control function parameters) can be set up only after setting XMDI/O in parameter **R023**.

CAUTION Set **C182=1** to allocate 2 functions to the same terminal**.**

I006 Function Selection for MDI Control

I006	**Range**	0 ÷ 2	0 → Inactive 1 → Clear all 2 → Set factory default
	Default	This is not a programming parameter: the input is set to zero whenever the drive is powered on and whenever the command is executed.	
	Level	ADVANCED	
	Address	1393	
	Function	0 → Inactive. 1 → Forces to “0 → Inactive” the settings of all the digital inputs. 2 → Forces to the default values the settings of all the digital inputs.	

C149 START Input

C149	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	1	MDI1
	Level	ADVANCED	
	Address	1149	
	Function	When the **START** input is **activated** (the **ENABLE-A** and **ENABLE-B** inputs are activated as well), **RUN** is enabled: the speed (torque) *setpoint* increases following the programmed ramp until it reaches the active *reference*. In IFD control mode, the main speed reference shall be other than zero for **RUN** enable. When the **START** input is **inactive** (even if the **ENABLE-A** and **ENABLE-B** inputs are activated) **RUN** is disabled: the reference is set to zero and the speed (torque) *setpoint* drops to zero based on the programmed deceleration ramp.	

NOTE If the PROFIdrive option is present, parameter **C149 START Input** must be assigned to value 1: MDI1.

C149a START B Input

C149a	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1297	
	Function	The **START B** input behaves as the **START** input (see the START section) when terminal board B is active.	

C150 STOP Input

C150	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1150	
	Function	This parameter disables the **RUN** function enabled by the **START** command. The setting of this function affects the enabling/disabling mode of the **RUN** command: it can be enabled/disabled using the **START and STOP keys** or the **START, STOP and REVERSE keys** instead of the **START** key as **an ON/OFF switch** (factory-setting). If the drive is enabled: Press **START** to enable the drive **RUN;** Press **STOP** to disable the drive **RUN**: reference is set to zero, so the speed (or torque) setpoint decreases to zero based on the preset deceleration ramp. In case of preset **STOP**, the keypad and one or more terminal boards may be enabled at a time. In this case, the ***START*** key and the ***STOP*** key in the display/keypad are active and can enable or disable the drive **RUN**. The **STOP** input is a normally closed input signal.	

NOTE According to factory setting, only the hardware terminal board selected with command source 1 (**C140**=1) is active as a switch-operated mode (**C150**=0).
To switch to the key-operated mode, set the **STOP** input (**C150** ≠0). The keypad and other terminal boards may be selected in key-operated mode only.
If the **STOP** input is not programmed, and the switch-operated mode is active, the keypad may be selected as the only command source (**C140**=5, **C141**=0, **C142** =0).

NOTE The **STOP** function has priority over the **START** function; if both inputs are active, the **STOP** input prevails. Therefore, the **STOP** input acts as a key and as a **switch**.

NOTE The START/STOP commands are ignored when the drive is disabled.

C150a STOP B Input

C150a	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1298	
	Function	The **STOP B** Input acts as the **STOP** Input (see **C150**) when Terminal Board B is active. The **STOP B** is a normally closed input signal.	

C151 REVERSE Input

C151	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1151	
	Function	The **REVERSE** function carries out a **START** command, but it reverses the motor direction of rotation. If both the **START** and **REVERSE** inputs are active at the same time, the drive is sent a STOP command. If the **STOP** input function is not programmed (**C150**=0), the **REVERSE** signal and the **START** input act as switches, otherwise they act as keys.	

NOTE

If the keypad is active, pressing the **FWD/REV** key on the display/keypad will also reverse the direction of rotation of the connected motor.
The reference direction of rotation can be reversed with **Cw/CCw** if this is set up (**C159** ≠ 0).
Both functions cause a signal reversal; if they are both active, they will cancel each other.

NOTE

The keypad and the terminal board can be simultaneously activated only if the **STOP** (**C150** ≠ 0) function is activated. Three sources for the signal reversal are then active: **REVERSE**, **Cw/CCw**, ***REV*** key; if two of them are active, they will cancel each other, while if all three sources are active, the reference sign will be reversed.

CAUTION

When the reference sign is reversed, the direction of rotation of the connected motor is not immediately reversed: the setpoint decreases to zero following the preset deceleration ramp, and it increases up to the reference value having the opposite sign following the preset acceleration ramp.

C151a REVERSE B Input

C151a	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1299	
	Function	The **REVERSE B** Input acts as the **REVERSE** Input (see **C151**) when Terminal Board B is active.	

The figure below illustrates the processing logic diagram for the **START**, **REV, Cw/CCw** functions and the ***START, STOP, REV*** keys on the display/keypad if the **STOP** function is not programmed.

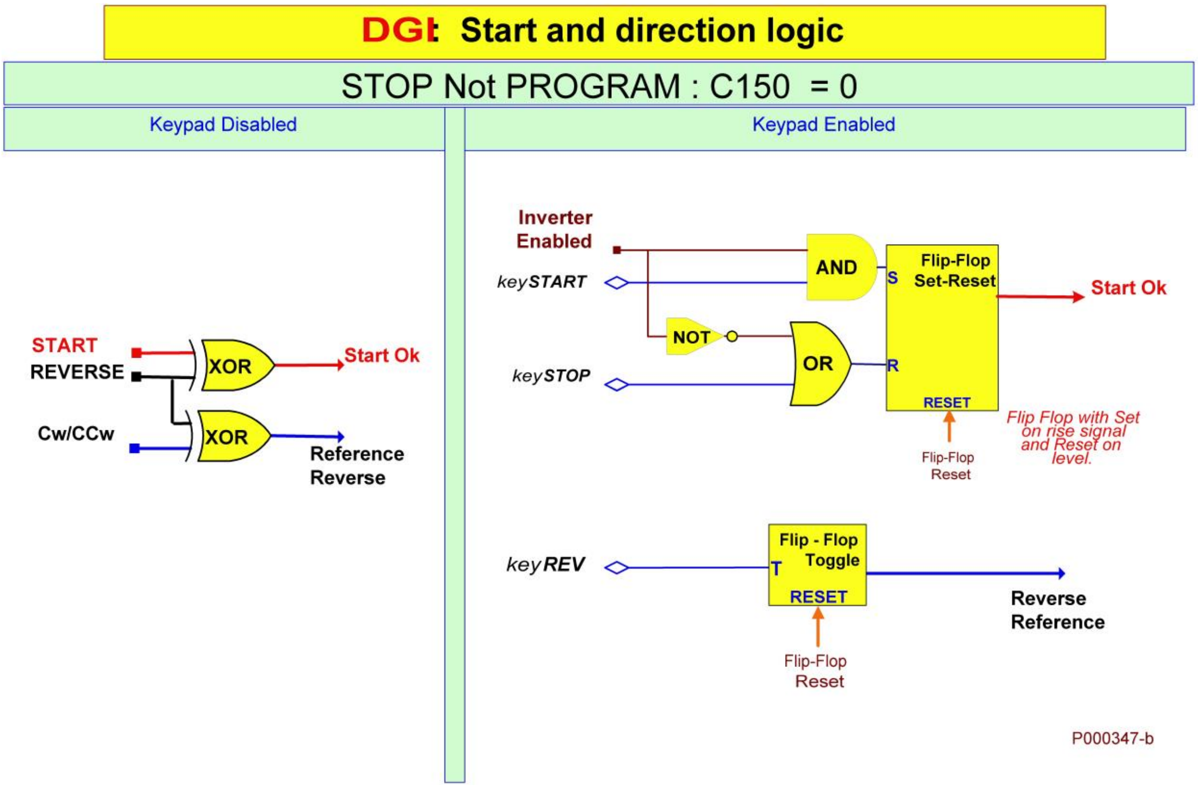


Figure 56: Controlling Run and Direction when the STOP Input is not programmed

The figure below illustrates the processing logic diagram for the **START**, **REV, Cw/CCw** functions and the ***START, STOP, REV keys*** on the display/keypad, if the **STOP** function is programmed.

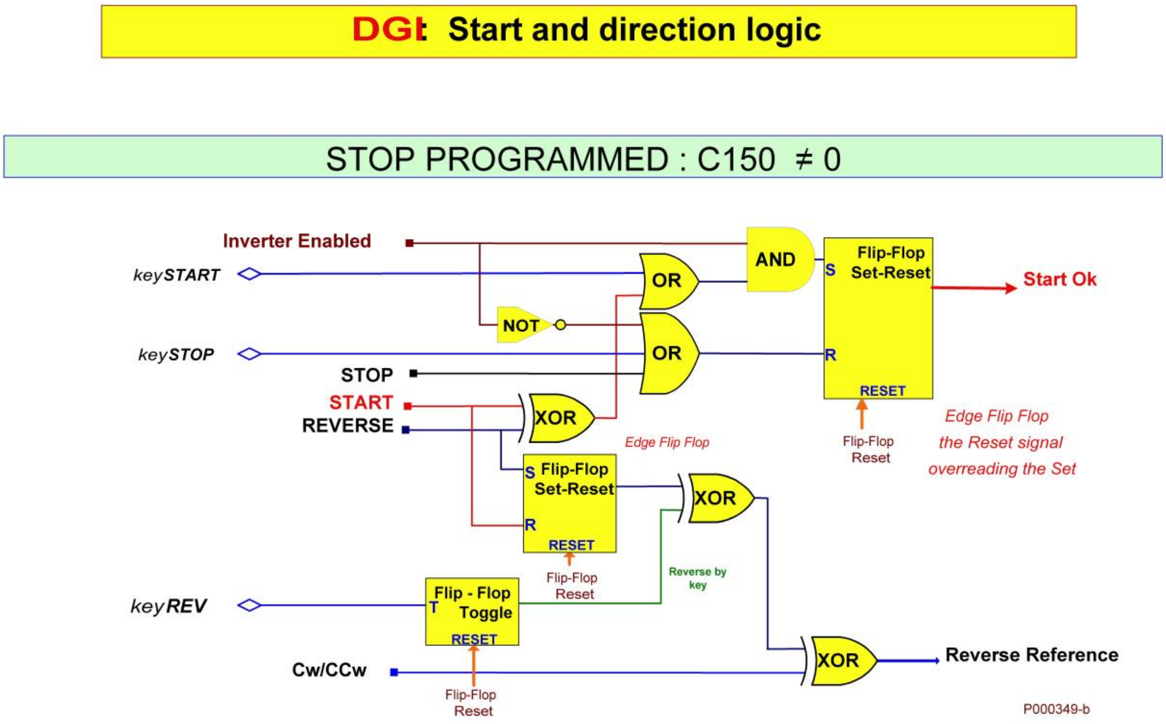


Figure 57: Controlling Run and Direction when the STOP Input is programmed

C152 ENABLE-SW Input

C152	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 if fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1152	
	Function	This is an additional software-controlled Enable signal which is estimated in series to the **ENABLE** function associated to **MDI2** inputs. If this function is enabled, the drive is enabled *if and only if* the **ENABLE-A**, **ENABLE-B** and **ENABLE-SW** inputs are simultaneously activated. If the **ENABLE-SW** function is programmed (**C152**≠0), do the following to enable the drive: • activate the **ENABLE-SW** signal • activate the **ENABLE-A** and **ENABLE-B** signals • activate **MDI2** inputs via serial link and fieldbus, if those inputs are selected via **C140**, **C141**, **C142**. • activate the **DISABLE** signal if programmed via **C153.**	

NOTE The **ENABLE-SW** signal may not delayed by the timers: if a timer is programmed to the terminal related to the **ENABLE-SW** signal, this will not affect the **ENABLE-SW** function, while it normally delays other functions set to the same terminal.

DANGER!!! The deactivation of the **ENABLE-SW** signal, the activation of the **DISABLE** signal, the deactivation of **MDI2** inputs from serial link or fieldbus DO NOT GUARANTEE that the Safe Torque Off – STO function is removed from the motor connected to the drive.
Safety stop conditions are guaranteed only when at least one of the two **ENABLE-A** and **ENABLE-B** inputs are opened.
For more details, consult the Safe Torque Off Function - Application Manual.

C153 DISABLE Input

C153	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1153	
	Function	The **DISABLE** function disables the drive and overrides any **ENABLE-A and ENABLE-B** signals**.** The **DISABLE** command sets the drive output voltage to zero, so the motor starts idling (the motor idles and stops due to friction or the mechanical load). If the **DISABLE** function is set up (**C153**≠0), do the following to enable the drive: • deactivate the input signal on the terminal selected via **C153** • activate the **ENABLE-A** and **ENABLE-B** signals • activate the **MDI2** inputs via serial link and fieldbus, if selected via **C140**, **C141**, **C142** • activate the **ENABLE-SW** signal if programmed via **C152**.	

DANGER!!! The deactivation of the **ENABLE-SW** signal, the activation of the **DISABLE** signal, the deactivation of **MDI2** inputs from serial link or fieldbus DO NOT GUARANTEE that the Safe Torque Off – STO function is removed from the motor connected to the drive.
Safety stop conditions are guaranteed only when at least one of the two **ENABLE-A** and **ENABLE-B** inputs are opened.
For more details, consult the Safe Torque Off Function - Application Manual.

C154 RESET Alarms Input

C154	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	3	NDI3
	Level	ADVANCED	
	Address	1281	
	Function	The function allows to reset the active alarm and unlock the inverter.	

C154a ENABLE via Terminal Board Only

C154a	**Range**	0 ÷ 1	0: NO; 1: Yes
	Default	0	0: NO
	Level	ADVANCED	
	Address	1154 bit 1	
	Function	When **C154a=1: Yes** it is possible to force the system to consider the only terminal physical input as the ENABLE input, independently of the active command sources set in **C140**, **C141**, **C142**.	

NOTE Parameter **C154a** may have binary values only.

Table 99: Coding of Parameter C154a

bit [15..2]	bit [1]	bit [0]
not used	**C154a**	not used

C155, C156, C157, C158 MULTISPEED Inputs

C155 C156 C157 C158	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	**C155** = 4, **C156** = 5, **C157** = 0, **C158** = 0.	**C155** = MDI4, **C156** = MDI5, **C157** = **C158** = Inactive.
	Level	ADVANCED	
	Address	1155, 1156, 1157, 1158	
	Function	This function generates up to 15 speed references that can be programmed with parameters **P081÷P098** according to the programming mode set in **P080**. The 4 Multispeed functions determine which of the 15 active speed references are active: active value (**1**) or inactive value (**0**) of each preset input signal determines a bit-logic binary number: **MULTISPEED 0** is the least significant bit (bit 0) and **MULTISPEED 3** is the most significant bit (bit 3). If one of these functions is not set up, its relevant bit is "zero".	

Table 100: Multispeed selection

Multispeed selected =	Bit 3	Bit 2	Bit 1	Bit 0
	MULTISPEED 3	**MULTISPEED 2**	**MULTISPEED 1**	**MULTISPEED 0**

Table 101: Selected Speed reference

Function:	**Status of the relevant input**																
START	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
MULTISPEED 0	X	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
MULTISPEED 1	X	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
MULTISPEED 2	X	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
MULTISPEED 3	X	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Multispeed selected	**X**	**0**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Resulting reference	0	(*)	P081	P083	P085	P087	P088	P089	P090	P091	P092	P093	P094	P095	P096	P097	P098

If one of these functions is not set up, its relevant bit is "zero".
For example, if **C156** and **C157** are Inactive (0), while **C155** and **C158** are programmed to two different terminals, only Multispeed 0, 1, 8, 9 can be selected, relating to the following references:

(*)	**P081**	**P091**	**P092**

(*) Factory-setting: (**P080** = ***Preset Speed***) if no Multispeed function is selected, the active reference **is** the reference set according to the parameters in the INPUTS FOR REFERENCES MENU.
If **P080** = ***Speed Sum***, the selected Multispeed function **adds up** to the active reference: the reference set according to the parameters in the INPUTS FOR REFERENCES MENU.
If **P080** = ***Preset Speed Esc***, the selected Multispeed **replaces** the active reference, which will be ignored. If no Multispeed function is selected, the resulting reference is equal to zero.
See also the INPUTS FOR REFERENCES MENU for the reference processing sequence: the **Speed Decrease** function and the **Reference Reversal** function become active downstream of the **Multispeed** function.

NOTE

In Table 101:
0 ⇒ Inactive input;
1 ⇒ Active input;
X ⇒ Input having no effect.

C159 CW/CCW Input

C159	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	8	MDI8
	Level	ADVANCED	
	Address	1159	
	Function	The **CW/CCW** function reverses the **active reference signal**: the connected motor decelerates to zero following the preset deceleration ramp, then it accelerates following the preset acceleration ramp until it reaches the new reference value.	

C160 DCB Input

C160	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1160	
	Control	IFD and VTC	
	Function	For FOC control, this function has no effect even if **C160**≠0. The DCB command enables **DC braking at stop** for a time period depending on the speed value determining the input activation. See the DC Braking Command Sent from Digital Input for more details.	

C161, C162 UP and DOWN Inputs

C161 C162	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1161, 1162	
	Function	This function increases (**UP**) or decreases (**DOWN**) the reference for which the **UpDown source from MDI has been selected** by adding a quantity to the reference itself. This also depends upon the following parameters: **C163** Up/Down Reset **P067** Up/Down Ramp Time **P068** Store Up/Down value at power off **P068a** Speed/Torque Up/Down Reset at stop **P068b** PID Up/Down Reset at stop **P068c** Speed/Torque Up/Down Reset at sources changeover **P068d** PID Up/Down Reset at sources changeover **P069** Up/Down Reference range	

C163 Reset Up/Down Input for Speed/Torque Reference

C163	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1163	
	Function	This function sets to zero the reference **variation** obtained via the **UP** or **DOWN** inputs or the ▲ and ▼ keys located on the display/keypad. The Up/Down reference (Speed/Torque only) may also be reset using different functions (see **P068a – P068c**).	

C164 , C165, C166 External Alarm Inputs

C164 C165 C166	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1164, 1165, 1166	
	Function	When allocating one of these 3 functions to a digital input, the status of this input will **ALWAYS BE CHECKED ON THE DRIVE'S TERMINAL BOARD**. When the command contact opens, the drive is locked due to an alarm tripped. Parameters **C164a, C165a, C166a** allow delaying external alarms. To restart the drive, the digital input set as an external alarm must be closed and a Reset procedure is required. Alarms tripped due to these 3 functions are **A083**, **A084**, **A085** respectively. This function is factory set as disabled.	

⚠ **CAUTION**

The terminal board for these 3 functions is the hardware terminal board of the drive. If different command sources are enabled (see the CONTROL METHOD MENU), the "External Alarm" signal command is obtained only for the hardware terminal board of the drive. Therefore, in order to avoid any external alarm, the input signal for the active terminal must be active in the terminal board.
Alarms trip when only one input signal for the terminal selected on one of the active command sources is disabled. A trip delay can be programmed with parameters **C164a, C165a, C166a.**

C164a (C165a, C166a) External Alarm Trip Delay

C164a C165a C166a	**Range**	0 ÷ 32000	0 ÷ 32000 msec
	Default	0	Instantaneous
	Level	ADVANCED	
	Address	1305, 1306, 1307	
	Function	External alarm trip delay. To avoid untimely alarm trip, it may be necessary to set a check time for the opening of the input set as an external alarm before the alarm trips.	

C167, C168 MULTIRAMP Inputs

C167 C168	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ENGINEERING	
	Address	1167, 1168	
	Function	This function allows selecting up to **4 acceleration/deceleration ramps**. Each ramp has its own programming parameters; see **P009 ÷ P025** (RAMPS MENU). These 2 functions determine which of the 4 ramps is to be selected: the active value (**1**) or inactive value (**0**) of each preset input signal determines a binary number with a bit-logic, where **Multiramp 0** is the least significant bit (bit 0) and **Multiramp 1** is the most significant bit (bit 1). **The ramps range from 1 to 4; for the selected ramp, add 1 to the binary figure obtained**. If one of these functions is not programmed, the relevant bit is “zero”.	

Table 102: Multiramp selection

		Bit 1	Bit 0	
Selected Ramp =	(	Multiramp 1	Multiramp 0	) + 1

Table 103: Selected ramp

Function:	Input Status			
Multiramp 0	0	1	0	1
Multiramp 1	0	0	1	1
Selected Ramp	**1**	**2**	**3**	**4**
Active ramp times (parameters determining the ramp model)	P009 P010 P014 (*)	P012 P013 P014 (*)	P015 P016 P020 (*)	P018 P019 P020 (*)

If one of these functions is not programmed, its bit is “zero”.
For example, if **C167** is Inactive (0) and **C168** is programmed for one terminal, only ramp **1** or ramp **3** can be selected.

NOTE (*) If the ramp rounding off function is enabled (**P021**≠0), the actual ramp times also depend on the values set in parameters **P022**, **P023**, **P024**, **P025**, **P031**.

C169 JOG Input

C169	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1169	
	Function	When the JOG function is enabled, the motor rotates at low speed following slow ramps which are manually controlled by the user only by means of the keys in keypad. If the drive is enabled (**ENABLE** function activated) but is not running, and if the JOG terminal is enabled, the drive will run: the connected motor will accelerate following a JOG ramp (**P029**) up to the JOG speed reference (**P070**). On the other hand, if the terminal is disabled, the drive will stop: the connected motor will decelerate to zero speed following the JOG ramp (**P029**). Reverse the direction of rotation of the active reference to reverse the **JOG** reference.	

CAUTION The motor starts running as soon as this terminal is activated (only if the drive is enabled).

NOTE The **RUN** function will override the **JOG** function.
Therefore, if the **RUN** function is active, the **JOG** function is ignored.

NOTE If the motor is not running in **SLAVE mode** (torque reference instead of speed reference), it can rotate at JOG speed when the user activates the **JOG** function.
In **SLAVE mode**, the **JOG** function is ignored if the motor is still rotating due to an active reference torque.

C169a Input for Selection of Speed Regulator Parameters

C169a	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1233	
	Control	FOC	
	Function	This function allows switching between the two parameter sets pertaining to the speed regulator. The two pairs of parameters concerned are the same as the parameters activating in case of automatic regulation based on the speed error (see SPEED LOOP AND CURRENT BALANCING MENU). For example, parameters **P126/P128** and **P125/P129** apply to **Motor 1**. Always referring to **Motor 1**, a low logic level of the input associated to the selector keeps parameters **P126/P128** active, while a high logic level affects speed regulation via parameters **P125/P129**. This applies to Motor 2 and Motor 3 as well for parameters **P136/P138** and **P135/P139** for **Motor 2**, or **P146/P148** and **P145/P149** for **Motor 3**.	

C170 SLAVE Input

C170	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1170	
	Control	VTC and FOC	
	Function	When activating the terminal allocated to the Slave Input, the main reference becomes a torque reference and the speed loop is by-passed. This function enables the *SLAVE* operating mode (**torque reference**), instead of the *MASTER* operating mode (**speed reference**); the Torque References and the Ramp Torques are used (see the INPUTS FOR REFERENCES MENU and the RAMPS MENU).	

NOTE This function is ignored if the operating mode selected for the active motor is the *SLAVE* mode, i.e. **C011 (C054, C097)** =1:Torque oppure =2:Torque w/Speed Limit.

Commands are factory-set to *MASTER* mode and the speed reference is selected as factory setting (**C011 (C054, C097)** =0: Speed).

NOTE Enabling this function means setting **C011 (C054, C097)** =1:Torque, not =2:Torque w/Speed Limit.

C171 PID DISABLE Input

C171	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1171	
	Function	This function is used for managing the PID regulator (see the PID CONFIGURATION MENU). When the terminal allocated to this function is activated, the PID regulator can be disabled: its output and its external variable are set to zero. More precisely, if the PID regulator is in **External Out** mode (**C294**=0), when the **PID DISABLE** function is enabled, the PID output is set to zero and the external variable regulated by the PID regulator (feedback) is no longer regulated by the PID regulator itself. In Reference mode, the **PID DISABLE** function disables the PID regulator as described above and **switches the reference,** thus becoming the main active reference again.	

C171a Input for PID Control Selection

C171a	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ENGINEERING	
	Address	1188	
	Function	This parameter pertains to the activation of the two PIDs or the 2-zone mode (see the PID CONFIGURATION MENU). It allows using the PID regulator outputs in different ways and allows disabling the 2-zone mode.	

C172 KEYPAD LOCK Input

C172	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1172	
	Function	This function **avoids accessing parameter modification** through the removable display/keypad and **avoids accessing the *LOCAL mode*** by pressing the **LOC/REM** key or by enabling the **LOCAL** input function **(C181).**	

NOTE

If the ***LOCAL*** mode is already active, the **LOCK** command will have no effect on the ***LOCAL*** function: it only avoids changing the programming parameters, while it is still possible to send references and the ***START/STOP/REV/JOG/RESET*** commands via keypad.
If the **LOCK** command is active and the ***LOCAL mode*** is disabled, the **LOCK** function prevents the LOCAL mode from activating.

C173, C174 MOTOR SEL Input

C173 C174	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ENGINEERING	
	Address	1173, 1174	
	Function	This function **activates motor 2 and 3** and sets the relevant programming parameters (see Table 104). A different active motor can be selected only when the drive is disabled.	

Table 104: Motor selection

Value of the terminal allocated to the **Sel. Motor n.2** (**C173**) function	Value of the terminal allocated to the **Sel. Motor n.3** (**C174**) function	**Active motor**
0	**0**	**Motor n.1**
1	**0**	**Motor n.2**
0	**1**	**Motor n.3**
1	**1**	**Motor n.1**

NOTE When both inputs are enabled, Motor 1 is selected again.

C175, C176, C177 SPEED VAR. Inputs

C175 C176 C177	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ENGINEERING	
	Address	1175, 1176, 1177	
	Function	This function generates up to 7 values of variation % for the active reference ranging from –100% to 100% with parameters **P115÷P121**. The 3 functions determine which of the 7 values of the speed reference variation is active: the active value (**1**) or inactive value (**0**) of each preset input signal determines a bit-logic binary number where **SPEED VAR. 0** is the least significant bit (bit 0), while **SPEED VAR. 2** is the most significant bit (bit 3) as shown in Table 105 and Table 106. If one of these functions is not set up, its bit is “zero”.	

Table 105: Selection of the speed reference variation

Variation of the Selected Speed Reference =	Bit 2	Bit 1	Bit 0
	SPEED VARIATION 2	SPEED VARIATION 1	SPEED VARIATION 0

Table 106: Variation of the selected speed reference

Function:	**Input Status**							
MULTISPEED 0	0	1	0	1	0	1	0	1
MULTISPEED 1	0	0	1	1	0	0	1	1
MULTISPEED 2	0	0	0	0	1	1	1	1
Variation of the selected speed reference	**None**	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Variation % selected	0	P115	P116	P117	P118	P119	P120	P121

If one of the functions above is not set up, its bit is “zero”.
For example, if **C175** and **C177** are INACTIVE (0) and **C176** is programmed for one terminal, only variation 2 corresponding to parameter **P116** can be selected.
In any case, the output speed must never exceed the max. allowable speed, even when a higher speed is required.

NOTE

In Table 106 above:
0 ⇒ Inactive Input;
1 ⇒ Active Input.

C178 PID Up/Down Reset Input

C178	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1178	
	Function	This function **resets the variation of the PID reference** obtained with the ▲ and ▼ keys on the KEYPAD page of the user interface on the display/keypad in PID mode.	

C179 Source Selection Input

C179	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	6	MDI6
	Level	ADVANCED	
	Address	1179	
	Function	The digital input set as a source selector is **considered in the drive terminal board only,** not in the virtual terminal boards, as Fieldbus or Serial Link (see Command Sources). When the digital input set as a source selector is open, only the first command sources and references programmed in the CONTROL METHOD MENU are considered (**C140** command source n.1 and **C143** reference source n.1 respectively) as well as the first reference and feedback sources programmed in the PID CONFIGURATION MENU (parameter **C285** for reference source n. 1 and **C288** for feedback source n.1). When the digital input set as a source selector is closed, only the second command source and the second reference source programmed in the CONTROL METHOD MENU are considered (**C141** for command source n. 2 and **C144** for reference source n.2), as well as the second reference sources and feedback sources set in the PID CONFIGURATION MENU (parameter **C286** for reference source n.2 and parameter C289 for feedback source n.2).	

CAUTION If set different from 0:Disabled, reference sources n.3 (**C145** in the CONTROL METHOD MENU and **C287** and **C290** in the PID CONFIGURATION MENU) and reference sources n.4 (**C146** in the CONTROL METHOD MENU) are always considered as summed up to the reference source selected by the source selector.

CAUTION Command source n.3 (**C142** in the CONTROL METHOD MENU), if programmed other than 0: Disabled, is always considered as OR bit by bit to the one selected by the selector. The ENABLE input (MDI2), however, is considered as AND to the selected source.

CAUTION **C179** programming is exclusive in respect to **C179a** and **C179b** and viceversa. If **C179** is ≠ 0, neither **C179a** nor **C179b** may be programmed. If **C179a** and **C179b** are not both set to 0, **C179** may not be programmed.

C179a Input for Source Selection

C179a	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1238	
	Function	Programming this parameter is an alternative to programming **C179**. Make sure that **C179** is set to zero before setting up **C179a**. The digital input set as Command selector **is considered only in the drive terminal board** and not in the vritual terminal boards, such as Fieldbus or Serial Links (see Command Sources). By programming a digital input as Command Selector, when this is not active (relevant MDI open in the terminal board) only the first control board **C140** programmed in the CONTROL METHOD MENU is considered. When the MDI programmed in **C179a** is closed, only the second command source **C141** programmed in the CONTROL METHOD MENU is considered.	

CAUTION Command source n.3 (**C142** in the CONTROL METHOD MENU), if set to value other than 0: Disabled, is always considered as OR bit by bit to the selected source. The ENABLE input (MDI2), however, is considered as AND to the selected source.

C179b Input for Reference Selection

C179b	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1239	
	Function	Programming this parameter is an alternative to programming **C179**. Make sure that **C179** is set to zero before setting up **C179b**. The digital input set as Reference selector **is considered only in the drive terminal board** and not in the virtual terminal boards, such as Fieldbus or Serial Links (see Command Sources). By programming a digital input as Source Selector, when this is not active (relevant MDI open in the terminal board) only the first control board **C143** programmed in the CONTROL METHOD MENU is considered, as well as the first reference and feedback source in the PID CONFIGURATION MENU (**C285** Reference Source N.1 and **C288** Feedback Source N.1 respectively). When the MDI programmed in **C179b** is closed, only the second command source **C144** programmed in the CONTROL METHOD MENU is considered, as well as the second reference and feedback source in the PID CONFIGURATION MENU (**C286** Reference Source N.2 and **C289** Feedback Source N.2 respectively).	

C180 LOC/REM Input

C180	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	7	MDI7
	Level	ADVANCED	
	Address	1180	
	Function	The digital input set as a source selector is **considered in the drive terminal board only,** not in the virtual terminal boards, as Fieldbus or Serial Link (see Command Sources). The **LOCAL mode** can be enabled via the relevant digital input (it ignores any enabling/disable delay times set via software timers) or by pressing the **LOC/REM** key located on the display/keypad. Factory setting allows enabling the Local mode only when the drive is not running. Settings may be changed through **C148 Changeover from Remote to Local Command** (see the CONTROL METHOD MENU); switching from Remote to Local command is allowed even when the drive is operating and when the running condition or reference must be maintained in Local mode. This function allows switching over to **LOCAL mode** and allows ignoring parameters **C140** to **C147** and **C285** to **C287** (see the PID CONFIGURATION MENU) when the PID controller is enabled, **thus allowing setting them via KEYPAD only**. The following functions are still active in the hardware terminal board of the control board being used: **ENABLE**, **External Alarm 1,2,3, Sel.Motor n.2, Sel.Motor n.3, SLAVE, PID Disable**, and **the LOCAL function itself**, that can be disabled at any time. If the input is deactivated when the drive is disabled, signals coming from different sources will activate again. If the main reference of the drive is the PID output, you can set **C180a Type of LOC/REM Contact** = **Pushbutton** and **P266 Type of Keypad page** in **Local Mode = Ref.Activated + Spd**. As a result, when the **Loc** key is pressed and released once, the drive enters the Local mode and the PID reference can be changed, whereas when the **Loc** command is pressed and released again (provided that the drive is not enabled) the PID is disabled and the RPM reference can be sent to the connected motor. See also the CONTROL METHOD MENU and the Keypad page and Local mode in the DISPLAY/KEYPAD menu.	

C180a Type of LOC/REM Contact

C180a	**Range**	0 ÷ 2	0:[Switch] 1:[Pushbutton] 2:[[Pushbutton+Storage]
	Default	2	2:[Pushbutton+Storage]
	Level	ADVANCED	
	Address	1303	
	Function	Factory-setting: the digital contact set as LOC/REM (**C180**) is Pushbutton based. If the PID output is the main reference and **P266 Type of Keypad Page in Local Mode = Ref.Activated + Spd**, allowing entering the LOCAL mode when the LOC/REM command is first sent, thus controlling the PID reference, and allowing the LOCAL mode to be maintained when the LOC/REM command is sent for the second time, thus disabling the PID and allowing setting a speed reference, the LOC/REM digital input must be set as **C180a=Pushbutton**. If **C180a=2**, the logic status of **LOC/REM** will be saved at power off and will be used when the drive is next powered on.	

C181 Safety Start

C181	**Range**	0 ÷ 1	Inactive, Active
	Default	0	Inactive
	Level	ADVANCED	
	Address	1181	
	Function	This function **enables** the ***Safety START mode.*** When this function is enabled and the drive is to be restarted after resetting an alarm, open and close the **ENABLE-A** and **ENABLE-B** terminals. This prevents the drive from RUNNING when it is turned off and on again (for example after a mains loss) and the **START** and **ENABLE-A** and **ENABLE-B** inputs are on.	

NOTE If multiple terminal boards are selected with parameters **C140**, **C141**, **C142**, open and close the **MDI2** terminals in one of the active terminal boards to restart the drive.

C182 Multiprogramming Enable

C182	**Range**	0 ÷ 1	Inactive, Active
	Default	1	Inactive
	Level	ENGINEERING	
	Address	1182	
	Function	This function allows allocating two different functions to the same terminal.	

NOTE Only few preset combinations are allowed.
When invalid configurations are set up, "ILLEGAL DATA" appears on the display/keypad of the Penta drive.

C183 Max. Fluxing Time Before Drive Disable

C183	**Range**	0 ÷ 65000	0 ÷ 65000 ms
	Default	0	Disabled
	Level	ADVANCED	
	Address	1183	
	Control	VTC and FOC	
	Function	This function disables the drive if the fluxing time period is longer than the preset time (if the **ENABLE** function, not a **START** command, is active). To restore motor fluxing, disable and enable the **ENABLE** function, or if with the active **ENABLE** function a **START** command is also activated.	

NOTE The time set in **C183** is added to the Fluxing Ramp Time set in **C041** / **C084** / **C127**.

C184 Fluxing at Activation only with START Closed

C184	**Range**	0 ÷1	0:No - 1:Yes
	Default	0	0:No
	Level	ADVANCED	
	Address	1184	
	Control	VTC and FOC	
	Function	Fluxing may be carried out only when the **START** command is closed.	

C184a Disable External Torque Limit During Fluxing

C184a			
	Range	0 ÷ 1	0:NO; 1:Yes
	Default	0	0:NO
	Level	ENGINEERING	
	Address	1200	
	Control	FOC	
	Function	During the fluxing stage, until the desired flux value is attained, the external torque limit (if any) set in **C147** is disabled (see CONTROL METHOD MENU). During that stage, only the limits set in **C047**, **C048** and **C049** (see LIMITS MENU) are applied. This function is useful to limit undesired motor operation—due to residual rotor magnetization—during the fluxing stage.	

C185 STOP Mode

C185			
	Range	0 ÷1	0: [Deceleration Ramp] – 1:[Free Wheel]
	Default	0	0: [Deceleration Ramp]
	Level	ADVANCED	
	Address	1185	
	Function	This function allows selecting whether the drive is to be deactivated with a controlled deceleration ramp or is left idling when the **START** command is open.	

C186 Fire Mode Enable Input

C186			
	Range	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ENGINEERING	
	Address	1186	
	Function	This parameter allows programming a digital input to activate the Fire Mode (see the Fire Mode section).	

C187 Torque Limit Source Ref. Disable Input

C187			
	Range	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1187	
	Function	This function sets a digital input allowing disabling the external torque limit. When the digital input set for **C187** is active, the torque limit will depend on the parameters contained in the LIMITS MENU of the active motor.	

C187a,C187b Multitorque Inputs

C187a C187b	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1094, 1095	
	Function	This function allows generating max. 3 torque limits that can be programmed via parameters **P101÷P103**. These 2 functions determine which of the 3 torque limits is active: the active value (**1**) or inactive value (**0**) of each programmed input signal determines a bit-controlled binary number, where **MULTITORQUE 0** is the least significant bit (bit 0). If one of the two functions is not programmed, the relevant bit value is zero.	

Table 107: Multitorque selection

Selected Multitorque =	Bit 1	Bit 0
	MULTITORQUE 1	**MULTITORQUE 0**

Table 108: Selected Multitorque reference

Function:	**Status of the relevant input**			
MULTITORQUE 0	0	1	0	1
MULTITORQUE 1	0	0	1	1
Selected Multitorque	**0**	**1**	**2**	**3**
Resulting multitorque limit	(*)	P101	P102	P103

(*) If both Multitorque inputs are inactive, the torque limit applied is the one that would be present if no Multitorque inputs were active, such as:

- If **C147** ≠ 0, the limit coming from the source set in **C147**;
- If **C147** = 0, the limit defined by **C047**, **C048** and **C049** (see LIMITS MENU).

When switching between the two Multitorque modes, the ramps defined by parameters **P026**, **P027** (see RAMPS MENU).
The activation of the input programmed in **C187** (if any) disables the torque limit forced by **C187a**, **C187** as follows:

- If both Multitorque inputs are OFF, the limit set by **C047**, **C048** and **C049** is forced without applying any ramps.
- If at least one of the Multitorque inputs is ON, the limit set by **C047**, **C048** and **C049** is forced by applying the ramp in **P026**.
- When the input set in **C187** is disabled, the limits set in **P101÷P103** are applied following the ramps in **P026**, **P027**.

C188a, C188b, C188c Inputs for PID MULTIREFERENCES

C188a C188b C188c	**Range**	0 ÷ 16 0 ÷ 24 if ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1365, 1366, 1367	
	Function	This function allows generating up to 7 PID references that can be programmed with parameters **P081a** to **P087a** according to the operating mode selected with **P080a**. The 3 functions determine which is the active reference among the 7 available PID references: the active value (**1**) or the inactive value (**0**) of each programmed input signal determines a bit-logic value, where **MULTIREF 0** is the least significant bit (bit 0) and **MULTIREF 2** is the most significant bit (bit 2). If one of the available functions is not programmed, the value of the relevant bit is “zero”.	

Table 109: Selection of PID Multireferences

Multireference selected =	**Bit 2**	**Bit 1**	**Bit 0**
	MULTIRFERENCE 2	**MULTIRFERENCE 1**	**MULTIRFERENCE 0**

38. ENCODER/FREQUENCY INPUTS MENU

38.1. Overview

Three quick acquisition digital inputs are available in the Sinus Penta control board:
- **MDI6/ECHA/FINA;**
- **MDI7/ECHB;**
- **MDI8/FINB.**

These inputs can be used as incremental encoder reading (encoder A) or as frequency inputs.

WARNING Digital inputs **MDI6/ECHA/FINA** and **MDI7/ECHB** are not active if ES847 or ES870 I/O expansion board is mounted: they are automatically replaced by the corresponding **XMDI6** and **XMDI7** digital inputs (see the Sinus Penta's Motor Drives Accessories - User Manual).
MDI8/FINB, on the contrary, is always active, also with ES847 or ES870 mounted.

In addition, if **ES836**, **ES913** or **ES861** optional board is used (see the Sinus Penta's Motor Drives Accessories - User Manual), an additional encoder reading (encoder B) is allowed.

NOTE If **MDI6** and **MDI7** are used for encoder reading, only Push–Pull encoders can be used.

NOTE For the reversal of the incremental encoder speed measure, properly set up parameter **C199**.

38.1.1. Without Optional Boards

- **Reading an Incremental Encoder**:

Digital inputs **MDI6** and **MDI7** are used for reading the two channels of a 24V push–pull encoder powered directly by the Sinus Penta control board (see the Sinus Penta's Installation Guide).
No function can be programmed for **MDI6** and **MDI7**; if you attempt to program **MDI6** and **MDI7,** alarm **A082** Illegal Encoder Configuration will trip when the **ENABLE** function is activated.

- **Reading a Frequency Input**:

Digital inputs **MDI6** or **MDI8** can be used.
If **MDI6** is programmed as a frequency input (**FINA**) with **C189**, no other function can be programmed; otherwise, alarm **A100** MDI6 Illegal Configuration trips when the **ENABLE** function is activated.
If **MDI8** is programmed as a frequency input (**FINB**) with **C189**, no other function can be allocated to MDI8 and **ES836**, **ES913** or **ES861** optional board must not be applied to the power drive, otherwise, alarm **A101** MDI8 Illegal Configuration trips when the **ENABLE** function is activated.

- **Reading a Frequency Input and an Incremental Encoder**:

MDI6 and **MDI7** are used to read the push–pull encoder, and **MDI8** is used to read the frequency input. The following alarms may trip:
- **A082** Illegal Encoder Configuration, if additional functions are allocated to **MDI6** or **MDI7**;
- **A101 MDI8** Illegal Configuration, if additional functions are allocated to **MDI8** or if the power drive detects the presence of **ES836**, **ES913** or **ES861** optional board.

38.1.2. When Using ES836, ES913 or ES861 Optional Board

• **Reading 1 or 2 Incremental Encoders:**
To read one Encoder, use ES836 optional board or digital inputs **MDI6** and **MDI7** (if a push–pull encoder is used).
Both the optional board and digital inputs **MDI6** and **MDI7** can be used to read two encoders at a time. Use parameter **C189** to set the readout of the speed measure of the controlled motor or to read reference values.
You can use encoder **A** or encoder **B** as a speed feedback or a reference source (speed reference, torque reference or PID reference).

Example:
If you want to use encoder **A** as a speed reference source and encoder **B** as a speed feedback, set **C189** as 6:[A Ref ; B Fbk]; use **P073** and **P074** (INPUTS FOR REFERENCES MENU) to define the min. speed and the max. speed read for scaling and saturation of encoder **A** selected as a reference source (in one of parameters **C144** ÷ **C147**, CONTROL METHOD MENU); set parameter **C012** (motor 1) to [Yes] to enable the Speed Feedback from Encoder function.
If encoder A is selected, no function can be programmed for **MDI6** and **MDI7**; otherwise, alarm **A082** Illegal Encoder Configuration will trip when the **ENABLE** function is activated.
If encoder B is selected and **ES836**, **ES913** or **ES861** optional board is not detected by the drive, alarm **A082** Illegal Encoder Configuration will trip when the **ENABLE** function is activated.

• **Reading a Frequency Input:**
Only **MDI6** digital input (FINA) can be used as a frequency input; if **MDI8** is programmed as a frequency input (FINB) with **C189**, if the optional board is installed, alarm **A101 MDI8** Illegal Configuration trips.
No additional function must be assigned to **MDI6**; otherwise, alarm **A100 MDI6** Illegal Configuration will trip when the **ENABLE** function is activated.

• **Reading a Frequency Input and an Incremental Encoder:**
MDI6 Digital input (FINA) is used as a frequency input and Encoder B is used (because **ES836**, **ES913** or **ES861** board avoids reading frequency input FINB through MDI8).
If additional functions are programmed for digital input **MDI6**, alarm **A100 MDI6** Illegal Configuration will trip when **ENABLE** closes.
If alarm **A082** Illegal Encoder Configuration trips, this means that the drive has not detected **ES836**, **ES913** or **ES861** board (check the board wiring).
Parameter **C189** defines whether quick acquisition digital inputs are used to read a frequency input or an encoder, and if the encoder is a reference source or a feedback source.

In the **Encoder Menu**, you can also do the following:
- define the number of pls/rev for the encoder being used;
- enable or disable the speed alarm;
- define a time constant applied to read filtering;
- define whether encoders are read by means of quadrature channels or by channel A only (while the direction of rotation will be defined by channel B: ChB low level → negative rotation; ChB high level → positive rotation).

38.1.3. WHEN USING TWO ENCODERS

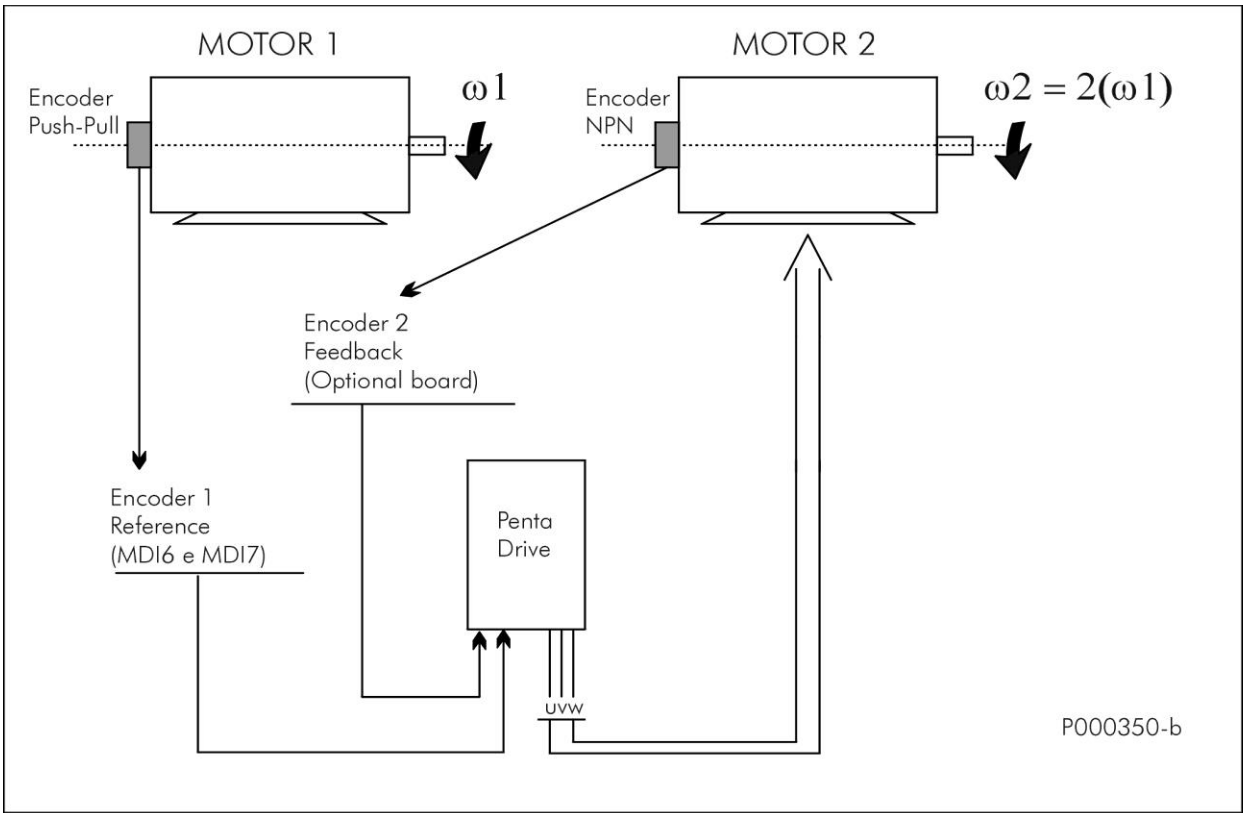


Figure 58: Using two encoders (example)

Suppose that motor 2 is to be controlled in closed-loop and that its speed value is twice the speed value of motor 1.
To do so, use speed of motor 1, provided with an encoder, as the reference for the Penta Drive, and use the speed measure of encoder B, which is coaxial to the motor controlled by the drive, as a speed feedback.
Suppose that motor 1 speed ranges from 0 to 750rpm and that motor 1 is provided with a Push–Pull encoder with Single–Ended outputs and that its resolution is 2048 pls/rev.

Motor 2 is provided with an NPN encoder with Single–Ended outputs; its resolution is 1024 pls/rev.
Only one Push-Pull encoder can be connected to digital inputs MDI6-MDI7, so encoder NPN of motor 2, representing the speed feedback of the drive, must be connected to ES836 board (drive Encoder B), whereas the encoder of motor 1 (Push–Pull), used as a reference, shall be connected to terminals MDI6 and MDI7 (drive Encoder A).
Encoder Configuration is as follows:

Encoder/Frequency Inputs Menu

(operating modes and encoder feature setting)

C189 = [6: A–Reference B–Feedback]	(Encoder/Frequency input operating mode)
C190 = 2048 pls/rev	(Number of pls/rev for Encoder A)
C191 = 1024 pls/rev	(Number of pls/rev for Encoder B)
C197 = [0: 2Ch.Quad.]	(Number of channels of Encoder A)
C198 = [0: 2Ch.Quad.]	(Number of channels of Encoder B)
C199 = [0: Fdbk.No Ref.No]	(Encoder reading sign reversal)

Motor Control 1 Menu

(Setup of control mode with speed feedback from encoder and min. speed and max. speed of the controlled motor)
C012 = [Yes] (Speed feedback from M1 encoder)
C028 = 0 rpm (Min. speed of motor M1)
C029 = 1500 rpm (Max. speed of motor M1)

Control Method Menu

(Setup of the source of the speed feedback from encoder)
C143 = [8: Encoder] (Selection of reference 1 source)
C144 = [0: Disable] (Selection of reference 2 source)
C145 = [0: Disable] (Selection of reference 3 source)
C146 = [0: Disable] (Selection of reference 4 source)

References Menu

(Setup of the reading range for the encoder used as a speed reference)
P073 = 0 rpm (Encoder input min. rpm)
P074 = 750 rpm (Encoder input max. rpm)

Ramps Menu

(Ramps time applied to the reference are reset to maintain the desired speed variation without entering any delay value)
P009 = 0 (Acceleration time 1)
P010 = 0 (Deceleration time 1)

When motor 1 reaches its max. speed (750rpm), the speed reference is 100% (because the speed value read by the encoder used as a reference source is saturated and scaled with respect to the min. rpm and max. rpm set in P073, P074). Because the max. speed of the motor controlled by the drive is 1500 rpm (C029), the speed reference is 1500 rpm.

38.2. List of Parameters C189 to C199

Table 110: List of Parameters C189 to C199

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C189	Encoder/Frequency input operating mode	BASIC	1189	0 [Not used, Not used]
C190	Number of pls/rev for encoder A	BASIC	1190	1024
C191	Number of pls/rev for encoder B	BASIC	1191	1024
C192	Speed searching error timeout	ENGINEERING	1192	5.00 sec
C193	Error between reference and speed	ENGINEERING	1193	300 rpm
C194	Tracking error alarm enable	ENGINEERING	1194	1: Active
C195	Filter time constant over value of feedback from encoder	ENGINEERING	1195	5.0 ms
C196	Filter time constant over value of reference from encoder	ENGINEERING	1196	5.0 ms
C197	Number of channels of Encoder A	ENGINEERING	1197	0:2 Quadrature channels
C198	Number of channels of Encoder B	ENGINEERING	1198	0:2 Quadrature channels
C199	Encoder sign reversal	ENGINEERING	1199	0[Fdbk.NO;Ref.NO]

C189 Encoder/Frequency Input Operating Mode

C189			
	Range	0 ÷ 14	See Table 111
	Default	0	0 [Not used; Not used]
	Level	BASIC	
	Address	1189	
	Function	This parameter determines the operating mode of the fast acquisition digital inputs or the encoders connected to the optional boards. If MDI8 is used as a frequency input, the optional board for encoder B is not required. MDI6 digital input may be used as a frequency input; if used along with MDI7, it can be used for encoder A reading. Reading both encoders A and B can be programmed; parameter **C189** defines the encoder to be used as a reference source (if set as a speed/torque reference source in the MOTOR CONFIGURATION MENU or as a PID reference source in the PID CONFIGURATION MENU) and the encoder to be used as a speed feedback. Configuration allowed for quick acquisition digital inputs is shown in Table 111. **If the encoder is used as a reference source, the detected speed value will be saturated and scaled based on values set in P073 and P074 respectively (minimum and maximum value for the encoder).** *Example*: **C189** [A Reference; B Unused], **P073** [–1500rpm], **P074** [1500rpm] if the encoder is used as a PID reference, the reference measure is expressed as a percentage of the max. value [|**P073**|; |**P074**|]. **If a frequency input is selected, its readout is saturated and scaled based on parameters P071 and P072 respectively (minimum and maximum value for the frequency input).**	

Table 111: Coding of Parameter C189

Value	When using Encoder A/FINA	When using Encoder B/FINB
0	*Not used*	*Not used*
1	**EncA Feedback**	*Not used*
2	**EncA Reference**	*Not used*
3	*Not used*	**EncB Feedback**
4	*Not used*	**EncB Reference**
5	**EncA Feedback**	**EncB Reference**
6	**EncA Reference**	**EncB Feedback**
7	**EncA Reference and Feedback**	*Not used*
8	*Not used*	**EncB Reference and Feedback**
9	**MDI6 Frequency Input**	*Not used*
10	*Not used*	**MDI8 Frequency Input**
11	**MDI6 Frequency Input**	**EncB Reference**
12	**EncA Reference**	**MDI8 Frequency Input**
13	**MDI6 Frequency Input**	EncB Feedback
14	**EncA Feedback**	**MDI8 Frequency Input**

Values 7-8: the same encoder can be used both as a reference source and as a reference feedback. Value 7: encoder A can be used both as a speed feedback for the motor control and as a PID regulator reference.

C190 Number of Pls/Rev for Encoder A

C190			
	Range	256 ÷ 10000	256 ÷ 10000 pls/rev
	Default	1024	1024
	Level	BASIC	
	Address	1190	
	Function	Defines the number of pls/rev for encoder A (encoder in the terminal board).	

C191 Number of Pls/Rev for Encoder B

C191			
	Range	256 ÷ 10000	256 ÷ 10000 pls/rev
	Default	1024	1024
	Level	BASIC	
	Address	1191	
	Function	Defines the number of pls/rev for encoder B (encoder that can be connected to ES836 optional board).	

C192 Timeout for Speed Alarm

C192			
	Range	0 ÷ 65000	0.00 ÷ 650.00 sec
	Default	500	5.00 sec
	Level	ENGINEERING	
	Address	1192	
	Function	If the speed alarm (**C194**) is enabled and the speed error exceeds the speed threshold (**C193**), this parameter determines the speed error timeout. Even if the alarm speed is disabled, time set in **C192** and error threshold set in **C193** are used to signal a speed searching error to digital outputs set with BRAKE or LIFT mode. Digital outputs are then disabled.	

C193 Speed Error Threshold

C193	**Range**	0 ÷ 32000	0 ÷ 32000 rpm
	Default	300	300 rpm
	Level	ENGINEERING	
	Address	1193	
	Function	If the speed alarm (**C194**) is enabled, this parameter determines the error threshold for the speed error timeout (**C192**).	

C194 Tracking Error Enable

C194	**Range**	0 ÷ 2	0: Disabled 1: Enabled 2: Active, except for when in torque limiting
	Default	1	1: Enabled
	Level	ENGINEERING	
	Address	1194	
	Function	This parameter enables the tracking error alarm (**A080**, Tracking error). 1: Inactive: In case of tracking error, no alarm trips. The tracking error activation is indicated by digital signal D32 (see Table 48). 2: Active: in case of tracking error, alarm **A080** trips. 3: Active, except for when in torque limiting: same as value 2, but the “tracking error” alarm trips only if: a) a limit source is preset in **C147**; b) the preset limit is <95% of the maximum torque value (parameters **C048 / C049**); c) the speed regulator output is in saturation mode due to the preset torque limits. If the tracking error is caused by saturation of the speed regulator due to external torque limit, no alarm trips. The tracking error activation is indicated by digital signal D32 (see Table 48). Alarm **A080** may be enabled both for FOC control with speed feedback from encoder and for VTC control.	

CAUTION

If the “Tracking Error” alarm is disabled, but **C303**=Yes, the time set in **C192** and the error threshold in **C193** are implemented to manage the tracking error, that deactivates the digital outputs set in BRAKE, ABS BRAKE or ABS LIFT modes and, consequently, activates the electromechanical brake.
Vice versa, when **C303**=No, digital outputs BRAKE, ABS BRAKE or ABS LIFT are NOT deactivated.

C195 Filter Time Constant over Value of Feedback from Encoder

C195	**Range**	0 ÷ 30000	5 ÷ 3000.0 ms
	Default	50	5.0 ms
	Level	ENGINEERING	
	Address	1195	
	Function	This parameter defines the time constant used for filtering the reading of the encoder used as a speed feedback.	

C196 Filter Time Constant over Value of Reference from Encoder

C196	**Range**	0 ÷ 30000	5 ÷ 3000.0 ms
	Default	50	5.0 ms
	Level	ENGINEERING	
	Address	1196	
	Function	This parameter defines the time constant used for filtering the reading of the encoder used as a reference.	

C197 Number of Channels of Encoder A

C197			
	Range	0 ÷ 1	0: 2 Quadrature Channels 1: Channel only
	Default	0	0: 2 Quadrature Channels
	Level	ENGINEERING	
	Address	1197	
	Function	This parameter defines the number of channels used for encoder A reading. Factory-setting is 2 Quadrature channels. Speed can be read through one channel only (as for phonic wheel); channel 2 can define the direction of rotation (low level → negative rotation; high level → positive rotation).	

C198 Number of Channels of Encoder B

C198			
	Range	0 ÷ 1	0: 2 Quadrature channels 1: Channel only
	Default	0	0: 2 Quadrature channels
	Level	ENGINEERING	
	Address	1198	
	Function	This parameter defines the number of channels used for encoder B reading (see parameter **C197**).	

C199 Encoder Sign Reversal

C198			
	Range	0 ÷ 3	See Table 112
	Default	0	0 [Fdbk. NO; Ref. NO]
	Level	ENGINEERING	
	Address	1199	
	Function	This parameter permits to reverse the speed sign measured by encoder inputs.	

NOTE When tuning the encoder, the encoder sign used as feedback is automatically adjusted to the direction of rotation of the connected motor.

Table 112: Coding of Parameter C199

Value	Feedback Encoder Sign Reversal	Reference Encoder Sign Reversal
0	Fdbk. NO	Ref. NO
1	Fdbk. YES	Ref. NO
2	Fdbk. NO	Ref. YES
3	Fdbk. YES	Ref. YES

39. BRAKING UNIT AND RAMP EXTENSION MENU

39.1. Overview

The Braking and Ramp Extension Menu enables the braking unit and sets its max. duty cycle for the drive braking resistance. If no braking resistance is installed, promptness of the DC bus voltage control can be adjusted in order to avoid OVERVOLTAGE alarm, causing abrupt deceleration. Special parameters are available, enabling controlling actions to limit DC bus voltage increase due to motor load variation.

39.1.1. BRAKING UNIT AND RAMP EXTENSION

NOTE The braking unit is not commanded if the drive is supplied from a Regenerative source (see **C008** = xT Regen, where x can be 2, 4, 5, or 6) and the ramp extension function is disabled.

To enable the braking unit, set **C210=[With resistor]**. In this operating mode, when DC bus voltage exceeds a preset threshold value depending on the drive voltage class, the braking unit closes in the braking resistor, so energy in excess is dissipated to the resistor and DC bus voltage does not exceed voltage ratings.
The max. duty cycle of the braking resistor is parameterized with **C212** and **C211**: maximum duty cycle (100 * Ton / (Ton+Toff) [%]) and maximum time of continuous supply (Ton) respectively. If the braking resistor activation is Ton = **C212** , when this interval is over, the relevant command will be disabled for a time equal to Toff = (100 – **C212**) * **C211** / **C212** [sec].

Example:
A hoisting application featuring a Sinus Penta 0086 at 400 V requires a braking resistor with a 50% duty cycle. The braking period is 30 s. According to the tables in the “Braking Resistors” section (Motor Drives Accessories - User Manual) the applicable braking resistor is 10 Ω – 24 kW.
The max. continuous duty for said resistor is 62 s: the braking period is then compatible with that rating. Otherwise, a higher rated resistor should be applied.
Parameter setting:
C210=**[With resistor]**.
C211=30 s
C212=50%

When **C210**=**[With resistor]** the deceleration ramp extension is never performed, unless the braking unit has been inactive for a time longer than the time set in parameters **C211**, **C212** (weak power resistance/energy).
Factory-setting assumes that no braking resistor is provided. In this case, **C210** sets promptness, with respect to variations of DC bus, for the deceleration ramp slowing-down, in order not to overload the bus capacitor bank.
If **C210** is set to zero in FOC control, overfluxing deceleration is performed. For the other controls with **C210**=0, deceleration slows down when given values of the bus voltage are reached (depending on the drive voltage class).
If **C210** is > 0, DC bus voltage is controlled by considering the derivative of the bus voltage. The higher the value in **C210**, the lower the values for voltage variation affecting deceleration ramp times.

39.1.2. TORQUE LIMIT AND FREQUENCY INCREASE DUE TO OVERVOLTAGE – SVC (SMART VOLTAGE CONTROL)

When voltage increases due to sudden load variations, the motor operates out of the regeneration range. The mechanical energy regenerated during the negative torque transient is maintained in the drive-motor unit.

Applications
This control method may be used for applications characterized by:

- sudden variations of the load:

- Olive presses, mills,
- Rock grinders, waste grinders, etc.

- periodic work cycles also including regenerating negative torque areas:

- Pump jacks
- Excentric loads (presses)
- Crank systems

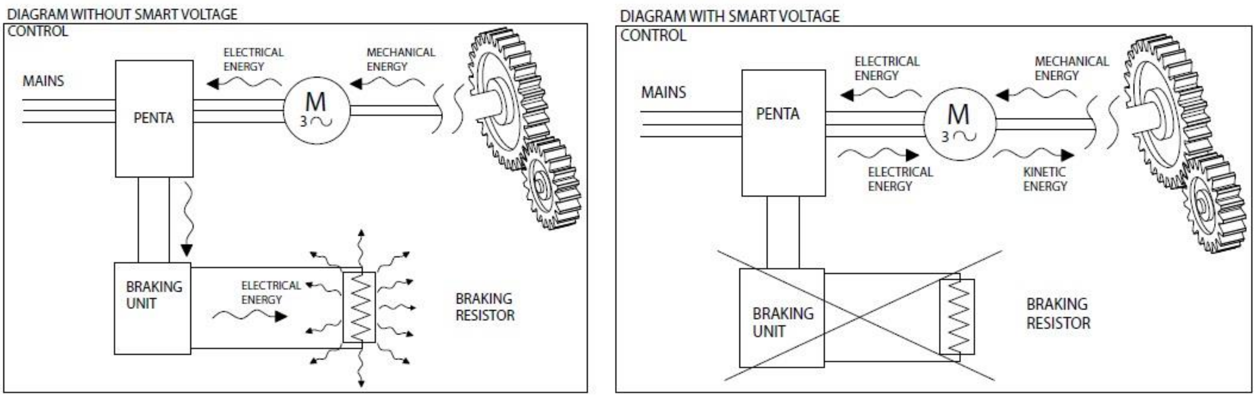
<u>VTC and FOC controls</u>: a special function is available, allowing reducing the resisting torque due to DC-bus voltage increase, in order to prevent the Overvoltage alarm from tripping. A PI regulator is implemented to keep DC voltage below a preset threshold, thus limiting the maximum value of the resisting torque.
<u>In FOC control only</u> this function is enabled only if **C210**=0.
The regulator may be controlled <u>in VTC control only</u>. Parameters **C213a** and **C213b** are the regulator's proportional gain and integral gain respectively. Parameter **C213c** sets the voltage threshold, that equals:

Vth = C213c * Vunlock /100

where **Vunlock** depends on the drive voltage class and is typically higher than the voltage threshold activating the braking resistor.
Parameter **C213d** enables reducing the rotor flux when the regulator activates, thus further limiting the DC voltage increase.

⚠ **CAUTION**		The reduction of the resisting torque generated by the function above affects the speed control when the motor accelerates due to external causes. Consequently, it can happen that the motor accelerates and exceeds the maximum allowable value set in parameter **C029**.

<u>IFD control only</u>: parameter **C213** causes a step increase of the output frequency to limit the DC bus voltage increase due to an abrupt change (decrease) of the motor load torque.



S000851

Figure 59: SVC (Smart Voltage Control)

39.2. List of Parameters C210 to C213d

Table 113: List of Parameters C210 to C213d

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C210	Automatic extension of down ramp	ENGINEERING	1210	See Table 82 and Table 86
C211	Max. time of continuous supply	ENGINEERING	1211	2.00sec
C212	Duty Cycle Braking (Ton/(Toff+Ton))	ENGINEERING	1212	10%
C213	Frequency Increase for Overvoltage Compensation	ENGINEERING	1279	0%
C213a	Torque Limit Proportional Gain due to Overvoltage	ENGINEERING	1251	0.020
C213b	Torque Limit Integral Gain due to Overvoltage	ENGINEERING	1252	0.010
C213c	Voltage Reference for Torque Limit	ENGINEERING	1253	100.0%
C213d	Flux Limit due to Torque Limit Activation	ENGINEERING	1254	0.0%

C210 Automatic Extension of Down Ramp

C210	Range	-1 ÷ 32000	–0.01: (With Resistance); 320.00%
	Default	See Table 82 and Table 86	
	Level	ENGINEERING	
	Address	1210	
	Function	If **C210 = [With Resistor]**, this parameter commands enabling resistor and DC bus relating to this operating condition, allowing dissipating energy regenerated from the motor. If no braking resistor is used, energy regenerated from the motor cannot be dissipated. In this condition, the down ramp is extended if the variation in DC bus voltage is too rapid or exceeds certain threshold values. Set a higher value in parameter **C210** for a more sensitive ramp extension (a lower rating of regenerated power allows obtaining longer ramps), thus avoiding overvoltage.	

NOTE

Parameter **C210** decreases the DC bus voltage threshold setting the ramp extension. The k factor is as follows:
k = Pout/(Pmax*100***C210**),
k ranges from 1.0 to 1.3

The greater the k factor, the lower the DC bus level setting the ramp extension.

For example, when **C210**=0.2, power Pout shall exceed 5% of Pmax in order to obtain k>1.
When **C210**=2, 0.5% of Pmax is required to obtain k>1.

NOTE

The braking resistor command is also supplied with **C210 ≠ [With Resistor]**: if the resistor is not connected, nothing happens; if it is connected it will turn on if the deceleration ramp is not sufficiently lengthened.

NOTE

Parameter **C210** is interlocked with parameter **P031** (Gradient variation acceleration reset) so that **C210 ≠ [With Resistor]** cannot be programmed in conjunction with **P031** = 0:No.

C211 Max. Time of Continuous Supply for Braking Resistance

C211			
	Range	0 ÷ 32000	0 ; 320.00 sec
	Default	200	2.00 sec
	Level	ENGINEERING	
	Address	1211	
	Function	This parameter determines the max. continuous operating time required for the braking resistance. If the braking resistance is used for a time **C211** without being deactivated, the braking resistance command is automatically disabled for a time of inactivity set in **C212**.	

C212 Duty Cycle Braking (Ton/(Toff+Ton))

C212			
	Range	0 ÷ 100	0 ÷ 100%
	Default	10	10%
	Level	ENGINEERING	
	Address	1212	
	Function	**C212** = (Ton/(Ton+Toff))*100 This parameter determines the operating duty cycle allowed for the braking resistance. It is expressed as a percentage and defines the time of inactivity of the braking resistance when it is continuously operating for the max. time set in **C211**.	

C213 Frequency Increase for Overvoltage Compensation – Smart Voltage Control SVC (Smart Voltage Control)

C213			
	Range	0 ÷ 1000	0 ÷ 0.1000
	Default	0	0.0000
	Level	ENGINEERING	
	Address	1279	
	Control	IFD	
	Function	If this parameter is set > 0, a value given by **C213** * derivative_voltage_DC (expressed in V/s) is summed up to the frequency currently set for the motor. In that way, when DC voltage abruptly changes due to sudden variations of the load torque, the output frequency is promptly adjusted to compensate for voltage increase and avoid overvoltage conditions. A value equal to 0.0200 ensures optimum operation in most applications; however, the optimum value for this parameter is to be found by trial and error. Example: Suppose that the DC-bus voltage increases by 3 V in 1 ms, such as 3000 V/s. If **C213** is worth 0.02, the following will be instantly summed up to the present output frequency: 3000 * 0.02 / 60 * 2 = 2 Hz for a motor with 2 pole pairs. This amount, however, is limited to 5% of the present output frequency. As per the example above, if fout = 30 Hz, the amount value would be limited to 30 * 0.05 = 1.5 Hz.	

NOTE Parameter **C213** has no effect if **C210** = [With Resistance].

C213a Torque Decrease Proportional Gain due to Overvoltage

C213a			
	Range	0 ÷ 32000	0.000 ÷ 32.000
	Default	20	0.020
	Level	ENGINEERING	
	Address	1251	
	Control	VTC	
	Function	This function is available only when the VTC control is activated. This is the proportional gain of the DC-bus voltage regulator adjusting the resisting torque limit when voltage exceeds the value set in parameter **C213c**.	

C213b Torque Decrease Integral Gain due to Overvoltage

C213b			
	Range	0 ÷ 32000	0.000 ÷ 32.000
	Default	10	0.010
	Level	ENGINEERING	
	Address	1252	
	Control	VTC	
	Function	This function is available only when the VTC control is activated. This is the integral gain of the DC-bus voltage regulator adjusting the resisting torque limit when voltage exceeds the value set in parameter **C213c**.	

C213c Voltage Reference for Torque Decrease

C213c			
	Range	0 ÷ 1200	0.0 ÷ 120.0%
	Default	1000	100.0%
	Level	ENGINEERING	
	Address	1253	
	Control	VTC	
	Function	This function is available only when the VTC control is activated. It sets the reference value for the regulator DC voltage adjusting the resisting torque limit. The limiting function activates when voltage exceeds the value below: **Vth = C213c * Vunlock /100** where **Vunlock** is based on the inverter voltage class and is typically higher than the trip voltage of the braking resistor. The default value ensures that the braking resistor trips before the torque limit function is activated. If the braking resistor is not fitted, it may be useful to set a lower value for this parameter to ensure prompt activation of the torque limit.	

C213d Flux Limit due to Torque Decrease Activation

C213d			
	Range	0 ÷ 1000	0.0 ÷ 100.0%
	Default	0	0.0%
	Level	ENGINEERING	
	Address	1254	
	Control	VTC	
	Function	This function is available only when the VTC control is activated. If the torque limit is adjusted by the DC bus voltage regulator, the rotor flux is decreased by the same value of the torque limit multiplied by the value of this parameter. Example: If the regulator generates a 50% instant torque limit and **C213d** is worth 30%, the flux will be decreased by 50 * 30 / (100 * 100) = 15%, and will be increased to 85% of the value that should be adopted under normal operating conditions. This parameter keeps DC voltage low when the motor acceleration due to external causes continues over time. Low parameter values (< 50%) may cause uncontrolled rotation of the motor.	

40. DC BRAKING MENU

40.1. Overview

When the IFD or VTC control algorithm are used, DC current can be injected into the motor to stop it. DC current may be automatically injected at stop and/or at start; DC current injection may also be controlled by the terminal board. All relevant parameters are included in the DC BRAKING MENU. The intensity of the DC current injected is expressed as a percentage of the rated current of the active motor.

40.1.1. DC Braking at Start and Non-condensing Function

To activate DC braking at start, set **C216** to [YES]. Braking occurs after sending a **START** command, with a speed reference other than zero, before the acceleration ramp. A **START** command may be one of the following: **RUN** command or **REV** command sent via terminal board; **START** command from keypad, etc., depending on the preset control mode. DC braking level and duration are set in the following parameters:

C220 Expressed as a percentage of the rated current of the controlled motor.
C218 Expressed in seconds.

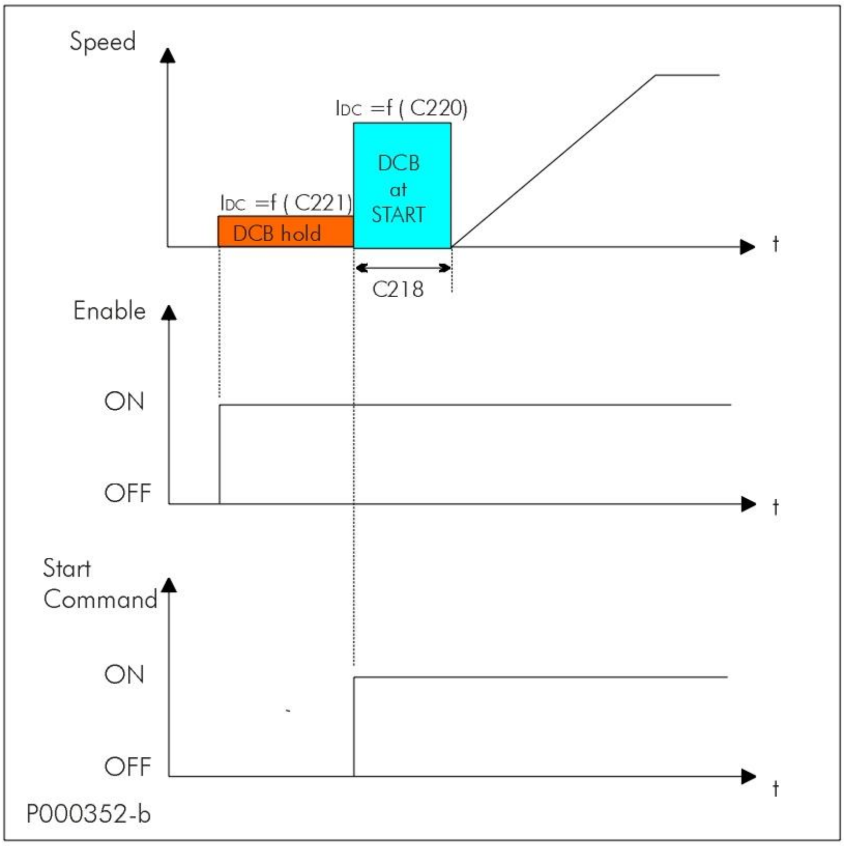


Figure 60: DCB Hold and DCB at Start

Output speed, holding and DC braking current when the DCB Hold and DCB at Start functions are active.

The non-condensing function consists in injecting DC into the motor. DC current brakes the motor and heats the motor windings, thus avoiding condensation. This function is active only for the IFD control if **C221** is other than zero and the **ENABLE** function is activated. For the other control algorithms, the non-condensing function is performed by injecting current during motor fluxing. Parameter **C221**, expressed as a percentage of the rated current of the controlled motor, determines the level of direct current injected into the motor.

Parameters used to program this function are the following:

C216 enabling DCB at Start;
C218 setting the duration of DCB at Start;
C220 setting the intensity of the DC braking;
C221 setting the intensity of the holding current (this function is active for the IFD control only).

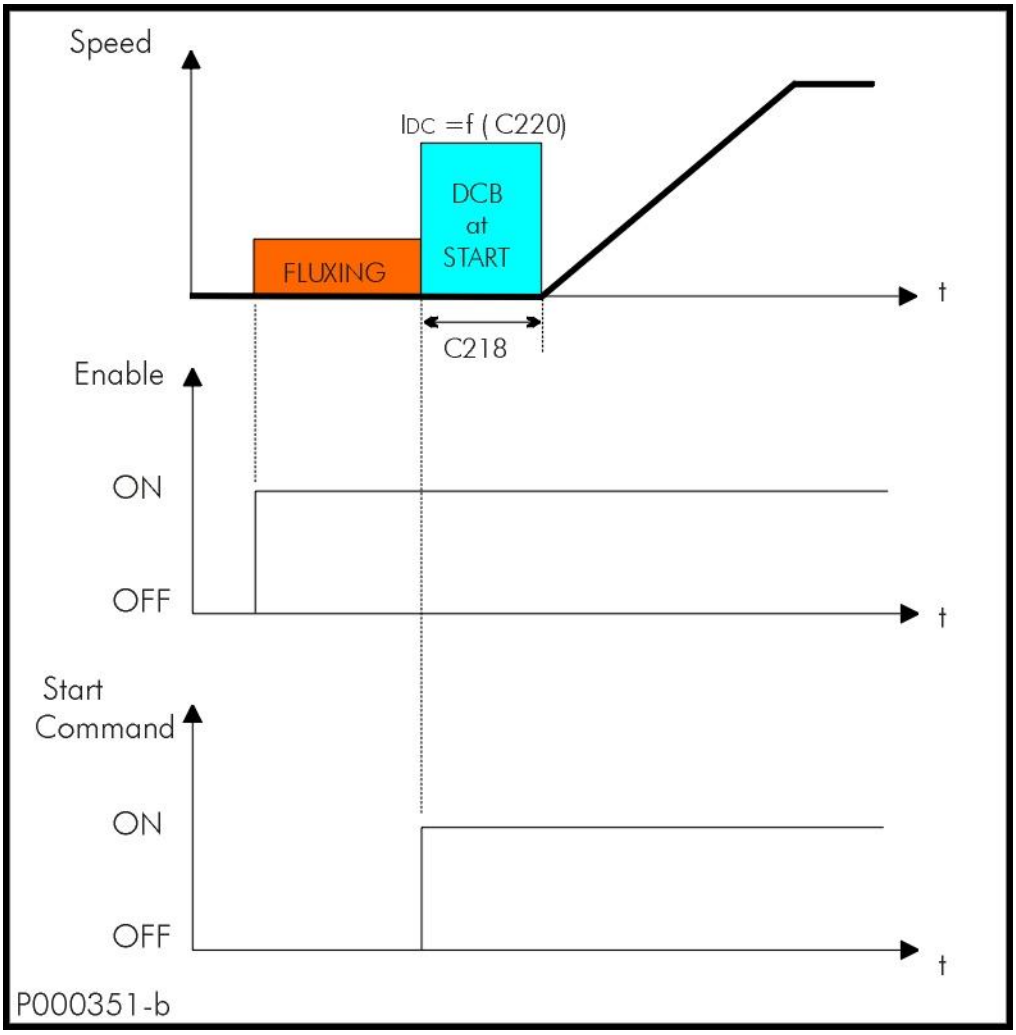


Figure 61: DCB at Start with VTC Control

Output Speed and DC Braking when the DCB At Start Function is active for the Vector Torque control.

40.1.2. DC BRAKING AT STOP

To activate this function, set **C215** to [YES] or, in Power Down mode, set **C234** (Power Down Stop Mode) as DCB.
DC Braking occurs after sending a “stop with ramp” command. The speed level for DC Braking is set in **C219**. If the drive is in Power Down mode and **C234** is set as DCB, the speed level is set in **C235** (Power Down Stop Level).
The figure below illustrates the output speed and DC Braking trends when the DC Braking at Stop function is active.

Parameters used to program this function are the following:

C215 function enabling;
C217 braking duration;
C219 motor speed at the beginning of DC Braking;
C220 intensity of DC braking.
In Power Down mode, if **C234** (Power Down Stop Mode) is set as DCB:
C235 motor speed at the beginning of DC Braking.

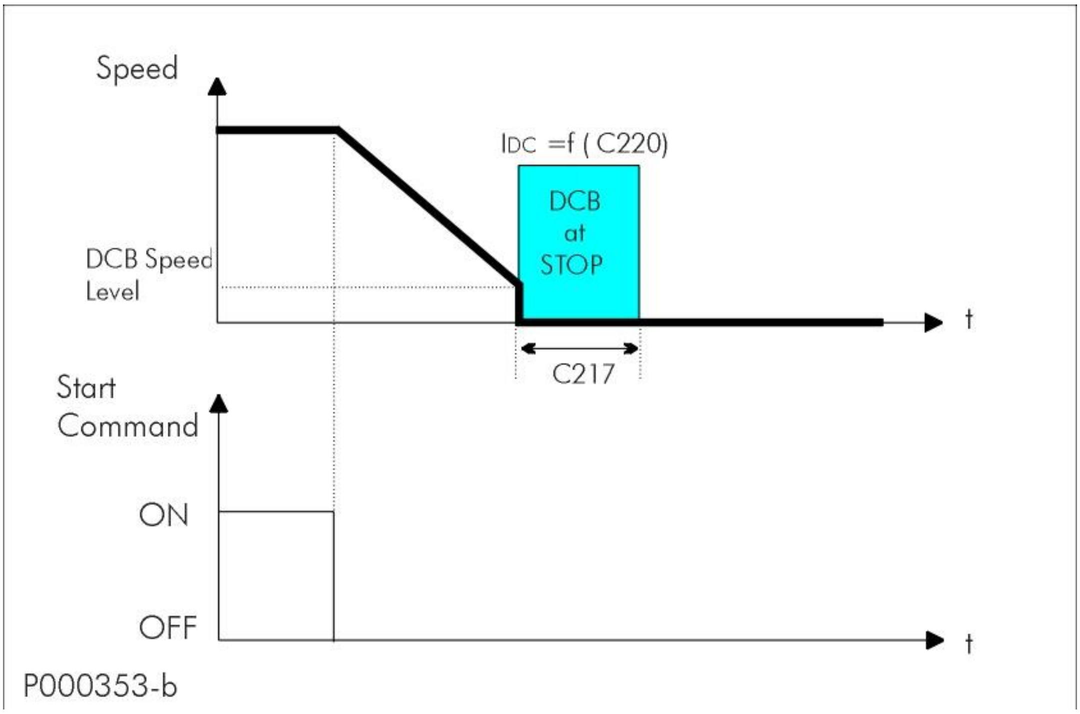


Figure 62: DCB at Stop

Motor speed and DC Braking patterns when the DC BRAKING AT STOP function is active.

40.1.3. DC BRAKING COMMAND SENT FROM DIGITAL INPUT

Activate the digital input set as DCB (**C160**) to send a DC Braking command. DC Braking duration is determined by the following formula:

$t^* =$ **C217** $* \; (n_{OUT}$ / **C219**) with n_{OUT} / **C219** equal to max. 10.

NOTE DC braking sent from digital input operates when the drive ist stopped in IFD and VTC controls. Also, Power Down mode must be disabled (**C225** = 0).

Possible cases:

a) **t1 > t*** time t1 for braking command is longer than t*.

To restart the motor following the preset acceleration ramp when DC Braking is over, just disable the DCB command and disable and enable again the **START** command (see figure below).

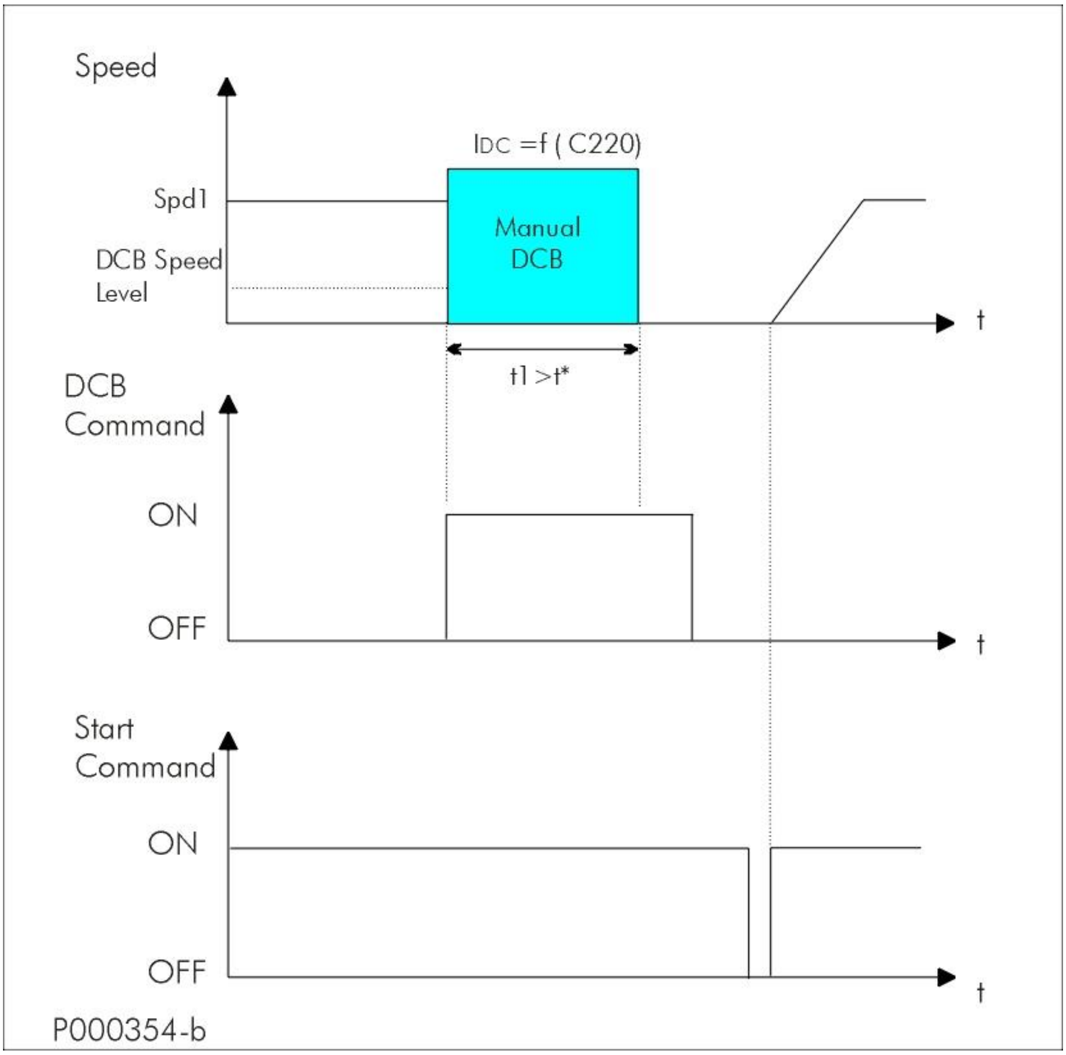


Figure 63: Manual DCB (Example 1)

Motor Speed, DC Braking, Manual DCB Command and START Command if t1>t*.

b) **t1 < t*** time t1 for braking command is shorter than t*.
Two different cases may occur, depending on the control algorithm and the setup of the motor speed searching function.

<u>Speed Searching function disabled (C245 [NO])</u>
Prematurely disable the manual braking command to stop DC braking. If the motor is still rotating, it will start idling. To restart the motor following the preset acceleration ramp, simply disable and enable the **START** command (see Figure 64).

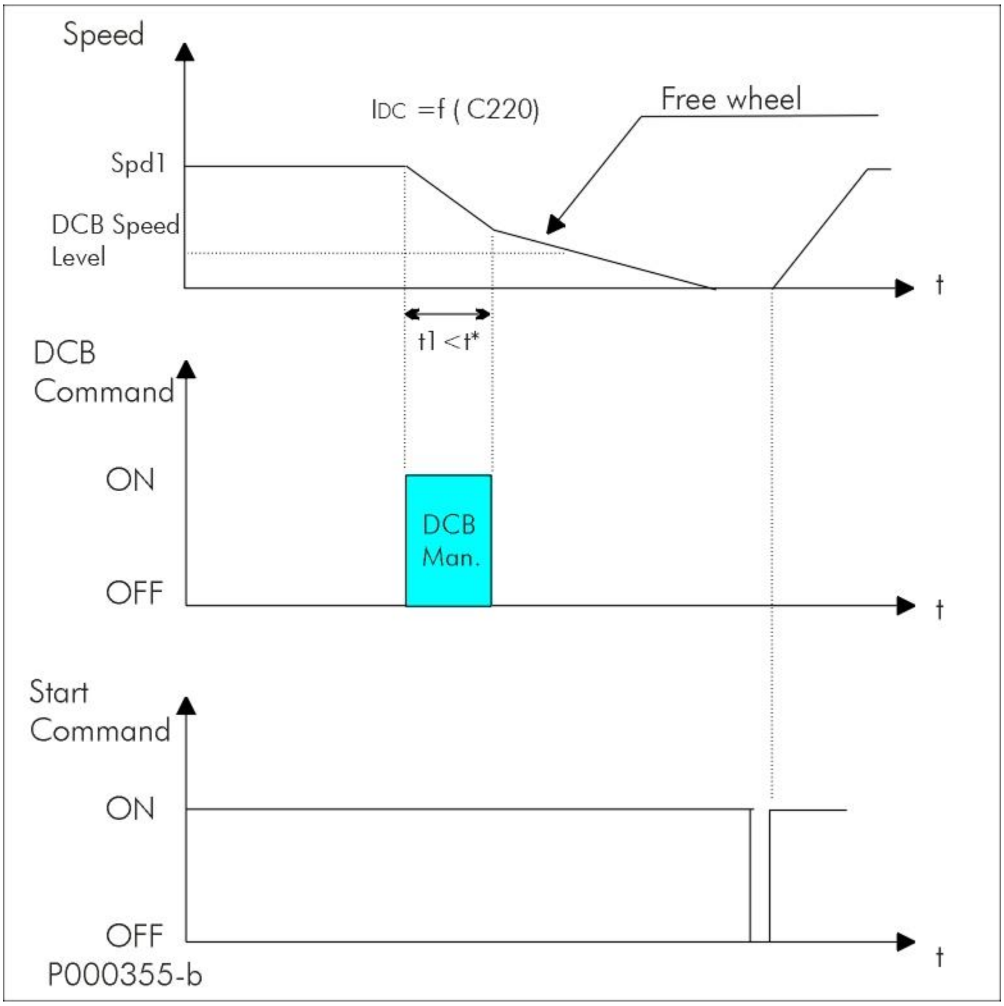


Figure 64: Manual DCB (Example 2)

Motor Speed, DC Braking, Manual DCB Command and START Command if t1<t* and the Speed Searching Function is disabled.

Speed Searching function enabled (C245 [YES])

Prematurely disable the manual braking command to activate the Speed Searching function. When the motor speed searching occurs, the motor speed is increased depending on the preset acceleration ramp (see Figure 65).

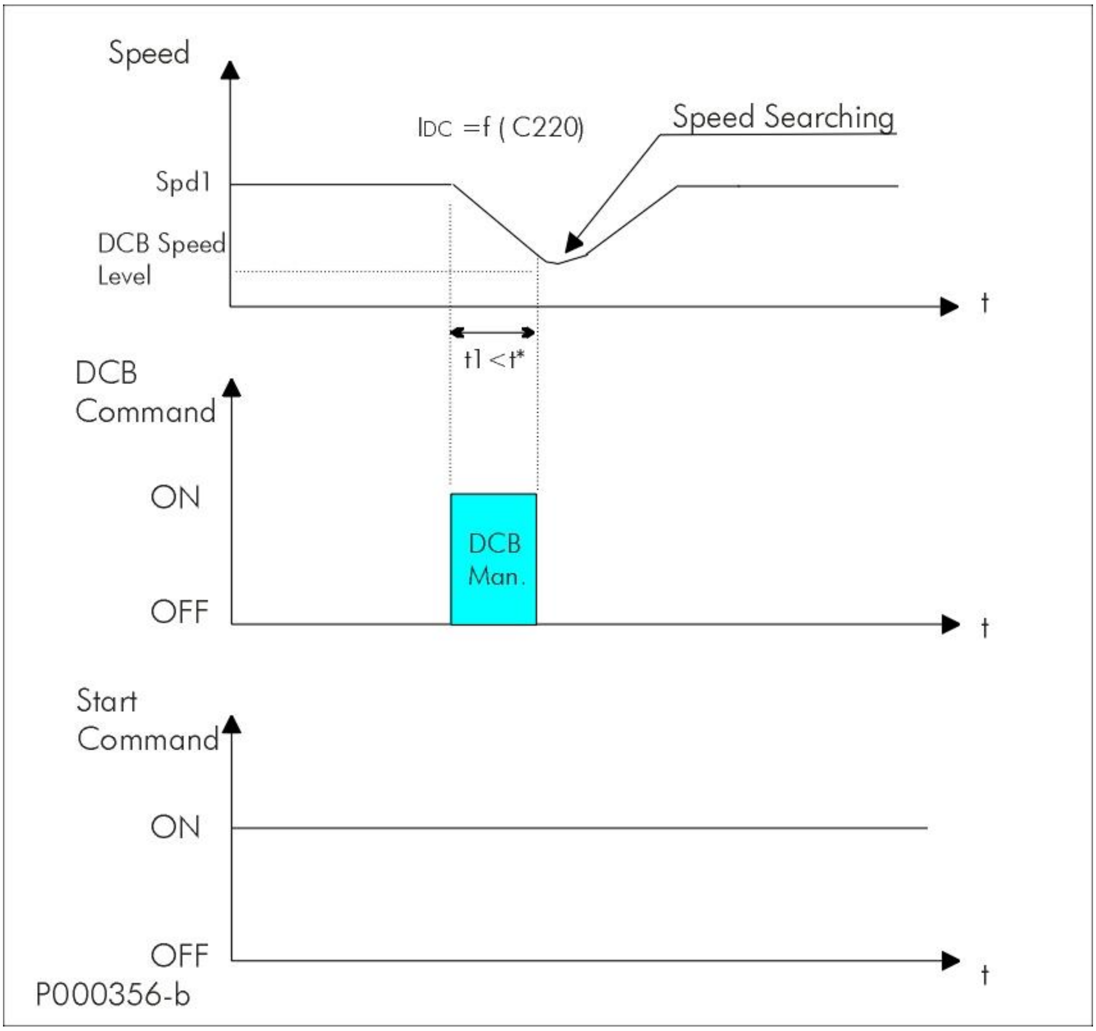


Figure 65: Manual DCB (Example 3)

Motor Speed, DC Braking and Manual DCB Command and START Command if t1<t*, the control algorithm is IFD and the Speed Searching Function is enabled.

40.2. List of Parameters C215 to C224

Table 114: List of Parameters C215 to C224

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
C215	Enabling DCB at Stop Function	ADVANCED	1215	0:NO
C216	Enabling DCB at Start Function	ADVANCED	1216	0:NO
C217	DCB at Stop Duration	ADVANCED	1217	0.5
C218	DCB at Start Duration	ADVANCED	1218	0.5
C219	Speed at the Beginning of DCB at Stop	ADVANCED	1219	50rpm
C219a	VTC Speed Ramp Duration	ENGINEERING	1213	500 ms
C220	DCB Current Level	ADVANCED	1220	100%
C220a	VTC Current Filter Time Constant	ENGINEERING	1214	300 ms
C220b	Proportional Gain of the VTC Current Controller	ENGINEERING	1236	20
C220c	Integral Time Constant of the VTC Current Regulator	ENGINEERING	1237	100 ms
C221	DCB Hold	ADVANCED	1221	0%
C222	Ramp Braking Time for Motor 1 DCB	ENGINEERING	1222	See Table 82 and Table 86
C223	Ramp Braking Time for Motor 2 DCB	ENGINEERING	1223	
C224	Ramp Braking Time for Motor 3 DCB	ENGINEERING	1224	

C215 Enabling DCB at Stop Function

C215			
	Range	0 ÷ 1	0: No; 1: Yes
	Default	0	0: No
	Level	ADVANCED	
	Address	1215	
	Control	IFD and VTC	
	Function	Enables DC Braking during deceleration when the speed set in **C219** is reached (or the speed set in **C235** if in Power Down mode and **C234** [DCB] is reached).	

C216 Enabling DCB at Start Function

C216			
	Range	0 ÷ 1	0: No; : Yes
	Default	0	0: No
	Level	ADVANCED	
	Address	1216	
	Control	IFD and VTC	
	Function	Enables the DC Braking at Start function.	

C217 DCB at Stop Duration

C217			
	Range	1 ÷ 600	0.1; 60.0 sec.
	Default	5	0.5 sec
	Level	ADVANCED	
	Address	1217	
	Control	IFD and VTC	
	Function	Determines the duration of the DCB at Stop function (**C215**=1:Yes or **C160** enabled).	

C218 DCB at Start Duration

C218			
	Range	1 ÷ 600	0.1 ÷ 60.0 sec.
	Default	5	0.5 sec
	Level	ADVANCED	
	Address	1218	
	Control	IFD and VTC	
	Function	Determines the duration of the DCB at Start function.	

C219 Speed at the Beginning of DCB at Stop

C219			
	Range	0; 1000	0; 1000 rpm
	Default	50	50rpm
	Level	ADVANCED	
	Address	1219	
	Control	IFD and VTC	
	Function	Determines the speed at the beginning of DCB at stop while decelerating (**C215**=1:Yes or **C160** enabled).	

C219a VTC Speed Ramp Duration

C219a			
	Range	1 ÷ 32000	1 ÷ 32000 ms
	Default	500	500 ms
	Level	ENGINEERING	
	Address	1213	
	Control	VTC	
	Function	Ramp duration to zero speed before activating DC Brake in case of manual request by digital input (VTC control).	

C220 DCB Current Level

C220			
	Range	0 ÷ MIN [(Ipeak inverter/Imot)*100) ; 120]	0% ÷ Min[Ipeak inverter/Imot, 120%]
	Default	100	100%
	Level	ADVANCED	
	Address	1220	
	Control	IFD and VTC	
	Function	Determines the level of direct current injected to brake the motor. It is expressed as a percentage of the rated current of the controlled motor.	

C220a VTC Current Filter Time Constant

C220a			
	Range	0 ÷ 32000	0 ÷ 32000 ms
	Default	300	300 ms
	Level	ENGINEERING	
	Address	1214	
	Control	VTC	
	Function	Filter time constant for a smooth change between actual currents and DC Brake currents (id=i_DCB, iq=0) when the VTC control algorithm is activated.	

C220b Proportional Gain of the VTC Current Controller

C220b			
	Range	0 ÷ 32000	0 ÷ 32000
	Default	20	20
	Level	ENGINEERING	
	Address	1236	
	Control	VTC	
	Function	Current proportional gain during DC Braking when the VTC control algorithm is activated.	

C220c Integral Time Constant of the VTC Current Regulator

C220c			
	Range	1 ÷ 32000	1 ÷ 32000 ms [Disabled]
	Default	100	100 ms
	Level	ENGINEERING	
	Address	1237	
	Control	VTC	
	Function	Current integral time constant during DC Braking when the VTC control algorithm is activated.	

C221 DCB Hold

C221			
	Range	0 ÷ 100	0; 100%
	Default	0	0%
	Level	ADVANCED	
	Address	1221	
	Control	IFD	
	Function	Determines the level of direct current injected during the Hold function. To activate this function, set a value other than zero in parameter **C221**. DC level is expressed as a percentage of the rated current of the controlled motor.	

C222 (C223, C224) Ramp Braking Time for DCB

C222 (Motor 1) C223 (Motor 2) C224 (Motor 3)			
	Range	2 ÷ 32000	2 ÷ 32000 msec
	Default	See Table 82 and Table 86	
	Level	ENGINEERING	
	Address	1222, 1223, 1224	
	Control	IFD and VTC	
	Function	This parameter represents the time required for field weakening before DCB.	

41. POWER DOWN MENU

41.1. Overview

In the case of power failure, the drive can be kept powered on by exploiting the kinetic energy of the motor and the load: energy recovered due to motor slowing down is used to power the drive, thus avoiding losing the drive control when a black–out occurs.
All parameters relating to the Power Down function are included in the Power Down submenu in the Configuration menu.
The following options are available (parameter **C225**):
– [**NO**]: The function is disabled.
– [**YES**]: After the time set in **C226** (Power Down start delay), starting from the instant when power down occurs, a deceleration ramp takes place (deceleration ramp in Power Down **C227**). The time period of the deceleration ramp can be user-defined.
– [**YES V**]: In case of power down for a time longer than **C226**, the motor coasts to stop, so that DC bus voltage value is kept constant at **C230**. To do so, a PI (proportional–integral) regulator is used, which is adjusted through parameter **C231** (proportional term) and **C232** (integral term).
– [**Alarm**]: In case of power down, when the time set in **C226** is over, alarm **A064** trips (factory setting).

NOTE If the mains loss deactivates the **ENABLE-A** and **ENABLE-B** commands, the motor cannot coast to stop, because these commands are required for the hardware enable of IGBTs.

NOTE If a drive is DC-powered by a Regenerative Penta (or an equivalent drive stabilizing DC bus voltage), Power Down cannot occur (**C008** = xT Regen, where x can be 2, 4, 5, or 6).

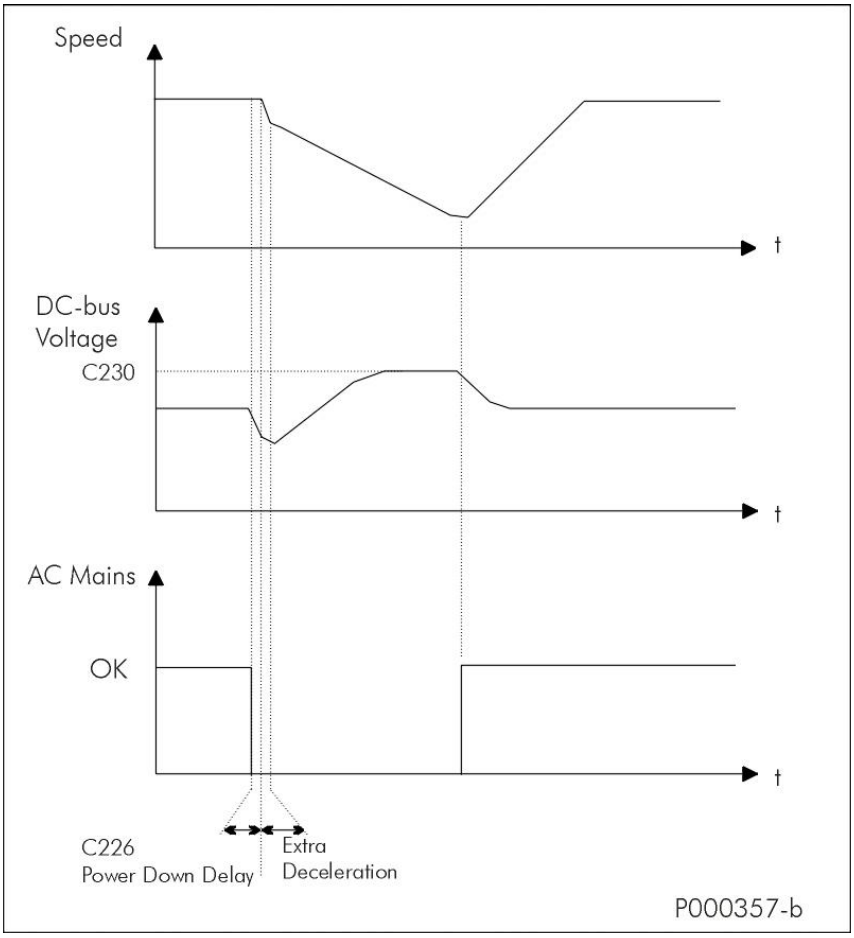


Figure 66: Power Down (Example)

The figure above illustrates the patterns of the motor speed and the DC bus voltage in case of mains loss. In the example above, power supply is restored before the drive turns off and before the deceleration ramp is over, so the motor accelerates with the preset acceleration ramp.

If power supply is restored during the deceleration ramp in Power Down, the connected motor accelerates following the selected acceleration ramp. A speed value for the end of Power Down can be set in **C235**; the desired operating mode at stop can be set in **C234**.
When the motor speed attains the end level of Power Down, the following functions can be selected in parameter **C234**:

– [**Stop**]:The drive will control the motor until it stops down, independently of the value set in **C235**.
When the motor stops and power supply is restored, the RUN command must be disabled and enabled again to accelerate the motor. Warning **W28 OPEN START** is displayed.

– [**DCB**]: When the speed of the Power Down end set in **C235** is attained, DC braking occurs.
If power supply is restored during DC braking, the RUN command must be disabled and enabled again to accelerate the motor. Warning **W28 OPEN START** is displayed.

– [**Stand–By**]: When the speed of the Power Down end set in **C235** is attained, the drive is in stand–by.
If power supply is restored when the drive is on stand-by, the RUN command must be disabled and enabled again to accelerate the motor. Warning **W28 OPEN START** is displayed.

41.2. List of Parameters C225 to C236

Table 115: List of Parameters C225 to C236

Parameter	FUNCTION	Access Level	MODBUS Address	Default Values
C225	Procedure in case of Power Down	ENGINEERING	1225	3:Alarm
C226	Power Down enable delay	ENGINEERING	1226	10 ms
C227	Stop ramp time in Power Down	ENGINEERING	1227	20 sec
C228	Start increment of ramp gradient in P.D.	ENGINEERING	1228	0.10%
C229	Improved sensitivity of DC bus control	ENGINEERING	1229	1
C230	Voltage level of DC bus in Power Down	ENGINEERING	1230	339 V for 2T class 679 V for 4T class (380÷480 V) 707 V for 4T class (481÷500 V) 813 V for 5T class 976 V for 6T class
C231	PI Proportional constant for automatic deceleration	ENGINEERING	1231	0.050
C232	PI Integral time for automatic deceleration	ENGINEERING	1232	0.5 sec
C234	Ramp action at the end of Power Down	ENGINEERING	1234	0: Stop
C235	Motor speed at the end of Power Down	ENGINEERING	1235	0 rpm
C236	Output phase failure alarm	ENGINEERING	441	0: Disable

C225 Procedure in Case of Power Down

C225			
	Range	0 ÷ 3	0: Disabled 1: Yes 2: YesV 3: Alarm
	Default	3	3: Alarm
	Level	ENGINEERING	
	Address	1225	
	Function	Type of power down: 0: **Disabled** The Power Down function is disabled. 1: **Yes** In case of mains loss after a time longer than the time set in **C226** starting from the mains loss detection, the deceleration ramp set in **C227** is performed. 2: **YesV** In case of mains loss, deceleration is automatically regulated by a PI regulator (see **C231** and **C232**), so that voltage level in DC link is kept constant at the reference value set in **C230**. IFD control: because no torque demand regulation is available, the deceleration ramp gradient is adjusted depending on the gradient value set in **C227**. 3: **Alarm** In case of power failure, the **A064 Mains Loss** alarm trips after the time set in **C226**.	

NOTE If a drive is DC-powered by a Regenerative Penta (or an equivalent drive stabilizing DC bus voltage), Power Down cannot occur (**C008** = xT Regen, where x can be 2, 4, 5, or 6).

C226 Power Down Enable Delay

C226			
	Range	1 ÷ 250	1 ÷ 250 ms
	Default	10	10 ms
	Level	ENGINEERING	
	Address	1226	
	Function	This parameter determines the Power Down delay after a mains loss is detected by the drive. If **C225** = Alarm, this delay is applied to the alarm tripped.	

NOTE Setting a too long Power Down delay in case of mains loss can cause the drive to switch off.

C227 Stop Ramp Time in Power Down

C227			
	Range	1 ÷ 32000	1 ÷ 32000 sec
	Default	20	20 sec
	Level	ENGINEERING	
	Address	1227	
	Function	Determines the gradient of the deceleration ramp occurring at Power Down (after the first extra deceleration stage) if **C225** = Yes. IFD Control algorithm: **C227** is the basic gradient for deceleration adjustment when **C225=** Yes V.	

C228 Start Increment of Ramp Gradient in Power Down

C228			
	Range	-100 ÷ 10000	-1.00 ÷ + 100.00 %
	Default	10	0.10%
	Level	ENGINEERING	
	Address	1228	
	Function	Determines an increase in deceleration ramp gradient at the beginning of the Power Down function. This is required to increase DC bus voltage. **C228 = 0%** start deceleration is due to C227 (C228 has no effect) **C228 = 100%** start deceleration is 100 times faster than deceleration set in C227 (start ramp = C227/100 sec) **C228 = -1.00%** start deceleration is zero (deceleration ramp of infinite time)	

C229 Improved Sensitivity of DC Bus Control

C229			
	Range	1 ÷ 250	1 ÷ 250
	Default	1	1
	Level	ENGINEERING	
	Address	1229	
	Function	Based on the DC bus voltage trend, this function allows detecting mains loss in advance. If the value for this coefficient is too high, erroneous mains loss conditions can be detected, due to a sudden drop in DC bus voltage.	

C230 Voltage Level of DC Bus in Power Down

C230	**Range**	250 ÷ 450 for 2T Class 400 ÷ 800 for 4T Class 500 ÷ 960 for 5T Class 600 ÷ 1150 for 6T Class	250 ÷ 450 V for 2T Class 400 ÷ 800 V for 4T Class 500 ÷ 960 V for 5T Class 600 ÷ 1150 V for 6T Class
	Default	339 for 2T Class 679 for 4T Class (380÷480V) 707 for 4T Class (481÷500V) 813 for 5T Class 976 for 6T Class	339 V for 2T Class 679 V for 4T Class (380÷480V) 707 V for 4T Class (481÷500V) 813 V for 5T Class 976 V for 6T Class
	Level	ENGINEERING	
	Address	1230	
	Function	Determines the reference value for DC bus voltage in case of automatic deceleration in Power Down; **C225** = Yes V.	

C231 PI Proportional Constant for Automatic Deceleration

C231	**Range**	0 ÷ 32000	0.000 ÷ 32.000
	Default	50	0.050
	Level	ENGINEERING	
	Address	1231	
	Function	Proportional coefficient used in PI regulator controlling automatic deceleration in case of Power Down; **C225** =Yes V.	

C232 PI Integral Time for Automatic Deceleration

C232	**Range**	1 ÷ 32000	0.001 ÷ 31.999 sec 32000 = Disabled
	Default	500	0.5 sec
	Level	ENGINEERING	
	Address	1232	
	Function	Integral time used in PI regulator controlling automatic deceleration in case of Power Down; **C225** =Yes V.	

C234 Ramp Action at the End of Power Down

C234	**Range**	0 ÷ 2	0: Stop 1: Stand–by 2: Dcb
	Default	0	0: Stop
	Level	ENGINEERING	
	Address	1234	
	Function	When the motor speed during Power Down attains the Power Down end value set in **C235,** three operating modes are possible depending on **C234** programming: [**Stop**] If the drive is capable of bearing DC bus voltage, it will control the motor until it stops irrespective of the speed value set in **C235**. If power supply is restored when the deceleration ramp is over, the RUN command must be disabled and enabled again to accelerate the motor. If power supply is restored when the motor is still decelerating, the speed of reference is forced to the motor with the preset acceleration ramp. [**Stand–by**] When decelerating, once the speed value set in **C235** is attained, the drive is put on stand–by and the motor keeps decelerating (motor idling). If power supply is restored, the same conditions as described in the step above (see [Stop]); instead of stopping the motor, the drive is put on stand–by. [**DCB**] When decelerating, once the speed value set in **C235** is attained, DC braking occurs. Its duration depends on the speed value set in **C235** and on DC braking parameters (see the DC BRAKING MENU): t* = **C217** * (**C235** /**C219**) with **C235**/**C219** equal to max. 10. If power supply is restored, the same conditions as described in the step above occur (see [Stop]); instead of stopping the motor, the drive performs DC braking.	

C235 Motor Speed at the End of Power Down

C235	**Range**	0 ÷ 5000	0 ÷ 5000 rpm
	Default	0	0 rpm
	Level	ENGINEERING	
	Address	1235	
	Function	Motor speed at the end of Power Down. If **C234** is set as [Stand–by], the drive is put on stand-by; if **C234** is set as [DCB], it determines DC braking. Both conditions occur during the deceleration ramp due to Power Down and when the speed value set in **C235** is attained.	

C236 Output phase failure alarm

C236	**Range**	0÷1	0: Disable 1: Enable
	Default	0	0: Disable
	Level	ENGINEERING	
	Address	441	
	Control	IFD	
	Function	Enables management of the output phase failure alarm (**A129**).	

42. SPEED SEARCHING MENU

42.1. Overview

When a command is sent to disable the drive, the motor idles. When the drive activates again, the Speed Searching function allows the drive to reach the motor speed.
All parameters relating to this function are included in the Speed Searching submenu in the Configuration menu.
For FOC control, the motor speed of rotation is always known, so this function is always active and independent of the parameters of the relevant menu.

NOTE The Speed Searching parameters are used for IFD and VTC control algorithm.

When **C245** is set to [YES], do the following to activate the Speed Searching function:
– deactivate and reactivate the **ENABLE** function before t_{SSdis} is over (**C246**);
– if **C185** = 1:[Free wheel], open and close the START command before t_{SSdis} (**C246**) is over;
– disable the DC Braking command before the DC braking preset time is over (see the DC BRAKING MENU);
– reset any alarm tripped (with reference other than 0) before t_{SSdis} is over.
If **C250 ≠ 0 [Disable]**, the Speed Searching function activates only if the programmed input is active.
Speed searching does not take place when the drive turns off due to mains loss.
If the drive restarts after a time longer than t_{SSdis} (**C246**), frequency output is generated following the acceleration ramp, and no speed searching takes place.
If **C246 0: (Always On)**, speed searching (if enabled with **C245**) occurs when the drive restarts (RUN), irrespective of the time elapsed from disabling.
The figures below show output frequency and motor rpm during speed searching.
After time t_0 for rotor demagnetization, speed searching occurs as follows (see 3 steps below):

Speed at the beginning of the speed searching function depends on the settings in C249.

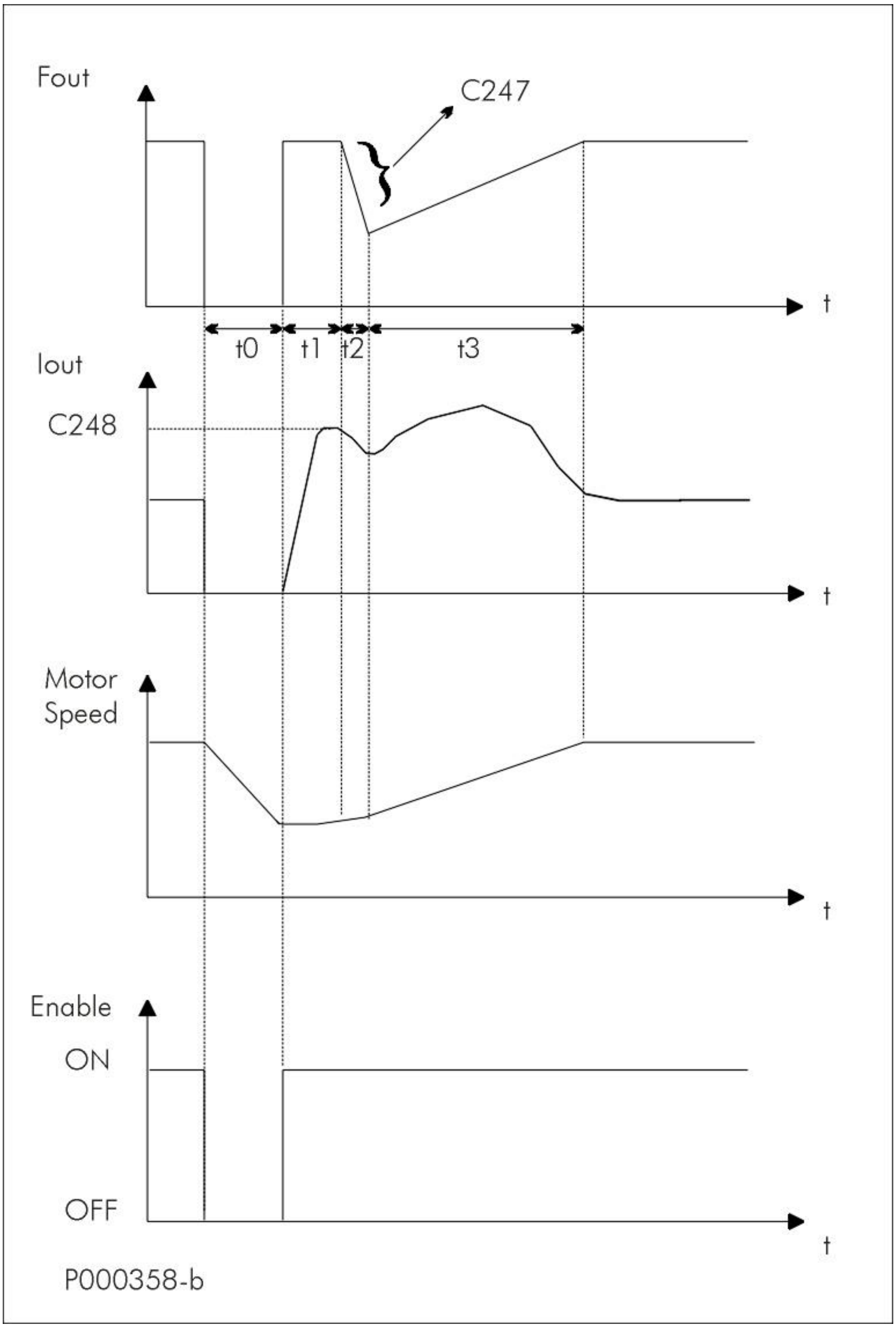


Figure 67: Speed Searching (Example 1)

– Output Frequency and motor RPM for the Speed Searching Function (**C245** = [YES]) activated by the **ENABLE-A** and **ENABLE-B** command. $t_O < t_{SSdis}$ (**C246**) or **C246** = 0.

Three stages:

Time t_1 The drive output frequency corresponds to the last value which was active before disabling the drive; output current matches with the value set in **C248**;
Time t_2 Output frequency is decremented following the ramp set in **C247** for rotation speed searching;
Time t_3 The connected motor accelerates following the acceleration ramp.

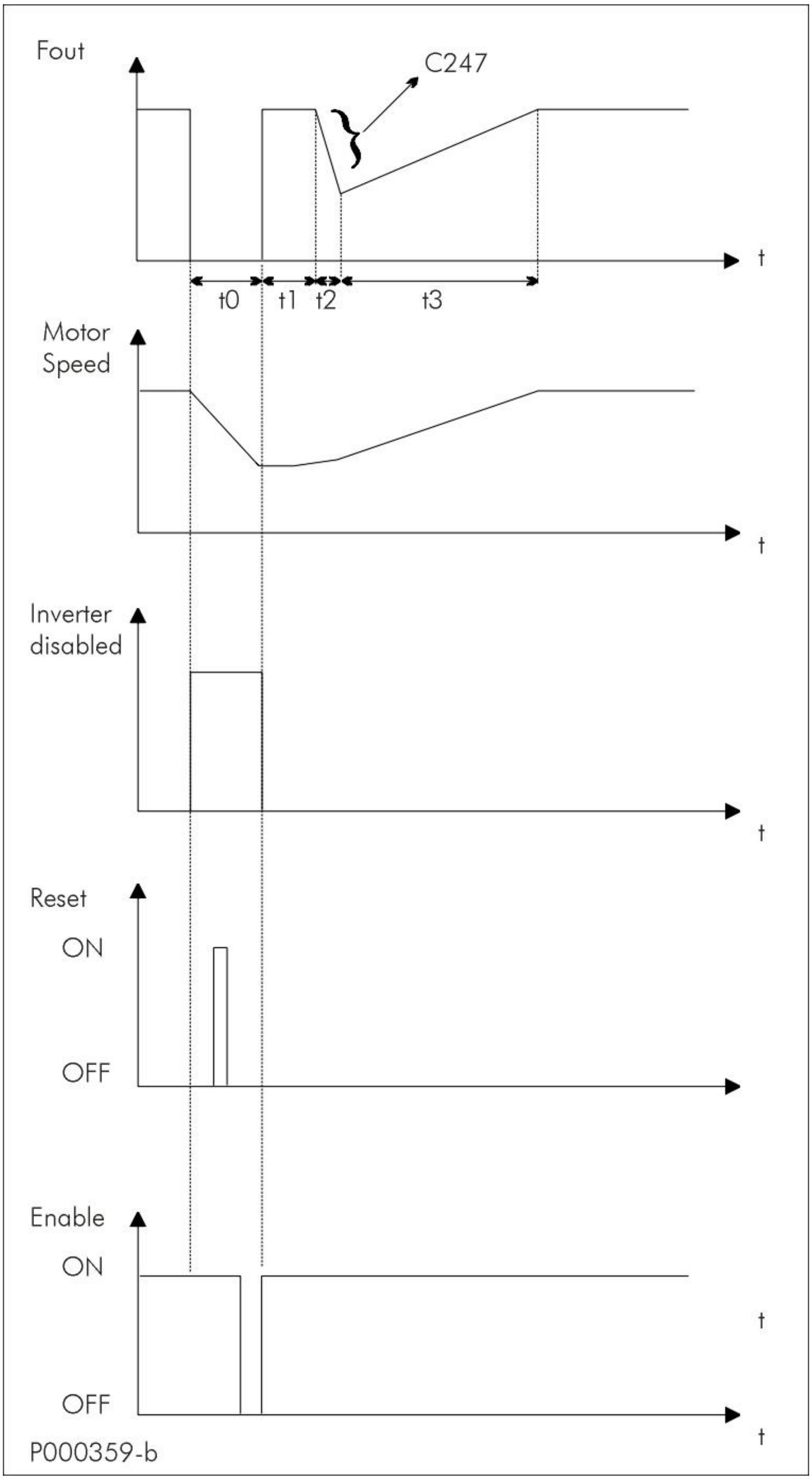


Figure 68: Speed Searching (Example 2)

Frequency, Motor Rpm, Drive Lock, **RESET** and **ENABLE** during Speed Searching (**C245** =[YES]) due to an Alarm Trip $t_{OFF} < t_{SSdis}$ (**C246**) or **C246** = 0.

NOTE If the Safety at Start function is disabled (**C181** = [Inactive]), it is not necessary to activate and deactivate the **ENABLE** function; the Speed Searching activation would match with the **RESET** command.

42.2. List of Parameters C245 to C250

Table 116: List of Parameters C245 to C250

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
C245	Speed Searching enable	ENGINEERING	1245	1: No
C246	Run limit delay for Speed Searching	ENGINEERING	1246	1 sec
C247	Speed Searching time as % deceleration ramp	ENGINEERING	1247	10%
C248	Current used for Speed Searching	ENGINEERING	1248	75%
C249	Speed searching starting level	ENGINEERING	1249	Last speed
C250	MDI for Speed Searching enable	ENGINEERING	1250	0: Disable

C245 Speed Searching Enable

C245			
	Range	0 ÷ 1	0: No ÷ 1: Yes
	Default	0	0: No
	Level	ENGINEERING	
	Address	1245	
	Control	IFD, VTC	
	Function	This parameter enables the speed searching function. The Speed Searching function is enabled in the following cases: – when the **ENABLE** function is deactivated and reactivated before time t_{SSdis} (**C246**); – when the DC Braking command is disabled before the preset time is over (see the DC BRAKING MENU); – when an alarm is reset (with a reference other than 0) before time t_{SSdis}.	

C246 Run limit delay for Speed Searching

C246			
	Range	0; 3000	0:[Always ON] ÷ 3000 sec
	Default	1	1 sec
	Level	ENGINEERING	
	Address	1246	
	Control	IFD, VTC	
	Function	Determines the maximum allowable time passing between the drive disable and enable command when the Speed Searching function is activated. When the drive is restarted, output frequency will depend on the preset acceleration ramp. When **C246** = 0: (Always ON) , speed searching will always occur, independently of the time passing between the drive disable and enable.	

C247 Frequency Decrease Rate

C247			
	Range	1 ÷ 1000	1 ÷ 1000%
	Default	10	10%
	Level	ENGINEERING	
	Address	1247	
	Control	IFD, VTC	
	Function	This parameter sets the frequency decrease rate during the speed search stage. This rate (expressed in Hz/s) is given from the following formula: v = (f_{max} x **C247**) / 10 This means that when **C247**=100%=1, the Penta drive takes 10s to go from the max. frequency to 0Hz. When C247=10%=0.1 (default value), the system takes 100s to go from the max. frequency to 0Hz. The maximum frequency of the connected motor is given from the following formula: f_{max} = (npoles x **C029**) / (2 x 60).	

NOTE The frequency decrease rate is not dependent on the preset ramp times.

NOTE When the Penta drive enters the current limitation mode, the time the system takes for speed searching can be longer than the preset time.

C248 Current Used for Speed Searching

C248			
	Range	20 ÷ Min[Ipeak inverter/Imot, 100]	20% ÷ Min[Ipeak inverter/Imot, 100%]
	Default	75	75%
	Level	ENGINEERING	
	Address	1248	
	Control	IFD, VTC	
	Function	Determines the max. current level for speed searching; it is expressed as a percentage of the rated motor current.	

C249 Speed Searching Starting Level

C249			
	Range	0 ÷ 3	0: Last speed 1: MaxSpd/Last dir. 2: MaxSpd/Pos. Dir. 3: MaxSpd/Neg.Dir.
	Default	0	0: Last speed
	Level	ENGINEERING	
	Address	1249	
	Control	IFD, VTC	
	Function	Speed Searching starts according to the value set in **C249**: **C249 = 0:[Last Speed Value]** – the last speed search value generated before disabling the system is used for speed searching. **C249 = 1:[MaxSpd/LastDir.]** – the max. speed programmed for the motor in the last direction of rotation of the connected motor is produced. **C249 = 2:[MaxSpd/Pos.Dir]** – the speed searching function will begin with the max. speed programmed for the motor in the positive direction of rotation independently of the last frequency value produced before disabling the drive. **C249 = 3:[MaxSpd/Neg.Dir]** – as “2”, but the direction of rotation of the connected motor will always be negative.	

C250 MDI for Speed Searching Enable

<table>
<tr><td rowspan="6">C250</td><td>Range</td><td>0 ÷ 16
0 ÷ 24 if ES847 or ES870 is fitted</td><td>0 → Inactive
1 ÷ 8 → MDI1 ÷ MDI8
9 ÷ 12 → MPL1 ÷ MPL4
13 ÷ 16 → TFL1 ÷ TFL4
17 ÷ 24 → XMDI1 ÷ XMDI8</td></tr>
<tr><td>Default</td><td>0</td><td>0: Inactive</td></tr>
<tr><td>Level</td><td colspan="2">ENGINEERING</td></tr>
<tr><td>Address</td><td colspan="2">1250</td></tr>
<tr><td>Control</td><td colspan="2">IFD, VTC</td></tr>
<tr><td>Function</td><td colspan="2">If set to Inactive, it will take no effect. Otherwise, Speed Searching activates only if the preset input is active.</td></tr>
</table>

43. AUTORESET MENU

43.1. Overview

The Autoreset function can be enabled in case an alarm trips. You can enter the maximum number of autoreset attempts and the time required for resetting the attempt number. If the Autoreset function is disabled, you can program an autoreset procedure at power on, which resets an active alarm when the drive is shut off. Undervoltage alarms or mains loss alarms can be saved in the fault list in the Autoreset menu.
To activate the Autoreset function, set a number of attempts other than zero in parameter **C255**. When the number of reset attempts is the same as the value set in **C255**, the autoreset function is disabled. It will be enabled again only when a time equal to or longer than the time set in **C256** has passed.
If the drive is turned off when an alarm is active, the alarm tripped is stored to memory and will be active at next power on. Regardless of the Autoreset function setup, an automatic reset of the last alarm stored can be obtained when the drive is next turned on (**C257** [Yes]). Undervoltage alarm **A047** (DC bus voltage below allowable threshold with motor running) or Mains Loss alarm **A064** (mains loss when the motor is running and the Power Down function is disabled) are not stored in the fault list when the drive is powered off (factory-setting). To enable parameter storage, set **C258** to [Yes].

43.2. List of Parameters C255 to C258

Table 117: List of Parameters C255 to C258

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
C255	Autoreset Attempt Number	ENGINEERING	1255	0
C256	Attempt Counting Reset Time	ENGINEERING	1256	300 sec
C256a	Autoreset Delay Time	ENGINEERING	440	0 sec
C257	Alarm Reset at Power On	ENGINEERING	1257	0: [Disabled]
C258	Enable Undervoltage and Mains Loss alarms	ENGINEERING	1258	0: [Disabled]

C255 Autoreset Attempt Number

C255			
	Range	0 ÷ 100	0 ÷ 100
	Default	0	0
	Level	ENGINEERING	
	Address	1255	
	Function	If set other than 0, this parameter enables the Autoreset function and sets the max. allowable number of reset attempts. The autoreset attempt count is reset when a time equal to the time set in **C256** passes starting from the last alarm tripped.	

C256 Attempt Counting Reset Time

C256			
	Range	0; 1000	0; 1000 sec.
	Default	300	300 sec.
	Level	ENGINEERING	
	Address	1256	
	Function	Determines the time that passes from the last alarm tripped to reset the autoreset attempt number.	

C256a Autoreset Delay Time

C256a			
	Range	0; 65000	0; 6500.0 sec
	Default	0	0.0 sec
	Level	ENGINEERING	
	Address	440	
	Function	If this parameter is other than zero, the inverter waits for the time set in **C256a** before automatically resetting any alarm.	

C257 Alarm Reset at Power On

C257			
	Range	0; 1	0: [Disabled]; 1: [Yes]
	Default	0	0: [Disabled]
	Level	ENGINEERING	
	Address	1257	
	Function	At power on, this parameter enables the automatic reset of the alarms tripped when the drive is powered off.	

C258 Enable Saving Undervoltage and Mains Loss Alarms

C258			
	Range	0; 1	0: [Disabled]; 1: [Yes]
	Default	0	0: [Disabled]
	Level	ENGINEERING	
	Address	1258	
	Function	This parameter saves Undervoltage and Mains Loss alarms to the fault list.	

44. MOTOR THERMAL PROTECTION MENU

44.1. Overview

The Motor Thermal Protection function protects the motor against overloads.
Some Sinus Penta models offer the possibility to set the heatsink temperature for the activation of cooling fans.
All relevant parameters are included in the Motor Thermal Protection menu.

NOTE

Each connected motor has its own thermal model.
If the drive is used to control only one motor and its control mode is selected through the selection of the different motors, the motor thermal protection is ensured by setting PTC protection for all motors.

For each programmable motor, thermal protection can be configured in 4 modes, which can be selected with parameter **C265** (or **C268** or **C271** for motor 2 and 3 respectively), depending on the cooling system being used (configuration modes 1, 2 and 3):

Value	Descr.	IEC 34-6 Compliance	Description
0:NO	**[NO]**	-	The Motor Thermal Protection function is disabled.
1:YES	**[No Derated]**	IC410	The Motor Thermal Protection function is active with trip current **It** independent of operating speed (No derating).
2:YES A	**[Forced Cooling]**	IC416	The Motor Thermal Protection function is active with trip current **It** depending on operating speed, with fan-cooled motor de-rating (Forced Cooling).
3:YES B	**[Fan on Shaft]**	IC411	The Motor Thermal Protection function is active with trip current **It** depending on operating speed, de-rating is suitable for motors having a fan keyed to the shaft (Fan on Shaft) (factory setting).

When **C265**=1, 2 and 3, the motor thermal model is considered. The heating of a motor is proportional to the square of the current flowing (I_o^2). The Motor overheated alarm (**A075**) will trip after the time "t" computed based on the motor thermal model is over.
The alarm can be reset only after a given time depending on the thermal constant (**C267**) of the motor, thus allowing for the correct cooling of the motor.

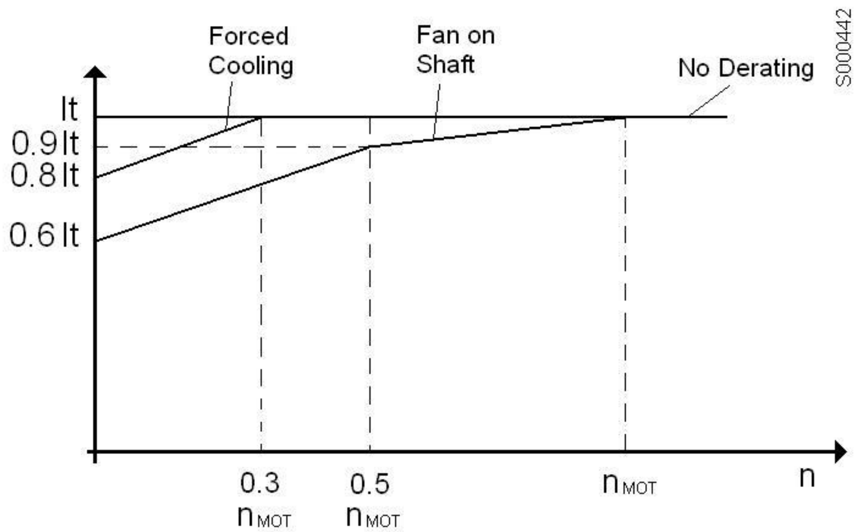


Figure 69: Trip current reduction depending on speed values

The graph above shows how trip current **It** is reduced depending on the generated speed based on the value set in parameter **C265**.

NOTE The motor heating can be monitored with measure **M026a**.
This value is expressed as a percentage of the asymptotic value that can be attained.

When **C274**=Enabled, the thermal protection function is implemented from a PTC sensor: the PTC alarm (**A055**) trips when voltage acquired by AIN2 used as a PTC signal input exceeds a preset threshold value when the characteristic temperature is attained. Alarm **A055** can be reset only if temperature decreases by 5% with respect to the trip temperature.

NOTE In any case, parameter **C265** is independent of parameter **C274**. These two configurations can coexist and if either one is disabled, the other will still be active.

44.2. Choosing the Characteristic Parameters

Parameter **C266** relates to the instantaneous trip current that the internal thermal protection function will begin to monitor the current. The default value of 105% is a typical value and it is usually unnecessary to change it.

The motor thermal time is specific to the motor design and it varies between different motor manufacturers.

If the motor thermal time is unknown, the thermal time constant (**C267**) can be set up as described in the sections below (IEC Class, Maximum Locked Rotor Time – Basic and Maximum Locked Rotor Time – Enhanced).
The first method is the most simple and gives an approximate result. The other two methods are more complex, but give more accurate results.

44.2.1. IEC Class

The motor can be protected as defined in the IEC 60947-4-1 standard for the thermal overload relays.
If the protection class is known, in order to set-up the thermal protection for a certain IEC trip class, the value of **C267** can be entered as:

IEC Class	C267 [s]
10	360
20	720
30	1080

Table 118: Suggested values for the motor thermal time constant

The standard above defines a 7.2 ratio between LRC and FLC.
The value to be entered in **C267** is then defined from the formula below:

C267 = IEC Class x 36.

If the ratio between LRC and FLC is not 7.2, please refer to the graph in Figure 70.

44.2.2. Maximum Locked Rotor Time – Basic

If the IEC class is not known, then the IEC class can be approximated by the procedure described below.

The following values must be known:
- Full Load Current (FLC) of the motor
- Locked Rotor Current (LRC)
- Maximum Locked Rotor Time (LRT) or Direct On Line (DOL) Start Time

The FLC of the motor can be obtained directly from the nameplate on the motor. The LRC and LRT must be obtained from the manufacturer or the motor datasheets.
The LRC, also referred to as starting current or motor start-up current, is the current that a motor draws at start-up when full voltage is applied to the terminals.
LRT is the time a motor can safely maintain LRC from a cold start. This information might also be available as a thermal withstand curve or a thermal damage curve. If this is the case, then the LRC and LRT must be deduced from the curves.

The following formula can be applied:

$$\text{IEC Class} = \frac{\text{LRC} \times \text{LRT}}{\text{FLC} \times 6}$$

Once the approximated IEC class has been calculated, use the motor thermal time constant (**C267**) that corresponds to the closest IEC class from above.

Example 1a: the 7.5k W motor in the table below can be approximated to have a trip class of:

$$\text{IEC Class} = \frac{820 \times 20}{100 \times 6} = 27.3$$

The motor thermal time constant that you would select is IEC class 30, **C267** = 1080 s.

NOTE As an even quicker guide, the IEC trip class can generally be approximated as the locked rotor time.

Table 119: Typical datasheet for 4-pole, 50Hz-400V motors

Output [kW]	IEC Frame	Locked Rotor Current - LRC [% FLC]	Full Load Current - FLC [A]	Locked Rotor Time (cold) - LRT [s]	Rated speed [rpm]	
0.12	63	450	0.41	44	1415	
0.18	63	460	0.58	59	1400	
0.25	71	500	0.7	106	1400	
0.37	71	500	1.03	81	1395	
0.55	80	600	1.3	37	1430	
0.75	80	570	1.61	35	1420	
1.1	90S	700	2.37	31	1445	
1.5	90L	750	3.28	22	1450	
2.2	112M	720	4.42	55	1455	
4	112M	660	7.85	26	1445	
5.5	132S/M	850	10.34	26	1465	
7.5	132S/M	820	14	20	1465	Example 1a/1b
9.2	160M	560	17.4	59	1460	
11	160M	600	20.84	42	1465	
15	160L	650	28.4	37	1465	
18.5	180M/L	800	34.83	26	1470	
22	180L	790	39.4	35	1475	
30	200L	700	55.6	40	1475	
37	225S/M	720	65.2	35	1480	
45	225S/M	740	78.11	33	1480	
55	250S/M	720	95.2	37	1480	
75	250S/M	750	131.25	35	1480	
90	280S/M	780	154.41	55	1485	
110	315S/M	760	189	64	1485	
132	315S/M	780	225.53	55	1485	
150	315S/M	750	260	44	1485	
160	315S/M	760	277	44	1485	
185	355M/L	720	320	117	1490	
200	355M/L	660	342	108	1490	
220	355M/L	700	375	84	1490	
250	355M/L	690	425	79	1490	Example 2
260	355M/L	650	445	90	1490	
280	355M/L	710	471	86	1490	
300	355M/L	670	504	103	1490	
315	355M/L	670	529	92	1490	
330	355M/L	650	554	70	1490	

44.2.3. Maximum Locked Rotor Time – Enhanced

If a more precise calculation is required, when the ratio between LRC and FLC is different from 7.2, you can refer to the graph below, where the x axis shows the LRC/FLC ratio, and the y axis shows the multiplicative constant to be applied to the LRT to calculate the value of parameter **C267**:

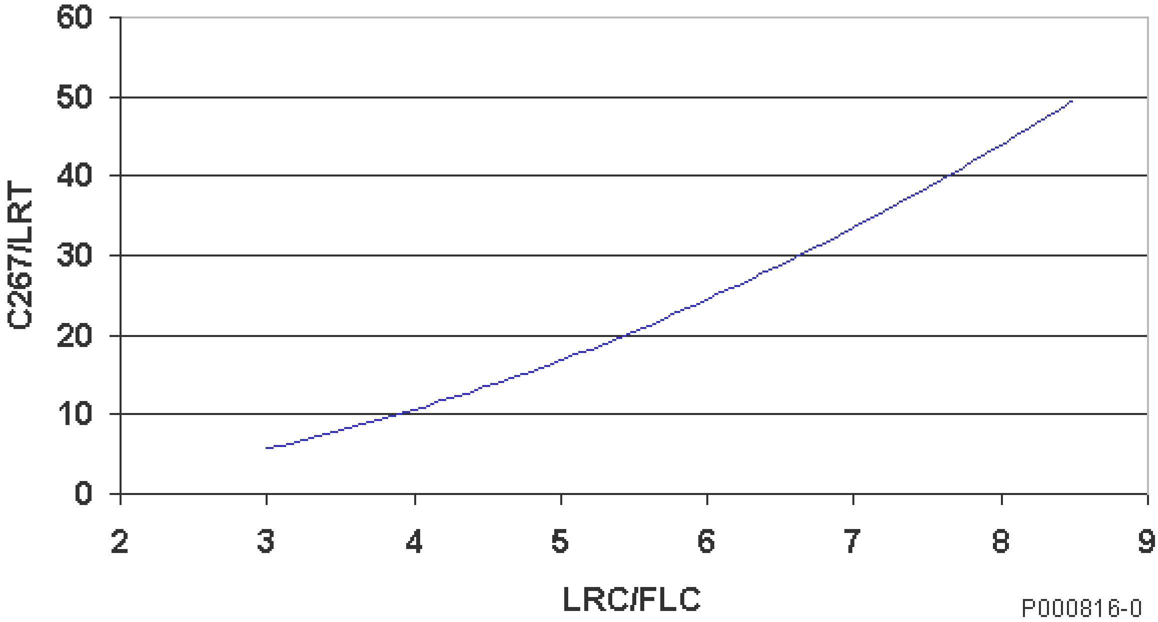


Figure 70: Set up of parameter C267 depending on the LRC/FLC ratio

Example 1b: When using a 7.5 kW motor, the multiplicative constant corresponding to an LRC/FLC=8.2 is approx. 46 if referring to the graph above.

As a result, the motor thermal time constant that you would select is 27.3 x 46, **C267** = 1257 s, which is a more accurate value than 108 0s computed in Example 1a.

Example 2: The 250 kW motor in Table 119 can be approximated to have a trip class of:

$$\text{IEC Class} = \frac{690 \times 79}{100 \times 6} = 90.85$$

Because this value is not given in Table 118, the motor thermal time constant that you would select is directly **C267** = 90.85 x 36 = 3260 s, or 90.85 x 33 = 2998 s if the value “33” is considered, resulting from Table 119 with a ratio between LRC/FLC=6.9.

44.3. Thermal Protection Trip Delay

The graph below shows the thermal protection trip delay depending on the IEC Class and the current flowing (which is supposed to be constant).
Parameter **C266** (trip current) is factory set to 105%.

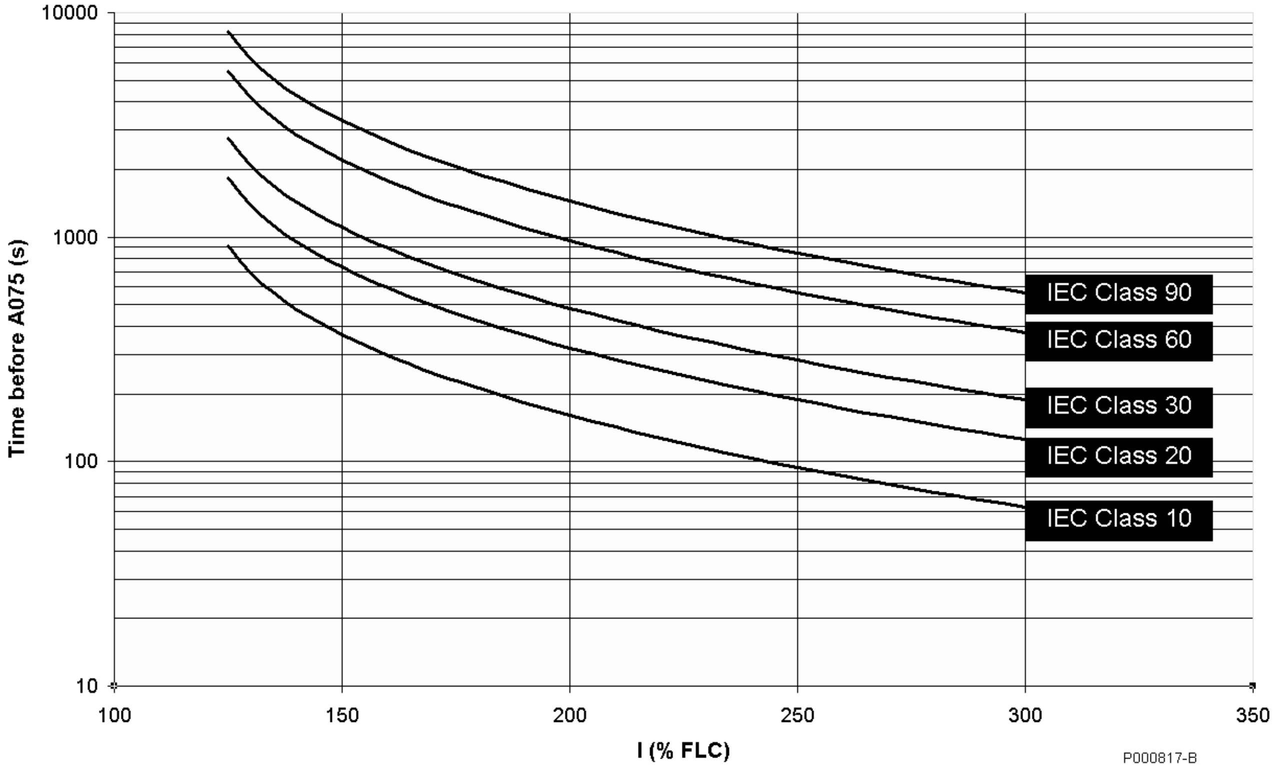


Figure 71: Trip delay of alarm A075 based on the IEC Class

Example: The protection level is compliant with IEC Class 30. If the current flowing is 200% of the FLC, alarm **A075** will trip after approx. 480s (8 minutes).

44.4. List of Parameters C264 to C274

Table 120: List of Parameters C264 to C274

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
C264	Heatsink Temperature for Fan Activation	ADVANCED	1264	50 °C
C264a	Fan Activation Logic Selector	ADVANCED	1280	0: Default
C265 M1	Thermal Protection Activation	BASIC	1265	3: [Fan Shaft]
C268 M2		ENGINEERING	1268	
C271 M3			1271	
C266 M1	Trip Current for [Imot%]	ADVANCED	1266	105%
C269 M2		ENGINEERING	1269	
C272 M3			1272	
C267 M1	Thermal Time Constant	BASIC	1267	720 s
C270 M2		ENGINEERING	1270	
C273 M3			1273	
C274	PTC Thermal Protection Enable	BASIC	1274	0: [Disabled]

C264 Heatsink Temperature for Fan Activation

C264			
	Range	0 ÷ 50	0 ÷ 50°C
	Default	50	50°C
	Level	ADVANCED	
	Address	1264	
	Function	This parameter sets the heatsink threshold for the activation of its cooling fans according to the control logic set in **C264a**. This parameter is active only if **C264a**=0: Default or 2: By Temperature Only. The actual temperature of the heatsink can be displayed in measure parameter **M064**.	

C264a Fan Activation Logic Selector

C264a			
	Range	0 ÷ 2	0: [Default] 1: [Always On] 2: [By Temperature Only]
	Default	0	0: [Default]
	Level	ADVANCED	
	Address	1280	
	Function	This parameter defines the control logic of the heatsink cooling fans. 0: [Default]: The heatsink cooling fans are on whenever the drive is enabled (and IGBTs are switching); when the drive is disabled, fans are off only if the heatsink temperature drops below **C264**. 1: [Always On]: Fans are always on. 2: [By Temperature Only]: Fans are on only if the heatsink temperature is higher than the value set in **C264**, regardless of the drive status.	

NOTE

Parameters **C264** and **C264a** take effect only for the Penta models where fans are controlled directly by the drive control board (F), as displayed on the Product screen in the PRODUCT MENU. See Table 17 and Table 18.

P	r	o	d	u	c	t		N	a	m	e				
P	E	N	T	A											
T	y	p	e		0	0	2	0		4	T		F	-	-

C265 (C268, C271) Thermal Protection Activation

C265 (Motor 1) **C268 (Motor 2)** **C271 (Motor 3)**	**Range**	0 ÷ 3	0 : [Disabled] 1 : [No Derating] 2 : [ForcedCool.] 3 : [Fan Shaft]
	Default	3	3: [Fan Shaft]
	Level	BASIC (**C265**); ENGINEERING (**C268**, **C271**)	
	Address	1265; 1268; 1271	
	Function	This parameter enables the Motor Thermal Protection function. It also selects the type of thermal protection among different trip patterns.	

C266 (C269, C272) Pick-up Current

C266 (Motor 1) **C269 (Motor 2)** **C272 (Motor 3)**	**Range**	1 ÷ minimum between Imax/Imot and 120%	1 ÷ minimum between Imax/Imot and 120%
	Default	105	105%
	Level	ADVANCED (**C266**); ENGINEERING (**C269**, **C272**)	
	Address	1266, 1269, 1272	
	Function	This parameter sets the thermal protection pick-up current expressed as a percentage of the rated current of motor 1 (2, 3).	

C267 (C270, C273) Thermal Time Constant

C267 (Motor 1) **C270 (Motor 2)** **C273 (Motor 3)**	**Range**	1 ÷ 10800	1 ÷ 10.800 s
	Default	720	720 s (corresponding to IEC Class 20)
	Level	BASIC (**C267**); ENGINEERING (**C270**, **C273**)	
	Address	1267; 1270; 1273	
	Function	This parameter sets the thermal time constant of the connected motor. The time constant is the time within which the calculated thermal stage has reached 63% of its final value. The motor attains its thermal time constant when it operates in constant load conditions for a time equal to approx. 5 times the constant set in this parameter.	

C274 PTC Thermal Protection Enable

C274	**Range**	0 ÷ 1	0: Disabled ÷ 1: Enabled
	Default	0	Disabled
	Level	ADVANCED	
	Address	1274	
	Function	This parameter enables the PTC probe (AIN2 analog input)	

NOTE If the PTC thermal protection (**C274**) is enabled, the reference from **AIN2** is automatically managed as a 0 ÷10V input. The only parameter enabled for the control of AIN2 is **P064**; **P060, P061, P062** and **P063** cannot be viewed and are not considered for calculations.

45. MAINTENANCE MENU

45.1. Overview

The Maintenance menu allows setting partial counters for the drive Operation Time (**M065**) and Supply Time (**M066**). When the preset time is reached, a warning message appears (**W48** OT Time over and **W49** ST Time over respectively).

45.2. List of Parameters C275 to C278

Table 121: List of Parameters C275 to C278

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C275	Operation time counter reset	ENGINEERING	1275	NO
C276	Operation time threshold	ENGINEERING	1276	0h
C277	Supply time counter reset	ENGINEERING	1277	NO
C278	Supply time threshold	ENGINEERING	1278	0h

C275 Operation time counter reset

C275			
	Range	0 ÷ 1	0: [NO] ÷ 1 [YES]
	Default	0	NO
	Level	ENGINEERING	
	Address	1275	
	Function	This parameter resets the partial counter for the drive operation time.	

C276 Operation Time Threshold

C276			
	Range	0 ÷ 65000	0 ÷ 650000h
	Default	0	0h
	Level	ENGINEERING	
	Address	1276	
	Function	This parameter sets the threshold for the operation time of the drive. When this time is exceeded, Warning “**W48 OT Over**” appears. To reset the warning message, reset the partial counter or set the counter threshold to zero.	

C277 Supply Time Counter Reset

C277			
	Range	0 ÷ 1	0: [NO] ÷ 1 [YES]
	Default	0	NO
	Level	ENGINEERING	
	Address	1277	
	Function	This parameter resets the partial counter for the drive supply time.	

C278 Supply Time Threshold

C278			
	Range	0 ÷ 65000	0 ÷ 650000h
	Default	0	0h
	Level	ENGINEERING	
	Address	1278	
	Function	This parameter sets the threshold for the supply time of the drive. When this time is exceeded, Warning “**W49 ST Over**” appears. To reset the warning message, reset the partial counter or set the counter threshold to zero.	

46. PID CONFIGURATION MENU

46.1. Overview

The Sinus Penta is provided with two separate PID (Proportional, Integral, Derivative) regulators allowing performing regulation loops such as pressure control, delivery control, etc., with no need to connect external auxiliary devices.
The PID Configuration Menu defines configuration parameters for the two PID regulators.
The configuration parameters for the PID regulator can be modified only when the drive is in stand-by and they set the following variables: reference sources, feedback sources and type of PID output action.
The programming parameters for the two PID regulators, including coefficients of proportional, integral and derivative terms, output saturation, etc., are covered in the PID PARAMETERS MENU and the PID2 PARAMETERS MENU.

46.2. Operation and Structure of the PID Regulator

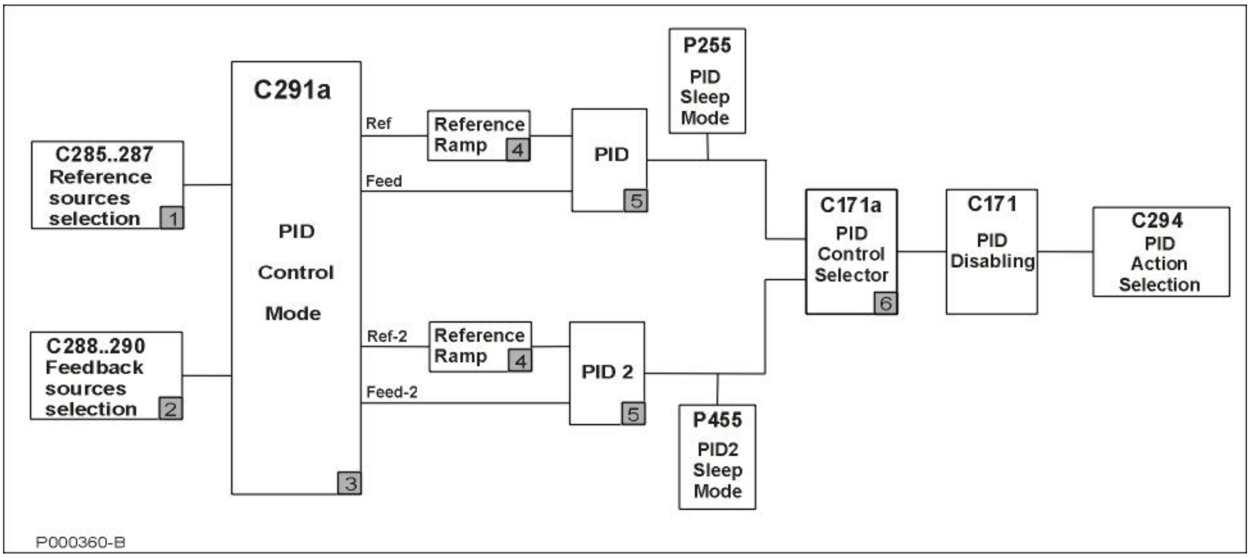


Figure 72: Structure of the PID Regulator

The figure above illustrates the block diagram of the PID regulator. Each block is described below:

Block 1: PID reference sources
Multiple reference sources can be selected at a time (up to 3 reference sources can be selected with parameters **C285**, **C286**, **C287**).
The resulting reference value depends on the setup in **C291a** (see block 3).
Dynamic selection is possible between two reference sources using the digital input configured as the source selector (see **C179** and **C179b**); this parameter has effect only if the Two PIDs mode is activated.

Block 2: PID feedback sources
Multiple feedback sources can be selected at a time (up to 3 feedback sources can be selected with parameters **C288, C289, C290**).
The resulting reference value depends on the setup in **C291a** (see block 3).
Dynamic selection is possible between two feedback sources using the digital input configured as the source selector (see **C179** and **C179b**); this parameter has effect only if the Two PIDs mode is activated.

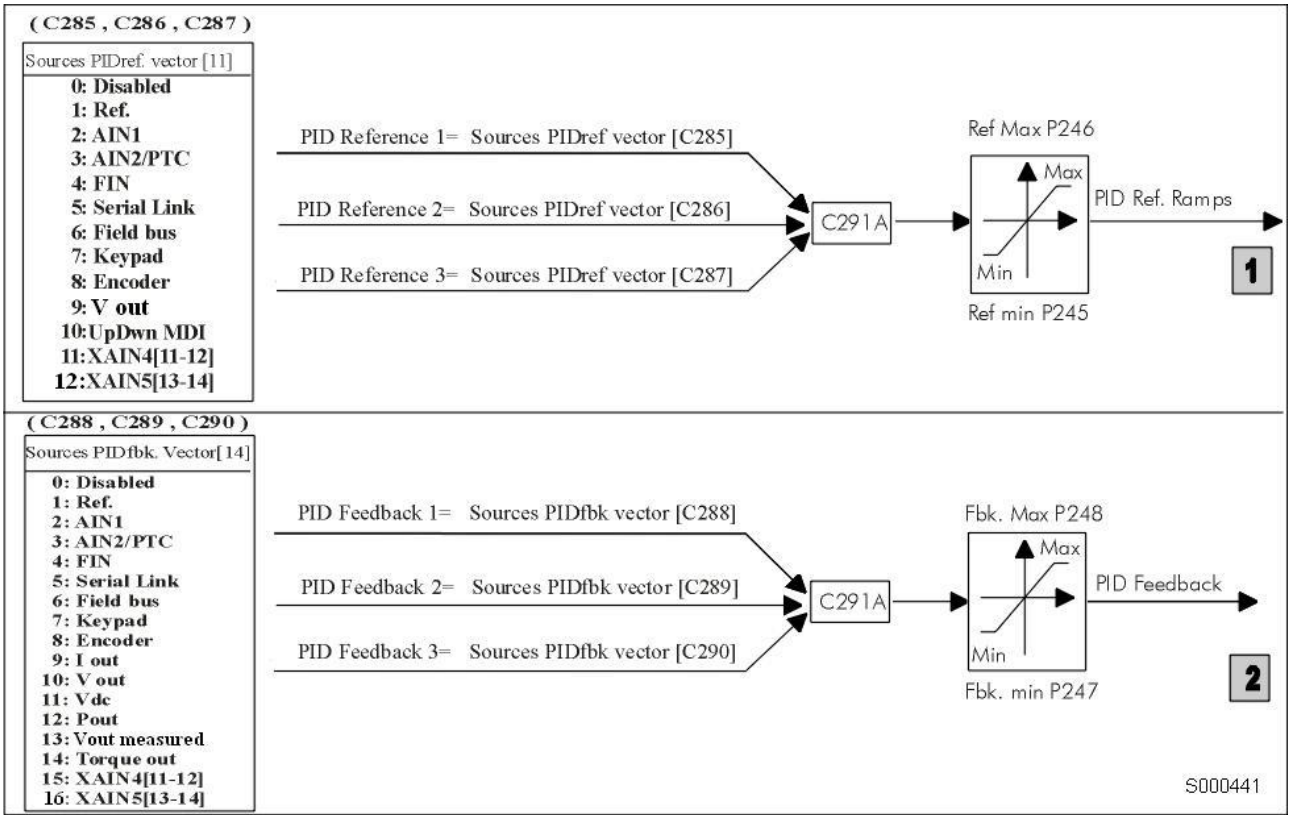


Figure 73: Reference source and feedback source selection

	NOTE	The signals selected in the Sources Vector are to be considered as percentage values; therefore, analog signals are expressed as a percentage of the preset maximum values and minimum values. For example, when selecting a reference source, if **P052** Ref. max. = 8V and **P051** Ref. min. = –3V, 100% will be considered when Ref. = 8V and –100% will be considered when Ref. = –3V.
	NOTE	Among the allowable variables for the PID feedback, electrical variables Iout (output current), Vout (output voltage), Vdc (DC bus voltage), Pout (output power) and Torque out (output torque – only with VTC and FOC control). Their percentage values relate to rated current values and rated voltage values of the selected motor and to 1500VDC respectively.
	NOTE	In Local mode, the PID regulator is disabled if set as **C294 = Add Reference or Add Voltage.**

Block 3: PID Control Mode
This block allows applying different processing types to the feedback signals and allows enabling/disabling the PID2 integrated into the system (see **C291a**).

Block 4: Ramp over PID Reference
A ramp may be applied to the PID references sent from block 3. The same ramp is applicable for both blocks: the processed references are the ones actually used in the PID regulator. The parameters of the PID reference ramp are illustrated in the figure below. The initial rounding-off is applied to the reference whenever a new acceleration/deceleration ramp is started, while the end reference is applied at the end of each ramp.

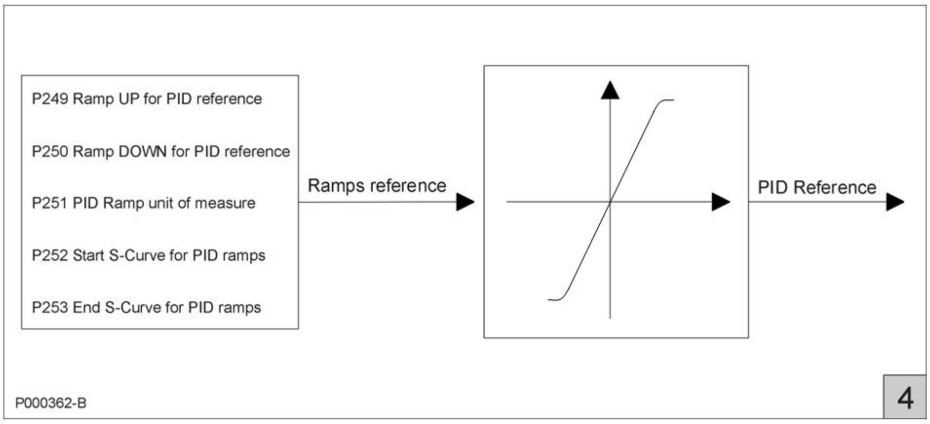


Figure 74: PID ramp reference

NOTE The PID2 ramp reference control is the same, but parameters **P2xx** are replaced with parameters **P4xx**.

Block 5: PID regulators
This is the actual PID regulator. Its output may be disabled by an external digital command (if programmed with **C171**). If the PID regulator is used as a reference source and **P255** (**P455** for PID2) is not set to zero, the PID output value control is enabled. If the PID output equals the preset minimum value for a time longer than **P255** (**P455** for PID2), the drive is automatically put on stand-by.

In the last block, the PID output is applied to the function defined by the “PID Action” parameter (**C294**).

The PID regulator structure is detailed in the diagram below (block 5).

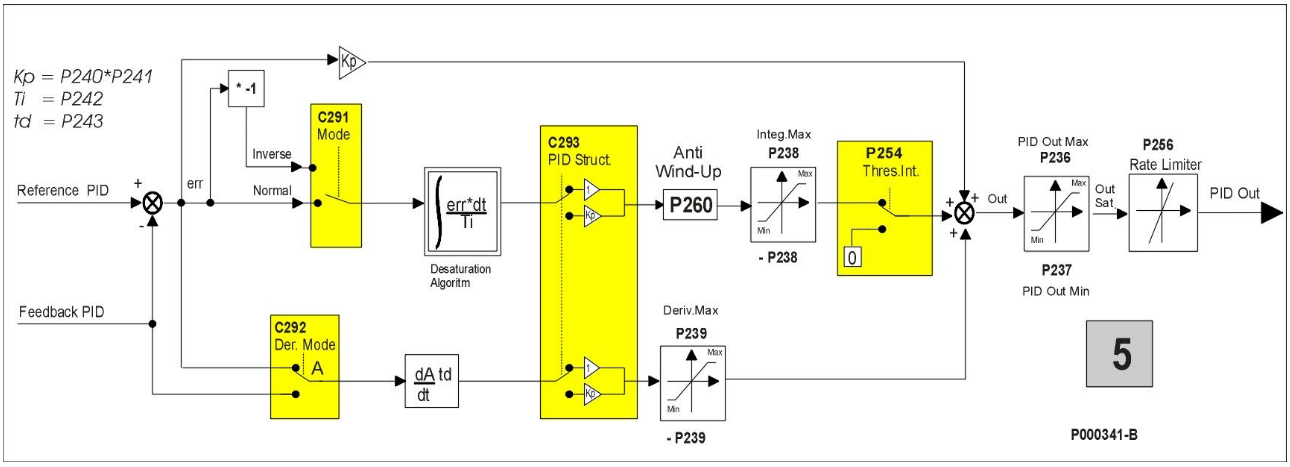


Figure 75: Details of the PID regulator structure

NOTE The PID2 structure is the same as the PID structure, but parameters **P2xx** are replaced with **P4xx** and parameter **C291** is replaced with parameter **C291b**. Parameters **C292** and **C293** are in common for PID and PID2.

Block 6: Digital input for PID control selection.
Block 6 activates only when both PIDs are enabled (**C291a** = **2 PID**) or when in 2-Zone mode (**C291a** = **2-Zone MIN** or **2-Zone MAX**).

In Two PIDs mode:

if **C171a** = **0: Disabled**, the PID output is summed with the PID2 output;
if **C171a** is enabled, the logic state of the configured input determines which is the output of the PID regulator to be used: 0 → PID, 1→ PID2.

In 2-zone mode:
if **C171a** is enabled, when the selected input is activated, the 2-zone mode (MIN or MAX) is disabled. In that case, the PID regulator always operates on the error resulting from **C285**–**C288** and with parameters **P2xx**.

The PID regulator output may be used as:
- an external output;
- a speed/torque reference of the drive;
- a speed/torque reference increase or, if the IFD control is used, the PID regulator input may be used for correcting the output voltage.

If the PID regulator output is the speed reference of the drive, the selected speed/torque ramp is applied.

SERIAL LINK

The ***Serial Link*** source is an input from the MODBUS link: the reference value shall be written by the user to the following addresses:

Table 122: Reference sources from serial link

MODBUS Address	Input	User Level	Type of Reference	Description	Range	Unit of Measure
1418	**I031**	BASIC	PID Reference	PID reference value	–10000 ÷ 10000	Set in **P267**
1420	**I033**	BASIC	PID Feedback	PID feedback value	Min. speed ÷ Max. speed	Set in **P267**

46.3. List of Parameters C285 to C294

Table 123: List of Parameters C285 to C294

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
C285	Selection of PID reference n. 1	ENGINEERING	1285	2:AIN1
C286	Selection of PID reference n. 2	ENGINEERING	1286	0:Disable
C287	Selection of PID reference n. 3	ENGINEERING	1287	0:Disable
C288	Selection of PID feedback n. 1	ENGINEERING	1288	3:AIN2/PTC
C289	Selection of PID feedback n. 2	ENGINEERING	1289	0:Disable
C290	Selection of PID feedback n. 3	ENGINEERING	1290	0:Disable
C291	PID operating mode	ENGINEERING	1291	0:Disable
C291a	PID control mode	ENGINEERING	1295	0:Standard SUM
C291b	PID2 operating mode	ENGINEERING	1296	1: Normal
C292	Selection of the variable for calculating the derivative term	ENGINEERING	1292	0:Measure
C293	Proportional Multiplier of derivative and integral terms	ENGINEERING	1293	0:NO
C294	PID action	ENGINEERING	1294	1:Reference

C285 (C286,C287) Selection of PID Reference n. 1 (2, 3)

C285 (C286, C287)	**Range**	0 ÷ 10 0 ÷ 12 if ES847 is fitted	0: Disable 1: REF 2: AIN1 3: AIN2/PTC 4: Pulse Input 5: Serial Link 6: Fieldbus 7: Keypad 8: Encoder 9: V out 10: Up Down from MDI 11: XAIN4 12: XAIN5
	Default	**C285** = 2 **C286** = 0 **C287** = 0	**C285** = 2: AIN1 **C286** = 0 **C287** = 0
	Level	ENGINEERING	
	Address	1285 (1286, 1287)	
	Function	**C285** selects the first PID reference source from the PID regulator. Up to three reference sources may be configured **(C285..C287)** considered as a sum. The sources are used by the PID and are expressed in percentage values (with reference to their max. value and min. value set in the References menu). If multiple reference sources are selected, their sum is considered. They are saturated between **P246** and **P245** (PID reference maximum and minimum value respectively). See Table 122 for source 5 (Serial Link). See section From the Master to the Sinus Penta in FIELDBUS CONFIGURATION MENU for source 6 (Fieldbus). Source 9 (V out) is useful when **C294** = 3: Voltage Sum. This is the output voltage in IFD control with no PID corrections. Sources 11 and 12 (XAIN4/5) can be selected only after setting **XAIN** in parameter **R023**.	

C288 (C289,C290) Selection of PID Feedback n.1 (2, 3)

C288 (C289, C290)	**Range**	0 ÷ 14 0 ÷ 16 if ES847 is fitted	0: Disable 1: REF 2: AIN1 3: AIN2/PTC 4: Pulse Input 5: Serial Link 6: Fieldbus 7: Keypad 8: Encoder 9: Iout 10: Vout 11: Vdc 12: Pout 13: Vout measured 14: Tout 15: XAIN4 16: XAIN5
	Default	**C288** = 3 **C289** = 0 **C290** = 0	**C288** = 3: AIN2/PTC **C289** = 0: Disable **C290** = 0: Disable
	Level	ENGINEERING	
	Address	1288 (1289, 1290)	
	Function	**C288** selects the first PID feedback source. Up to three feedback sources can be configured **(C288**..**C290)** among the available sources. If multiple sources are selected, their sum is considered. They are saturated based on parameters **P247** and **P248** (PID feedback maximum and minimum value respectively). See also parameter **C285**. See Table 122 for source 5 (Serial Link). See section From the Master to the Sinus Penta in FIELDBUS CONFIGURATION MENU for source 6 (Fieldbus). Source 13 (Vout measured) is useful if **C294** = 3:Add Voltage. This is a RMS measure of the output voltage obtained from the readout of the values of two properly transformed phase-to-phase output voltages from **AIN1** and **AIN2**. Sources 15 and 16 (XAIN4/5) can be selected only after setting **XAIN** in parameter **R023**.	

C291 PID Operating Mode

C291	**Range**	0 ÷ 2	0: Disable 1: Normal 2: Reverse
	Default	0	0: Disable
	Level	ENGINEERING	
	Address	1291	
	Function	This parameter defines how to compute the PID output. Three computing modes are available: 0: **Disable**, 1: **Normal**, 2: **Reverse**. If **0: Disable** is selected, the PID regulator is inactive and its output is always set to zero. In **1: Normal** mode, the actual PID output is considered. If **2: Reverse** is selected, the output actuated by the PID regulator results from the subtraction of the max. output value set in **P236** from the output obtained by the PID regulator. This operating mode can be used for special applications (see the Keeping Fluid Level Constant (Example) at the end of this chapter).	

C291a PID Control Mode

<table>
<tr><td rowspan="5">C291a</td><td>Range</td><td>0 ÷ 7</td><td>0: Standard SUM
1: Standard DIFF
2: Average
3: Minimum
4: Maximum
5: 2-Zone MIN
6: 2-Zone MAX
7: 2 PIDs</td></tr>
<tr><td>Default</td><td>0</td><td>0: Standard SUM</td></tr>
<tr><td>Level</td><td colspan="2">ENGINEERING</td></tr>
<tr><td>Address</td><td colspan="2">1295</td></tr>
<tr><td>Function</td><td colspan="2">This parameter sets the PID control mode.

Functions 0 to 4 set the processing mode of the feedback signal as detailed below.
1) If C179 Input for Source Selection and C179b (Input for Reference Selection) are both = 0: Disabled:
STANDARD SUM: All the selected feedback signals are summed up.
STANDARD DIFF: The sum of the remaining selected feedback signals is subtracted from the feedback signal programmed in C288.
AVERAGE: The resultant of the feedback is given from the arithmetical average of the selected signals.
MINIMUM: The signal having the smallest value among the selected signals is considered as the feedback.
MAXIMUM: The signal having the largest value among the selected signals is considered as the feedback.

2) If C179 or C179b are enabled:
STANDARD SUM: C288+C290 or C289+C290.
STANDARD DIFF: C288–C290 or C289–C290.
AVERAGE: AVG(C288,C290) or AVG(C289,C290).
MINIMUM: MIN(C288,C290) or MIN(C289,C290).
MAXIMUM: MAX(C288,C290) or MAX(C289,C290).

The references are always summed with each other, unless they are managed with the Source Selection (see C179 and C179b).</td></tr>
</table>

	Function	Functions 5 and 6 (2-Zone Mode) automatically disable the Source Selection function that can be programmed with **C179** and **C179b**. In functions 5 and 6 only the references selected with **C285-C286** and the feedback values selected with **C288-C289** are used. **2-Zone MIN**: The PID operates on the system with the larger algebraic error MAX(**C285–C288**,**C286–C289**). This means that the system takes control of the PID having the minimum feedback in respect to its setpoint. **2-Zone MAX**: The PID operates on the system with the smaller algebraic error MIN(**C285–C288**,**C286–C289**). This means that the system takes control of the PID having the maximum feedback in respect to its reference. **NOTE:** When **C171a Input for PID Control Selection** is activated and the selected input is activated, the 2-zone (MIN or MAX) mode is disabled and the PID always operates on the error resulting from **C285–C288**.
		Function 7 (Two PIDs programming) automatically disables the Source Selection function that can be programmed with **C179** and **C179b**. The two PIDs use only the signals selected with **C285/C288** for PID and with **C286/C289** for PID2. **2 PID:** PID and PID2 operate in parallel; the outputs of the two PIDs are matched based on the configuration of **C171a:** If **C171a** = **0: Disabled**, the outputs of the two PIDs are summed to each other; If **C171a** is enabled, the output of the PID regulator depends on the logic state of the configured input: 0 → PID, 1→ PID2.

C291b PID2 Operating Mode

C291b	Range	1 ÷ 2	1: Normal 2: Inverse
	Default	1	1: Normal
	Level	ENGINEERING	
	Address	1296	
	Function	This parameter sets how to calculate the PID2 output. Two modes are available: 1: **Normal**, 2: **Inverse**. In **Normal** mode, the output of the PID regulator is the actual PID2 output. If 2: **Inverse** is selected, the error sign is reversed. The Inverse operating mode can be used for special applications only (see Keeping Fluid Level Constant (Example)).	

C292 Selection of the Variable for Calculating the Derivative Term

C292	Range	0 ÷ 1	0: Measure 1: Error
	Default	0	0: Measure
	Level	ENGINEERING	
	Address	1292	
	Function	This parameter sets the variable used for calculating the derivative term. By default, the derivative term is computed according to the feedback measure, but it can also be computed according to the PID error: Error = Reference – Feedback.	

C293 Proportional Multiplier of Derivative and Integral Terms

C293	**Range**	0 ÷ 1	0: No 1: Yes
	Default	0	0: No
	Level	ENGINEERING	
	Address	1293	
	Function	This parameter defines if the proportional term is used for the multiplication of the derivative and integral terms as well. 0: No means that the proportional term DOES NOT multiply the integral term.	

C294 PID Action

C294	**Range**	0 ÷ 4	0: External output 1: Reference 2: Reference sum 3: Voltage sum 4: Full Ref. Sum
	Default	1	1: Reference
	Level	ENGINEERING	
	Address	1294	

	Function	This parameter sets the type of implementation carried out by the PID regulator. ***C294*** *= External Output:* The PID regulator is independent of the drive operation, unless a digital input is configured for PID disabling; if the digital input closes, the PID regulator is disabled and the output is set to zero. In order to use the PID regulator output externally to the drive, configure one of the analog outputs as PID Out. ***C294*** *= Reference:* The PID regulator output is the speed/torque reference of the connected motor (depending on the type of reference configured when the motor is running); any other reference source which will be selected will be ignored. If the output is a speed reference, 100% corresponds to the max. absolute value between min. speed and max. speed set for the motor being used. Mot1 ← Max { | **C028** |; | **C029** | } Mot2 ← Max { | **C071** |; | **C072** | } Mot3 ← Max { | **C114** |; | **C115** | } If the output is a torque reference, 100% is the max. absolute value between the min. limit and the max. limit of the torque of the active motor. Mot1 ← max { | **C047** |; | **C048** | } Mot2 ← max { | **C090** |; | **C091** | } Mot3 ← max { | **C133** |; | **C134** | } ***C294*** *= Add Reference:* The PID regulator output is a correction of the speed/torque reference of the active motor (depending on the type of reference configured when the motor is running). The percentage value of the PID output relates to the instant value of the speed/torque reference. For example, if the speed reference of the active motor is 800rpm and the PID output is ignored, if this drops to 50%, the overall speed setpoint will be 800 + 800*(50/100) = 1200rpm. Therefore, the PID regulator can never reversed the reference sign. ***C294*** *= Add Voltage Out:* This configuration is active only when the control algorithm of the active motor is IFD. In this case, the PID regulator output is a correction of the output voltage. The percentage value of the PID output relates to the instant voltage value. For example, if a motor is operating in IFD mode and the drive output voltage is 200V rms at 25 Hz with PID Output = 0, if PID Output drops to -10%, the actual voltage will be 200 + 200*(–10/100) = 180V. Another possible usage is the voltage drop compensation on a filter (if any) installed between the drive and the motor. To do so, set (**C285**, **C286**, **C287**) 9: Vout as a reference, and (**C288**, **C289**, **C290**) 13: Vout measured as a feedback. Two properly transformed phases are to be linked to analog inputs **AIN1** e **AIN2** downstream of the filter, in order to exploit the voltage actually delivered to the motor as the feedback. Only when **C285**, **C286** or **C287** are set to 9: Vout, the value percent of the PID output is referred to the nominal voltage. See “Example of Compensation of Voltage Drop in a Filter” at the end of this section. ***C294*** *= Add Reference Full:* The regulator output is a correction of the speed/torque reference of the connected motor (depending on the type of reference configured for the active motor). The value percent of the PID output is managed in the same way as **C294** = Reference and is summed to the main reference. For example, if a motor is speed-controlled with **C029**=1500rpm, considering the PID regulator output as null, the reference is 400rpm; if the PID output becomes 50%, the total speed setpoint is 400 + 1500*(50/100) = 1150rpm. In that way, if the PID output is other than zero, the reference generated will be other than zero as well, even if the main reference is null, unlike what would happen if **C294** = Add Reference.

NOTE If **C294** = 0: External Output, it is not possible to set the PID reference from keypad in remote mode, unless Keypad or UpDown from MDI is set as the PID reference for parameters **C285**, **C286**, **C287**.

46.4. Keeping Fluid Level Constant (Example)

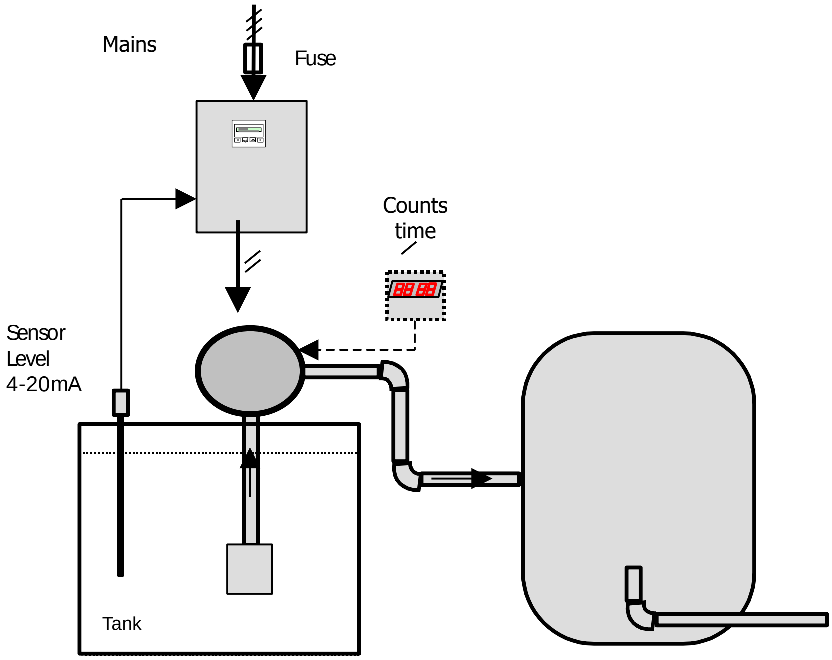


Figure 76: Keeping fluid level constant (Example)

Suppose that the maximum level in the tank is to be kept at 50% and that a 4–20mA level probe is used, with an output of 4mA for the min. level and 20mA for the max. level. The PID reference is sent from keypad, while the probe feedback is sent to AIN2/PTC analog input, which is configured as follows:

R	W	S	P060-Type of Reference for Input AIN2/PTC	2: 4-20mA [SW1-3 On]	
R	W	S	P061-Reference Minimum Value for Input AIN2/PTC	4.0	mA
R	W	S	P062-Reference Maximum Value for Input AIN2/PTC	20.0	mA
R	W	S	P063-Offset for Input AIN2/PTC	0.000	mA
R	W	S	P064-Filter AIN2/PTC Constant	5	ms

The reference shall be saved from keypad, thus avoiding setting it up again when the drive is shut off.

R	W	S	P068-Storage of UP/DN values at Power Off	1: Yes
R	W	S	P068a-Reset of Speed/Torque UP/DN value at Stop	0: No
R	W	S	P068b-Reset of PID UP/DN value at Stop	0: No
R	W	S	P068c-Reset of Speed/Torque UP/DN value at Source Selection	0: No
R	W	S	P068d-Reset of PID UP/DN value at Source Selection	0: No
R	W	S	P069-Amplitude of UP/DN and KPD Reference	1: Unipolar

The PID regulator action and the PID output computing mode must also be set.

R	W	S	C285-Selection of Reference Type 1 PID	2: AIN1 [5-6]
R	W	S	C286-Selection of Reference Type 2 PID	0: Disabled
R	W	S	C287-Selection of Reference Type 3 PID	0: Disabled
R	W	S	C288-Selection of Feedback Type 1 PID	3: AIN2 [7-8]
R	W	S	C289-Selection of Feedback Type 2 PID	0: Disabled
R	W	S	C290-Selection of Feedback Type 3 PID	0: Disabled
R	W	S	C291-PID Operating Mode	1: Normal
R	W	S	C291a-PID Control Mode	0: Standard SUM
R	W	S	C291b-PID2 Operating Mode	1: Normal
R	W	S	C292-Quantity Selection to Compute Derivative Term	0: Measure
R	W	S	C293-Kp Used as a Multiplier for Integral and Derivative Terms	0: No
R	W	S	C294-PID Operation	1: Reference

The PID regulator parameters are defined in the PID PARAMETERS MENU. This configuration limits the PID output between 0 and 100% for a proper rotation of the connected pump. Set **P255** = 1000 ts: if the PID output is equal to the min. value for 5 seconds, the drive is put on stand-by.

R	W	S	P236-PID Maximum Output	100.00	%	
R	W	S	P237-PID Minimum Output	0.00	%	
R	W	S	P237a-Wake-Up mode for PID	0: Disabled		
R	W	S	P237b-Wake-Up level for PID	0.00	%	
R	W	S	P238-Maximum Value of PID Integral Term	100.00	%	
R	W	S	P239-Maximum Value of PID Derivative Term	100.00	%	
R	W	S	P240-Proportional Coefficient Value	5.000		
R	W	S	P241-Proportional Term Multiplicative Factor	0: 1		
R	W	S	P242-Integral Time (Multiples of Tc)	500	Tc	Disabled
R	W	S	P243-Derivative Time (Multiples of Tc/1000)	0	mTc	
R	W	S	P244-Cycle Time Tc	5	ms	
R	W	S	P245-PID Reference Min. Value	-100.00	%	
R	W	S	P246-PID Reference Max. Value	100.00	%	
R	W	S	P247-PID Feedback Minimum Value	-100.00	%	
R	W	S	P248-PID Feedback Maximum Value	100.00	%	
R	W	S	P249-PID Ramp UP Acceleration Time	0.00	s	
R	W	S	P250-PID Ramp DOWN Deceleration Time	0.00	s	
R	W	S	P251-Unit of Measure for PID Ramps	2: 1 s		
R	W	S	P252-Start S-Curve for PID Ramps	1	%	
R	W	S	P253-End S-Curve for PID Ramps	1	%	
R	W	S	P254-PID Out Threshold Enabling Integral Implem.	0.0	%|Refmax	
R	W	S	P255-Inverter Disabling Time for PID Output Equal to Min. Value	5	s	Disabled
R	W	S	P256-Time Spent by PID Output from 0% to 100%	1	ms	

When the level of liquid in the tank exceeds the reference value set from keypad, a negative error is produced (Error = Reference – Feedback). Because the complemented output computing mode is selected and because the complemented output is the speed reference, the higher the error absolute value, the higher the PID output value. This means that the quicker the level increases, the quicker the pump suction. On the other hand, if the level is lower than the reference, a positive error is produced, because the PID output is limited to 0%, the pump will not activate; if the PID output is equal to the min. value for a timer longer than **P255** = 1000***P244** = 5sec , the drive is put on stand-by.

46.5. Example of Compensation of Voltage Drop in a Filter

Assume that a sinusoidal filter is installed between the Penta Drive and the motor. The drive output voltage is to be adjusted to compensate for voltage drop caused by that filter. The following can be used as a feedback signal:
1) an analog input, connected to a signal proportional to RMS voltage, downstream of the filter, obtained by transforming and rectifying one of the phases;
2) two analog inputs, connected to two signals obtained by transforming two of the phases, utilized by the system to compute the RMS voltage value (see **M051a**).

46.5.1. Voltage Drop Compensation – Feedback from Single Analog Input

Assume that a 0-10V voltage signal proportional to RMS voltage downstream of the filter is available and that 50Vrms correspond to 1V. This signal is linked to analog input **AIN1**. The rated motor voltage (**C019**) is assumed to be 400V.

Set the following in the PID CONFIGURATION MENU:

C285	Selection of PID Reference 1	9: V out
C288	Selection of PID Feedback 1	2: AIN1
C291	PID Operation	1: Normal
C294	PID Feedback	3: Add Voltage Output

Set the following in the INPUTS FOR REFERENCES MENU:

P055	Type of Reference for AIN1 Input	3: 0-10V
P057	Ref. Max. Value Limits for AIN1 Input	10.0V

Set the following in the PID PARAMETERS MENU:

P236	Max. PID Output	100.00%
P237	Min. PID Output	0.00%
P240	Proportional Coefficient Value	1.000
P242	Integral Time	Disabled
P245	PID Reference Min. Value	0.00%
P246	PID Reference Max. Value	125.00%

The selection criterion of parameters **P057** and **P246** is the following as per the hypothesis above: 10V for **AIN1** correspond to 500Vrms, i.e. 125% of the rated motor voltage set in **C019**.
The compensated output voltage will be as follows:
Vout = Vd + Vmot*PIDout, where:
Vd is the voltage that could be delivered without compensation,
Vmot is the rated motor voltage (**C019**),
PIDout is the PID output, given by (Vref - Vfbk)/Vmot.

46.5.2. Voltage Drop Compensation – Feedback from Two Analog Inputs

Assume that two +/–10V voltage signals proportional to the instantaneous voltage of two phases downstream of the filter are present and that 100V correspond to 1V. Those signals are linked to analog inputs **AIN1** and **AIN2**. Assume that the rated motor voltage (**C019**) is 400V. If the voltage downstream of the filter is a sinusoidal voltage, the voltage sinusoids will be 400*SQRT(2) = 565V at a rated voltage of 400Vrms. The amplitude of signals **AIN1** and **AIN2**, damped 1:100, will be 5.65V, i.e. within the allowable range.

Set the following in the PID CONFIGURATION MENU:

C285	Selection of PID Reference 1	9: V out
C288	Selection of PID Feedback 1	13: V out measured
C291	PID Operation	1: Normal
C294	PID Feedback	3: Add Voltage Output

Set the following in the INPUTS FOR REFERENCES MENU:

P055	Type of Reference for AIN1 Input	0: +/–10V
P057	Ref. Max. Value Limits for AIN1 Input	8.0V
P060	Type of Reference for AIN2 Input	0: +/–10V
P062	AIN2 Input Value Producing Maximum Reference	8.0V

Set the following in the PID PARAMETERS MENU:

P236	Max. PID Output	100.00%
P237	Min. PID Output	0.00%
P240	Proportional Coefficient Value	1.000
P242	Integral Time	Disabled
P245	PID Reference Min. Value	0.00%
P246	PID Reference Max. Value	200.00%

The selection criterion of parameters **P057** and **P246** is the following as per the hypothesis above: 8Vrms in **AIN1** and **AIN2** correspond to 800Vrms, i.e. 200% of the rated motor voltage set in **C019**. The upper limit for parameter **P246** is 200%, so **P057** = 10.00V, **P247** = 1000/400 = 250%, equivalent from a numerical point of view, would not be possible.
The compensated output voltage will be as follows:
Vout = Vd + Vmot*PIDout, where:
Vd is the voltage delivered without compensation,
Vmot is the rated motor voltage (**C019**),
PIDout is the PID output, given by (Vref - Vfbk)/Vmot.

47. BRIDGE CRANE MENU

47.1. Overview

For hoisting applications, it may be necessary to consider the opening/closing of a mechanical brake in order to obtain a proper control of the connected motor.
For example, if a mechanical brake takes 500ms to open after the start command – the delay is due to the type of brake – the motor will not be running for 500ms, while the speed reference increases the preset ramp. The motor then pushes against the brake, and when it can rotate freely, the motor torque will not match with the torque required to move the connected load.
If the speed setpoint is kept to zero for a given time after sending the start command (considering the time required for the mechanical brake to open), the motor control will implement the proper torque for the motor speed as soon as the motor can start rotating.
The brake closure can be controlled via a digital input that is properly set up; when the drive detects the brake closure, it automatically adjusts the value of the current injected into the motor to the fluxing value. This is required when, during the hoisting stage, the mechanical brake closes when the load is suspended after reaching negligible speed. In that case, the torque produced by the motor is capable of keeping the load hanging; when the brake closes, this has no effect on the speed regulator, because the motor is already standstill. When the brake closes, no torque must be generated to keep the load hanging, so the current injected into the motor drops to the value required for the motor fluxing.

NOTE The Bridge CRANE menu is used for VTC and FOC Control only.

NOTE For safety reasons, the brake closure contact must be an NO contact (closed contact only when the brake is engaged).

NOTE In addition to parameters **C300** to **C302**, a dedicated MDO must be set as 6:BRAKE (see the DIGITAL OUTPUTS MENU).

47.2. List of Parameters C300 to C303

Table 124: List of Parameters C300 to C303

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C300	Positive pretensioning torque [%Cmot]	ENGINEERING	1300	0.0%
C301	Positive pretensioning torque time	ENGINEERING	1301	0ms
C300a	Negative pretensioning torque [%Cmot]	ENGINEERING	1308	0.0%
C301a	Time period of negative pretensioning torque	ENGINEERING	1309	0ms
C302	Closed brake input (NO contact)	ENGINEERING	1302	0: None
C303	Brake activation during Tracking Error	ENGINEERING	1304	1: Yes

C300/C300a Pretensioning Torque [%Cmot]

C300/C300a			
	Range	-5000 ÷ +5000	-500.0% ÷ +500.0%
	Default	0	0.0 %
	Level	ENGINEERING	
	Address	1300/1308	
	Control	VTC and FOC	
	Function	If not set to zero, this parameter defines the torque value (expressed as a percentage of the rated torque of the selected motor) reached before the speed ramp starts after sending a **START** command. After sending a **START** command, the drive brings the motor torque to the level set in **C300/C300a** and torque is adjusted by the speed loop for the time set in **C301/C301a** in order to keep the motor standstill. Once this time has elapsed, the speed ramp can start and the motor follows the required speed profile. The torque sign defines the running direction. The sign of the speed reference determines which value percent is to be used; **C300** is for the positive sign, **C300a** is for the negative sign.	

C301/C301a Pretensioning Torque Time

C301/C301a			
	Range	0 ÷ 32000	0 ÷ 32000 ms
	Default	0	0
	Level	ENGINEERING	
	Address	1301/1309	
	Control	VTC and FOC	
	Function	Delay time passing between the start command and the speed ramp start. During this time, the motor torque output is set in **C300/C300a** to keep the load suspended.	

C302 Closed Brake Input (NO contact)

C302			
	Range	0 ÷ 12 0 ÷ 24 if ES847 or ES870 is installed	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷ TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
	Default	0	0 → Inactive
	Level	ENGINEERING	
	Address	1302	
	Control	VTC and FOC	
	Function	This parameter determines the digital input assigned to the feedback of he mechanical brake activation (NO contact, which closes only when the brake is engaged). When the brake closure is detected after a deceleration ramp, the current required for motor fluxing is injected into the motor. If no digital input is available for the detection of the brake closure, set max. time in **C183**, in order to avoid injecting current into the motor after the deceleration ramp. When the motor is not running, the **START** command is disabled and the speed setpoint is at zero for a time longer than the one set in **C183**, the drive will be put on standby.	

C303 Brake Activation during Tracking Error

C303	**Range**	0 ÷ 1	0: No 1: Yes
	Default	1	1: Yes
	Level	ENGINEERING	
	Address	1304	
	Control	VTC and FOC	
	Function	This parameter defines if, in case of tracking error (ENCODER/FREQUENCY INPUTS MENU, parameters **C192**, **C193**, **C194**), the output of the electromechanical brake is to be disabled, thus causing the activation of the brake itself. 0: No, in case of tracking error, the brake command output is kept active. 1: Yes, in case of tracking error, the brake command output is deactivated, thus causing the brake activation. If **C194**=1 (or =2 in some cases), the tracking error triggers alarm **A080**. In case of alarm, the brake output is disabled, independently of the value in **C303**.	

48. DATE AND TIME MENU

48.1. Overview

The Clock/Calendar of the control board (RTC – Real Time Clock) is based on the Clock/Calendar of the Data Logger ES851 or the Bridge Mini board (in both cases, please refer to the Motor Drives Accessories - User Manual).

NOTE The Data and Time Menu may be accessed only if the Data Logger board is installed (even the ES851 RTC version only) and if parameter **R021** Data Logger setting is set to 2: ENABLE.

NOTE If the Bridge Mini board (parameter **R021** set to 3: Bridge Mini) is installed, the date and time are not to be set, as this is done automatically when the board is connected to the network.

The clock/calendar can be updated via special parameters. The display/keypad permits to immediately update the clock/calendar: just select the Set Time page or the Set Date page and press **ENTER**. Press **ESC** to go to the next field; press **ENTER** to confirm.
If you use the serial link of the inverter where the Data Logger is installed, the Clock/Calendar is viewed in the measure parameters below. To update the Clock/Calendar via serial link, set the new values in **C310** to **C315** and send the edit command (**C316**).
Parameters **R050** to **R053** set the rules for daylight saving time.

Press Save/Enter for TIME setting →

```
C314  Set  TIME
DST:  OFF
>          16:29:55
 2011/JAN/01:SAT
```

First page of the Date and Time menu on the display/keypad

Press Save/Enter for DATE setting →

```
C310  Set  DATE

           16:29:55
>2011/JAN/01:SAB
```

Second page of the Date and Time menu on the display/keypad

The date and time on the display/keypad are represented by the measures below:

Time (Hours)

Time (Hours)			
	Range	0 ÷ 23	0 ÷ 23 hours
	Active	This measure is available only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851)	
	Address	3342	
	Level	BASIC	
	Function	Time - hours (current value).	

Minutes

Minutes	Range	0 ÷ 59	0 ÷ 59 min
	Active	This measure is available only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851)	
	Address	3343	
	Level	BASIC	
	Function	Minutes (current value).	

Seconds

Seconds	Range	0 ÷ 59	0 ÷ 59 sec
	Active	This measure is available only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851)	
	Address	3344	
	Level	BASIC	
	Function	Seconds (current value).	

Day of the Week

Day of the Week	Range	1 ÷ 7	1: Mon. 2: Tues. 3: Wed. 4: Th. 5: Fri. 6: Sat. 7: Sun.
	Active	This measure is available only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851)	
	Address	3345	
	Level	BASIC	
	Function	Day of the week (current value).	

Day of the Month

Day of the Month	Range	1 ÷ 31	1 ÷ 31 days
	Active	This measure is available only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851)	
	Address	3346	
	Level	BASIC	
	Function	Day of the month (current value).	

Daylight Saving Time

Daylight Saving Time	Range	0 ÷ 2	0 ÷ 2
	Active	This measure is available only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851)	
	Address	528	
	Level	BASIC	
	Function	Status of the DST: 0: Inactive 1: Inactive from less than 1 hour 2: Active	

Month

Month	**Range**	1 ÷ 12	1: January 2. February 3: March 4: April 5: May 6: June 7: July 8: August 9: September 10: October 11: November 12: December
	Active	This measure is available only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851)	
	Address	3347	
	Level	BASIC	
	Function	Month (current value).	

Year

Year	**Range**	2000 ÷ 2099	2000 ÷ 2099 years
	Active	This measure is available only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851)	
	Address	3348	
	Level	BASIC	
	Function	Year (current value).	

48.2. List of Parameters C310 to C316

Table 125: List of Parameters C310 to C316

Parameter	FUNCTION	User Level	MODBUS Address
C310	Day of the week to be changed	ADVANCED	1241
C311	Day of the month to be changed	ADVANCED	1242
C312	Month to be changed	ADVANCED	1243
C313	Year to be changed	ADVANCED	1244
C314	Time (Hours) to be changed	ADVANCED	1245
C315	Time (Minutes) to be changed	ADVANCED	1246
C316	Clock/Calendar editing command	ADVANCED	1248

C310 Day of the Week to be changed

C310	**Range**	1 ÷ 7	1: Mon. 2: Tues. 3: Wed. 4: Th. 5: Fri. 6: Sat. 7: Sun.
	Default	1	1: Mon.
	Level	ADVANCED	
	Active	This parameter can be viewed and changed only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851)	
	Address	1241	
	Function	This parameter sets the value of the day of the week to be changed.	

C311 Day of the Month to be changed

C311	**Range**	1 ÷ 31	1 ÷ 31 days
	Default	1	Day 1
	Level	ADVANCED	
	Active	This parameter can be viewed and changed only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851)	
	Address	1242	
	Function	This parameter sets the value of the day of the month to be changed.	

C312 Month to be changed

C312	**Range**	1 ÷ 12	1: January 2. February 3: March 4: April 5: May 6: June 7: July 8: August 9: September 10: October 11: November 12: December
	Default	1	1: January
	Level	ADVANCED	
	Active	This parameter can be viewed and changed only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851)	
	Address	1243	
	Function	This parameter sets the value of the month to be changed.	

C313 Year to be changed

C313	**Range**	2000 ÷ 2099	2000 ÷ 2099 years
	Default	0	Year 2000
	Level	ADVANCED	
	Active	This parameter can be viewed and changed only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851)	
	Address	1244	
	Function	This parameter sets the value of the year to be changed.	

C314 Time (hours) to be changed

C314	**Range**	0 ÷ 23	0 ÷ 23 hours
	Default	0	0 hours
	Level	ADVANCED	
	Active	This parameter can be viewed and changed only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851)	
	Address	1245	
	Function	This parameter sets the time (hour) to be changed.	

C315 Minutes to be changed

C315	**Range**	0 ÷ 59	0 ÷ 59 min.
	Default	0	0 minutes
	Level	ADVANCED	
	Active	This parameter can be viewed and changed only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851)	
	Address	1246	
	Function	This parameter sets the time (minutes) to be changed.	

C316 Clock/Calendar Editing Command

C316			
	Range	0 ÷ 1	0 ÷ 1
	Default	0	0
	Level	ADVANCED	
	Active	This parameter can be viewed and changed only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851)	
	Address	1248	
	Function	If this parameter is set to 1, all the values set in parameters **C310** to **C315** are written and stored to the clock/calendar of the board and the measures described above are instantly changed. **CAUTION** Also unchanged parameters are written to the clock/calendar. Make sure that unchanged parameters are correct.	

49. TIMED FLAGS MENU

49.1. Overview

The Timed Flag Menu includes the parameters setting the four timed flags for the inverter, TFL1..4. The following data items are set for each timed flag: activation time (Time ON), deactivation time (Time OFF), days of the week when activation shall occur.
The timed flags may be used as they were digital inputs, both when managing digital outputs (MDO) and when managing virtual digital outputs (MPL). It is also possible to assign the same control functions that can be associated to the other digital inputs (see DIGITAL INPUTS MENU).

NOTE The Timed Flags Menu may be accessed only if the Data Logger board is installed (even the ES851 RTC version only) and if parameter **R021** Data Logger setting is set to 2: ES851, or if the Bridge Mini board is installed and parameter **R021** is set to 3: Bridge Mini.

49.2. Examples

Every time flag features 3 parameters (Hour, Minute, Second) setting the activation time of the flag itself; 3 parameters (Hour, Minute, Second) setting the deactivation time of the flag itself; 1 parameter setting the days of the week when the flag shall activate. If the activation time precedes the deactivation time, the flag will have the TRUE logic value at the activation time, whilst it will have the FALSE logic value at the deactivation time in the days of the week concerned. If the activation time is subsequent to the deactivation time, the flag will have the TRUE logic value at the activation time, whilst it will have the FALSE logic value at the deactivation time of the following day.

Example 1:

C330	TFL1: Time ON – Hour	08
C331	TFL1: Time ON – Minutes	00
C332	TFL1: Time ON – Seconds	00
C333	TFL1: Time OFF – Hour	20
C334	TFL1: Time OFF – Minutes	00
C335	TFL1: Time OFF – Seconds	00
C336	TFL1: Days of the week	1000000

The timed flag TFL1 is TRUE from 8:00:00AM to 08:00:00PM every Monday.

Example 2:

C330	TFL1: Time ON – Hour	20
C331	TFL1: Time ON – Minutes	00
C332	TFL1: Time ON – Seconds	00
C333	TFL1: Time OFF – Hour	08
C334	TFL1: Time OFF – Minutes	00
C335	TFL1: Time OFF – Seconds	00
C336	TFL1: Days of the week	1000000

The timed flag TFL1 is TRUE from 08:00:00PM on every Monday to 8:00:00AM on every Tuesday.

49.3. List of Parameters from C330 to C357

Table 126: List of Parameters C330 to C357

Parameter	FUNCTION	User Level	DEFAULT VALUES	MODBUS Address
C330	TFL1: Time ON – Hour	ADVANCED	0	410
C331	TFL1: Time ON – Minutes	ADVANCED	0	411
C332	TFL1: Time ON – Seconds	ADVANCED	0	412
C333	TFL1: Time OFF – Hour	ADVANCED	0	413
C334	TFL1: Time OFF – Minutes	ADVANCED	0	414
C335	TFL1: Time OFF – Seconds	ADVANCED	0	415
C336	TFL1: Days of the week	ADVANCED	0	416
C337	TFL2: Time ON – Hour	ADVANCED	0	417
C338	TFL2: Time ON – Minutes	ADVANCED	0	418
C339	TFL2: Time ON – Seconds	ADVANCED	0	419
C340	TFL2: Time OFF – Hour	ADVANCED	0	420
C341	TFL2: Time OFF – Minutes	ADVANCED	0	421
C342	TFL2: Time OFF – Seconds	ADVANCED	0	422
C343	TFL2: Days of the week	ADVANCED	0	423
C344	TFL3: Time ON – Hour	ADVANCED	0	424
C345	TFL3: Time ON – Minutes	ADVANCED	0	425
C346	TFL3: Time ON – Seconds	ADVANCED	0	426
C347	TFL3: Time OFF – Hour	ADVANCED	0	427
C348	TFL3: Time OFF – Minutes	ADVANCED	0	428
C349	TFL3: Time OFF – Seconds	ADVANCED	0	429
C350	TFL3: Days of the week	ADVANCED	0	430
C351	TFL4: Time ON – Hour	ADVANCED	0	431
C352	TFL4: Time ON – Minutes	ADVANCED	0	432
C353	TFL4: Time ON – Seconds	ADVANCED	0	433
C354	TFL4: Time OFF – Hour	ADVANCED	0	434
C355	TFL4: Time OFF – Minutes	ADVANCED	0	435
C356	TFL4: Time OFF – Seconds	ADVANCED	0	436
C357	TFL4: Days of the week	ADVANCED	0	437

C330 (C337, C344, C351) Hour of Activation of the Timed Flag TFL1 (TFL2, TFL3, TFL4)

C330 C337 C344 C351	Range	0 ÷ 23	0 ÷ 23
	Default	0	0
	Level	ADVANCED	
	Address	410 (417, 424, 431)	
	Function	Sets the hour of activation of the timed flag **TFL1 (TFL2, TFL3, TFL4)**.	

C331 (C338, C345, C352) Minute of Activation of the Timed Flag TFL1 (TFL2, TFL3, TFL4)

C331 C338 C345 C352	Range	0 ÷ 59	0 ÷ 59
	Default	0	0
	Level	ADVANCED	
	Address	411 (418, 425,432)	
	Function	Sets the minute of activation of the timed flag **TFL1 (TFL2, TFL3, TFL4)**.	

C332 (C339, C346, C353) Second of Activation of the Timed Flag TFL1 (TFL2, TFL3, TFL4)

C332 C339 C346 C353	Range	0 ÷ 59	0 ÷ 59
	Default	0	0
	Level	ADVANCED	
	Address	412 (419, 426,433)	
	Function	Sets the second of activation of the timed flag **TFL1 (TFL2, TFL3, TFL4)**.	

C333 (C340, C347, C354) Hour of Deactivation of the Timed Flag TFL1 (TFL2, TFL3, TFL4)

C333 C340 C347 C354	Range	0 ÷ 23	0 ÷ 23
	Default	0	0
	Level	ADVANCED	
	Address	413 (420, 427,434)	
	Function	Sets the hour of deactivation of the timed flag **TFL1 (TFL2, TFL3, TFL4)**.	

C334 (C341, C348, C355) Minute of Deactivation of the Timed Flag TFL1 (TFL2, TFL3, TFL4)

C334 C341 C348 C355	Range	0 ÷ 59	0 ÷ 59
	Default	0	0
	Level	ADVANCED	
	Address	414 (421, 428,435)	
	Function	Sets the minute of deactivation of the timed flag **TFL1 (TFL2, TFL3, TFL4)**.	

C335 (C342, C349, C356) Second of Deactivation of the Timed Flag TFL1 (TFL2, TFL3, TFL4)

C335 C342 C349 C356	Range	0 ÷ 59	0 ÷ 59
	Default	0	0
	Level	ADVANCED	
	Address	415 (422, 429,436)	
	Function	Sets the second of deactivation of the timed flag **TFL1 (TFL2, TFL3, TFL4)**.	

C336 (C343, C350, C357) Days of the Week of the Activation of the Timed Flag TFL1 (TFL2, TFL3, TFL4)

C336 C343 C350 C357	Range	0000000b ÷1111111b binary	0 ÷ 127 0 → inactive 1 → active
	Default	0	0
	Level	ADVANCED	
	Address	416(423, 429,437)	
	Function	Sets the weekdays of activation of the timed flag **TFL1 (TFL2, TFL3, TFL4)**. Every bit corresponds to a day of the week: see Table 128. Example: 0011111: flag **TFL1** will activate every day of the week but Saturday and Sunday. 0000000: the flag will never activate. 1111111: the flag will activate every day.	

Table 127: Bits corresponding to the weekdays

Bit n°.	Day
0	Monday
1	Tuesday
2	Wednesday
3	Thursday
4	Friday
5	Saturday
6	Sunday

50. SERIAL COMMUNICATIONS

50.1. Overview

Sinus Penta drives may be connected to other devices through a serial link. This allows reading and writing the parameters accessed through the remotable display/keypad.

Enertronica Santerno also supplies the RemoteDrive software package allowing controlling the drive through a computer connected via serial link.
This application offers the following functionality: image copy, keypad emulation, oscilloscope functions and multifunction tester, data logger, history data table compiler, parameter setting and data reception–transmission–storage from and to a computer, scan function for the automatic detection of the connected inverters (up to 247 connected inverters).

50.2. MODBUS–RTU Protocol

Messages and data are sent by means of standard protocol MODBUS in RTU mode. This standard protocol performs control procedures using an 8–bit binary representation.
In RTU mode, a message begins with a silence interval equal to 3.5 times the transmission time of a character.
If the character transmission stops for a time equal to 3.5 times the transmission time of a character, the controller will consider this time interval as the end of the message. Similarly, a message starting with a shorter silence time is considered as part of the previous message.

Message beginning	Address	Function	Data	Error control	End of message
T1–T2–T3–T4	8 bits	8 bits	n x 8 bits	16 bits	T1–T2–T3–T4

Use parameter **R004** (TimeOut) to increase the silence time interval up to max. 10000 ms for the systems that do not recognize standard timeouts.

Address
The address field acknowledges any value ranging from 1 to 247 as the address of the slave peripheral device. The master device queries the peripheral device specified in the address field; the peripheral device will respond with a message containing its address to let the master device know which the slave source of the response is. A master device query with a 0 address is addressed to all slave devices, which will not respond at all (broadcast mode).

Function
The function related to the message may be chosen within the legal field ranging from 0 to 255. A response of the slave device to a message of the master device will simply return the function code to the master device if no error took place; otherwise, the most significant bit in this field is set to 1.

The only functions allowed are

- **03h: Read Holding Register,**
- **06h: Write Single Register** and
- **10h: Preset Multiple Register** (see below).

Data
The data field contains any additional information for the function being used.

Error Control
The error control is performed through the CRC (Cyclical Redundancy Check) method. The16–bit value of the relevant field is computed when the message is sent by the transmitter and is then re–computed and checked by the receiver.
CRC Register is computed as follows:
1. CRC Register is set to FFFFh
2. Exclusive OR is executed between CRC register and the first 8 bits of the message; the result is saved to a 16–bit register.
3. This register is right–shifted of one place.
4. If the right bit is 1, exclusive OR is executed between the 16–bit register and value 1010000000000001b.
5. Steps 3 and 4 are repeated until 8 shifts are performed.
6. Exclusive OR is performed between the 16–bit register and the next 8 bits of the message.
7. Steps 3 to 6 are repeated until all message bytes are processed.
8. The result is a CRC, that is attached to the message by sending the least significant byte as the first byte.

Supported Functions
03h: Read Holding Register
Allows reading the register state of the slave device. This function does not allow the broadcast mode (address 0).

Additional parameters are the address of the basic digital register to be read and the output number to be read.

QUERY	RESPONSE
Slave address	Slave address
03h Function	03h Function
Register address (high)	Byte number
Register address (low)	Data
Register N. (high)	…
Register N. (low)	Data
Error correction	Error correction

06h: Write Single Register
Sets the state of one register for the slave device. In broadcast mode (address 0), the state of that register is set for all the connected slave devices. Additional parameters are the register address and the relevant value.

QUERY	RESPONSE
Slave address	Slave address
06h Function	06h Function
Register 1 addr. (Hi)	Register 1 addr. (Hi)
Register 1 addr. (Lo)	Register 1 addr. (Lo)
Data (high)	Data (high)
Data (low)	Data (low)
Error correction	Error correction

10h: Preset Multiple Register
Sets the state of consecutive multiple registers (max 123) for the slave device. In broadcast mode (address 0), the state of those registers is set in all the connected slave devices. Additional parameters are the basic register address, the number of registers to be set, the relevant value and the number of bytes used for the data items.

QUERY	RESPONSE
Slave address	Slave address
10h Function	10h Function
Register 1 addr. (Hi)	Register 1 addr. (Hi)
Register 1 addr. (Lo)	Register 1 addr. (Lo)
Register N. (Hi)	Register N. (Hi)
Register N. (Lo)	Register N. (Lo)
Byte number	Error correction
Data (Hi)	
Data (Lo)	
…	
Data (Hi)	
Data (Lo)	
Error correction	

Error Messages

If a message error is detected, the inverter will send a message to the master:

Slave address	Function (MSB = 1)	Error code	Error correction

The error code meaning is the following:

Code		DESCRIPTION
0x01	ILLEGAL FUNCTION	The function sent by the Master is different from 0x03 (Read Holding Registers), from 0x06 (Write Single Register) and 0x10 (Preset Multiple Registers).
0x02	ILLEGAL ADDRESS	The Master wrote to or read from an illegal address.
0x03	ILLEGAL DATA VALUE	The numerical value the Master tried to write is not included in the correct range.
0x06	DEVICE BUSY	The drive refused the Master writing attempt (e.g. because it is running and a Cxxx parameter is activated).
0x07	ANOTHER USER WRITING	Other users are writing to the selected parameter when the Master is trying to write to this parameter (e.g. display/keypad in editing mode or Upload/Download to/from keypad).
0x09	BAD ACCESS LEVEL	The parameter the Master is trying to write to is not included in the selected User Level (e.g. it is trying to write an ADVANCED parameter when the BASIC user level is selected).

51. SERIAL LINKS MENU

51.1. Overview

NOTE Please refer to the Sinus Penta's Installation Guide for the description of the serial links and connections.

NOTE For a greater immunity against communication interference, an optional optoisolated serial board (ES822) may be used instead of RS485 serial link. Serial links RS232 and RS485 can interface with ES822 board.
Please refer to the Sinus Penta's Installation Guide for the description of the optional optoisolated board.

NOTE The parameters described in this menu are **Rxxx** parameters.
Once changed and saved, they become active only when the drive is next switched on or when the control board is reset (by holding down the **RESET** key for more than 5 secs or sending the **I014** command via serial link).

Drives of the SINUS PENTA series may be connected to peripheral devices through a serial link. This enables both reading and writing of all parameters normally accessed through the display/keypad. Two-wire RS485 is used, which ensures better immunity against disturbance even on long cable paths, thus reducing the communication errors.

Two serial links are available. **Serial Link 0** is provided with a 9-pole, male D connector; **Serial Link 1** is provided with an RJ45 connector (or a three-phone connector) connected to the display/keypad.

NOTE The display/keypad connected through RJ45 connector dialogues correctly with the drive using the default values preset in the parameter set for serial link 1.

The drive will typically behave as a slave device (i.e. it only answers to queries sent by another device). A master device (typically a computer) is then needed to start serial communications.
The following items may be configured for both serial links:

1. The drive MODBUS address.
2. The drive response delay to a Master query.
3. The baud rate of the serial link (expressed in bits per second);
4. The time added to the 4 byte–time;
5. The serial link watchdog (which is active if the relevant parameter is not set at 0);
6. The type of parity used for serial communications.

51.1.1. WATCHDOG ALARMS

The Watchdog alarms determined by the serial link may be the following:

- **A061** Serial alarm n.0 WDG
- **A062** Serial alarm n.1 WDG
- **A081** Keypad Watchdog

The first two alarms trip when no legal message is sent from the serial link to the drive for a time longer than the time set in the relevant watchdog parameters; **these alarms are active only if parameters R005 or R012 are set other than zero.**

NOTE Alarms **A061** and **A062** do not trip if, due to the parameters in the CONTROL METHOD MENU or due to the status of the SOURCE SELECTION or LOC/REM inputs (see DIGITAL INPUTS MENU), the information sent via serial link is not currently used for the commands or the references.

The third alarm trips only if the **display/keypad used as a reference/command source** detects a communication loss for a time longer than 2 seconds.

51.2. List of Parameters R001 to R013

Table 128: List of Parameters R001 to R013

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
R001	Drive MODBUS Address for Serial Link 0 (D9-pole)	ENGINEERING	588	1
R002	Response Delay for Serial Link 0 (D9-pole)	ENGINEERING	589	5msec
R003	Baud Rate for Serial Link 0 (D9-pole)	ENGINEERING	590	6:38400 bps
R004	Time added to 4byte–time for Serial Link 0 (D9-pole)	ENGINEERING	591	2msec
R005	Watchdog time for Serial Link 0 (D9-pole)	ENGINEERING	592	0.0sec
R006	Parity Bit for Serial Link 0 (D9-pole)	ENGINEERING	593	1:Disabled 2 Stop-bit
R008	Drive MODBUS address for Serial Link 1 (RJ45)	ENGINEERING	595	1
R009	Response Delay for Serial Link 1 (RJ45)	ENGINEERING	596	5 msec
R010	Baud Rate for Serial Link 1 (RJ45)	ENGINEERING	597	6:38400 bps
R011	Time Added to 4byte–time for Serial link 1 (RJ45)	ENGINEERING	598	2msec
R012	Watchdog Time for Serial Link 1 (RJ45)	ENGINEERING	599	0.0sec
R013	Parity Bit for Serial Link 1 (RJ45)	ENGINEERING	600	1:Disabled 2 Stop-bit

R001 Drive MODBUS Address for Serial Link 0 (D9-pole)

R001	**Range**	1 ÷ 247	1 ÷ 247
	Default	1	1
	Level	ENGINEERING	
	Address	588	
	Function	This parameter determines the address assigned to the drive connected through RS485 of serial link 0 (9-pole, male D connector).	

R002 Response Delay for Serial Link 0 (D9-pole)

.R002	**Range**	1 ÷ 1000	1 ÷ 1000 msec
	Default	5	5 msec
	Level	ENGINEERING	
	Address	589	
	Function	This parameter determines the drive response delay after a master query sent through serial link 0 (9-pole, male D connector).	

R003 Baud Rate for Serial Link 0 (D9-pole)

R003	**Range**	1 ÷ 7	1: 1200 bps 2: 2400 bps 3: 4800 bps 4: 9600 bps 5: 19200 bps 6: 38400 bps 7: 57600 bps
	Default	6	6: 38400bps
	Level	ENGINEERING	
	Address	590	
	Function	This parameter determines the baud rate, expressed in bits per second, for serial link 0 (9-pole, male D connector).	

R004 Time added to 4–Byte–Time for Serial Link 0 (D9-pole)

R004	**Range**	1 ÷ 10000	1 ÷ 10000 msec
	Default	2	2 msec
	Level	ENGINEERING	
	Address	591	
	Function	This parameter determines the limit time when no character is received from serial link 0 (9-pole, male D connector) and the message sent from the master to the drive is considered as complete.	

R005 Watchdog Time for Serial Link 0 (D9-pole)

R005	**Range**	0 ÷ 60000	0 ÷ 6000.0 sec
	Default	0	0.0 sec
	Level	ENGINEERING	
	Address	592	
	Function	If not set at zero, this parameter determines the time limit after which alarm **A061** WDG Serial 0 Alarm trips if the drive does not receive any legal message through serial link 0 (9-pole, male D connector).	

R006 Parity Bit for Serial Link 0 (D9-pole)

R006	**Range**	0 ÷ 3	0: Disabled 1 Stop–bit 1: Disabled 2 Stop–bit 2: Even (1 Stop bit) 3: Odd (1 Stop bit)
	Default	1	1: Disabled 2 Stop–bit
	Level	ENGINEERING	
	Address	593	
	Function	This parameter determines whether the parity bit is used or not when creating the MODBUS message through serial link 0 (9-pole, male D connector).	

R008 Drive MODBUS Address for Serial Link 1 (RJ45)

R008	**Range**	1 ÷ 247	1 ÷ 247
	Default	1	1
	Level	ENGINEERING	
	Address	595	
	Function	This parameter determines the address assigned to the drive connected to the network through RS485 of serial link 1 (RJ45 connector).	

NOTE The display/keypad connected through RJ45 connector dialogues correctly with the drive using the default values preset in the parameter set for serial link 1 (RJ45).

R009 Response Delay for Serial Link 1 (RJ45)

R009	**Range**	1 ÷ 1000	1 ÷ 1000 msec
	Default	5	5 msec
	Level	ENGINEERING	
	Address	596	
	Function	This parameter determines the drive response delay after a master query sent through serial link 1 (RJ45 connector).	

R010 Baud Rate for Serial Link 1 (RJ45)

R010	**Range**	1 ÷ 7	1: 1200 bps 2: 2400 bps 3: 4800 bps 4: 9600 bps 5: 19200 bps 6: 38400 bps 7: 57600 bps
	Default	6	6: 38400bps
	Level	ENGINEERING	
	Address	597	
	Function	This parameter determines the baud rate, expressed in bits per second, for serial link 1 (RJ45 connector).	

R011 Time Added to 4–Byte–Time for Serial Link 1 (RJ45)

R011	**Range**	1÷10000	1 ÷ 10000 msec
	Default	2	2 msec
	Level	ENGINEERING	
	Address	598	
	Function	This parameter determines the time limit when no character is received from serial link 1 (RJ45 connector) and the message sent from the master to the drive is considered as complete.	

R012 Watchdog Time for Serial Link 1 (RJ45)

R012	**Range**	0 ÷ 60000	0 ÷ 6000.0 sec
	Default	0	0.0 sec
	Level	ENGINEERING	
	Address	599	
	Function	If this parameter is not set at zero, it determines the time limit after which alarm **A062** WDG Serial Link 1 Alarm trips if the drive does not receive any legal message through serial link 1 (RJ45 connector).	

R013 Parity Bit for Serial Link 1 (RJ45)

R013	**Range**	0 ÷ 3	0: Disabled 1 Stop–bit 1: Disabled 2 Stop–bit 2: Even (1 Stop bit) 3: Odd (1 Stop bit)
	Default	1	1: Disabled 2 Stop–bit
	Level	ENGINEERING	
	Address	600	
	Function	This parameter determines whether the parity bit is used or not when creating the MODBUS message through serial link 1 (RJ45 connector).	

52. FIELDBUS CONFIGURATION MENU

52.1. Overview

NOTE See the OPTIONAL BOARDS FOR FIELDBUS (SLOT B) section in the Sinus Penta's Motor Drives Accessories - User Manual for the description of the required optional board and Motorola Firmware Version.

NOTE The parameters included in this menu are **Rxxx** parameters.
Once saved, they are active only when the drive is next switched on or when the control board is reset (by holding down the **RESET** key for more than 5 secs or by sending the **I014** command via serial link).

CAUTION This menu is not applicable to ES919 communications boards (see relevant section in the Sinus Penta's Motor Drives Accessories - User Manual). ES919 boards act as gateways and change the **MODBUS** RS485 packets into the packets of each protocol being used.
The exchanged parameters are all the **Mxxx** measures from the Sinus Penta to the Master and all the **Ixxx** inputs from the Master to the Sinus Penta (as detailed in the MEASURES MENU, Table 89 and Table 91).

52.1.1. Alarm A070 (Communication Suspended)

Alarm **A070** trips if the Sinus Penta is not sent any legal message via FIELDBUS within the timeout set in parameter **R016**. Set parameter **R016** = 0 to disable alarm **A070**.
A legal message is as follows:

- **PROFIdrive:** The master drive writes bit 11=1 of the Control Word (see PROFIdrive COMMUNICATIONS BOARD - Installation and Programming Guide).
- **Other Fieldbuses:** The master drive writes the digital input word (word 5 - **M035**) with bit 15=1 or as set in parameter **R018b**.

A legal message is the word of the digital inputs (**M035**) with bit 15=1 written by the master.
Important: this is enabled only when the drive receives the first message with this bit =1.

Do the following to reset alarm **A070:**

- restore communication between the Master drive and the Sinus Penta;
- Re-activate the control of bit 15 of the digital input word as above (bit 11 of the Control Word when using PROFIdrive);
- Send a reset command to the board.

If communications between the Master and the Slave (Penta) cannot be restored, alarm **A070** is reset after setting parameter **R016** to zero and after resetting the Penta drive. When the drive is next powered on, resetting the alarm reset will affect the drive control board.

NOTE Alarm **A070** does not trip if, due to the parameters in the CONTROL METHOD MENU or due to the status of the SOURCE SELECTION or LOC/REM inputs (see DIGITAL INPUTS MENU), the information sent via serial link is not currently used for the commands or the references.

52.2. List of Parameters R016 to R018b and I080

Table 129: List of Parameters R016 to R018b and I080

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
R016	Fieldbus Watchdog Time	ENGINEERING	603	0 ms
R017	Analog Outputs Controlled by the Fieldbus	ENGINEERING	604	000b
R018	Node Address in the Fieldbus	ENGINEERING	230 bit 0-7	0
R018a	Fieldbus BaudRate	ENGINEERING	230 bit 8-11	125k
R018b	Type of Fieldbus Watchdog	ENGINEERING	230 bit 12-15	0 → bit 15 at 1
I080	IP Address Reset	ENGINEERING	519	Inactive

R016 Fieldbus Watchdog Time

R016	**Range**	0 ÷ 60000	0 ÷ 60000 ms
	Default	0	0 ms
	Level	ENGINEERING	
	Address	603	
	Function	If not set to zero, this parameter determines the time limit after which **A070** Fieldbus WDG trips if no legal writing is received from the fieldbus.	

NOTE The Watchdog activates only once the drive has received the first legal message from the master, as described in Alarm A070 (Communication Suspended). This avoids untimely activation due to different start times between the master and the drive.

R017 Analog Outputs Controlled by the Fieldbus

R017	**Range**	000b ÷ 111b binary 0000h ÷ 0007h hex 0 ÷ 7 decimal	000b → None 001b → AO1 010b → AO2 100b → AO3
	Default	000b	000b → None
	Level	ENGINEERING	
	Address	604	
	Function	Select the bit corresponding to the analog output to be controlled by the fieldbus. Example: **R017** = 0011b = 3 decimal → analog outputs AO1 and AO2 are controlled directly by the fieldbus, **irrespective of their configuration in the** ANALOG AND FREQUENCY OUTPUTS MENU.	

R018 Node Address in the Fieldbus

R018	**Range**	0 ÷ 126 for Profibus and CANopen 0 ÷ 63 for DeviceNet	0 ÷ 126 for Profibus and CANopen 0 ÷ 63 for DeviceNet
	Default	0	0
	Level	ENGINEERING	
	Validity	Boards: B40 Profibus, CANopen and DeviceNet	
	Address	230 bit 0-7	
	Function	This is the slave address. This parameter is active only for Profibus, CANopen and DeviceNet fieldbus with B40 boards.	

R018a Fieldbus Baud Rate

R018a	**Range**	0÷3	0 → 125k 1 → 250k 2 → 500k 3 → Autodetect
	Default	0	0 → 125k
	Level	ENGINEERING	
	Validity	Boards: B40 CANopen and DeviceNet	
	Address	230 bit 8-11	
	Function	This is the slave baud rate in bps. It is active only for CANopen and DeviceNet fieldbus with B40 boards.	

R018b Type of WatchDog

R018b	**Range**	0÷2	0 → bit 15 at 1 1 → bit 15 in toggle 2 → with B40 state
	Default	0	0 → bit 15 at 1
	Level	ENGINEERING	
	Address	230 bits 12-15	
	Validity	Boards: B40	
	Function	Indicates the type of active WatchDog: 0 → after having established a connection to the Master device for the first time, if **R016** > 0, the system checks if bit 15 of word 5 (digital inputs from Fieldbus) is set to 1. If the bit drops to zero for a time longer than **R016**, alarm **A070** Fieldbus WDG trips. 1 → After having established a connection to the Master device for the first time, if **R016** > 0, the system checks if bit 15 of word 5 (digital inputs from Fieldbus) continuously changes 0-1. If the bit is kept at one of the two values for a time longer than **R016**, **A070** alarm **A070** Fieldbus WDG trips. 2 → After having established a connection to the Master device for the first time, if **R016** > 0, the system checks if the status of B40 board is kept in Connect status. If the Disconnect status is kept for a time longer than **R016**, **A070** alarm **A070** Fieldbus WDG trips. It is active only for B40 boards.	

NOTE When using different boards than B40, the Watchdog is always managed as: 0 → bit 15 at 1.

Table 130: Coding of Parameters R018, R018a and R018b

bit [15..12]	bit [11..8]	bit [7..0]
R018b	**R018a**	**R018**

I080 IP Address Reset

I080	**Range**	0 ÷ 1	0 → Inactive 1 → Address reset
	Default	This is not a parameter: **I080** is set to zero at power on and whenever the command is executed.	
	Level	ENGINEERING	
	Validity	Boards: B40 Modbus TCP, Profinet and Ethernet IP	
	Address	519	
	Function	Pressing the button forces the following after the board is reset: IP → 192.168.0.2 subnet mask → 255.255.255.0 gateway → 0.0.0.0 and DHCP disabled. This parameter is active only for Modbus TCP, Profinet, and Ethernet fieldbus with B40 boards.	

52.3. Exchanged Parameters

The tables below state the Sinus Penta parameters exchanged via Fieldbus.

Each table contains:
1) the parameter code;
2) its description;
3) its range;
4) its unit of measure (also indicated on the display);
5) the ratio between the Sinus Penta value (exchanged via Fieldbus) and the represented hardware value (as displayed).

NOTE Each parameter is exchanged as an integer value with 16-bit sign (-32768 to +32767).

NOTE Bytes are exchanged in **big-endian mode** (the most significant value is stored to the smallest memory address).
When using an Intel based master/PLC chipset, then the data below will be byte-swapped.

NOTE The PLC must enter all the exchange variables, with no exception. If required, it is possible to suppress all the variables in sequence after suppressing the variable desired.
For example, if all data are required from the Master to the Slave up to "Commands for digital outputs from Fieldbus", the first six variables shall be entered by the PLC. Variables from 7 on may not be entered to the PLC.

52.3.1. From the Master to the Sinus Penta

Word	1) Code	2) Description	3) Range	4) Unit of Measure	5) Scaling
1	M042	Speed reference/limit from FIELDBUS (integer portion)	– 32000 ÷ + 32000	rpm	1
2	M043	Speed reference/limit from FIELDBUS (decimal portion)	– 99 ÷ + 99	rpm	x 100
3	M045	Torque reference/limit from FIELDBUS	– 5000 ÷ + 5000	%	x 10
4	M047	PID reference from FIELDBUS	– 10000 ÷ + 10000	%	x 100
5	M035 + M036b	Digital and Auxiliary Digital Inputs from FIELDBUS	–	–	–
6	-	Command for Digital Outputs from FIELDBUS	–	–	–
7	AO1	Analog Output 1 controlled by FIELDBUS	+ 167 ÷ + 2833	–	–
8	AO2	Analog Output 2 controlled by FIELDBUS	+ 167 ÷ + 2833	–	–
9	AO3	Analog Output 3 controlled by FIELDBUS	+ 167 ÷ + 2833	–	–
10	M049	PID Feedback from FIELDBUS	– 10000 ÷ + 10000	–	x 100

The parameter exchange memory zone may also be used to read and write all the Penta drive's parameters by referring to their Modbus address.

Word	1) Number	2) Description	3) Range	4) Unit of measure	5) Ratio
11	Type of cycle	Read or write cycle	Allowable values 0x80, 0x40	–	1
12	Address	Modbus address of the variable to be read/written	0 ÷ 8191	–	1
13	Value	Value to be written to the Modbus address	–32768 ÷ +32767	–	1

Word 1: Speed reference/limit from FIELDBUS (integer portion)

Word 1 of the memory map details the integer portion of the speed reference (**M042**) in either IFD, VTC or FOC mode.

bit [15..8]	bit [7..0]
Speed reference integer portion	

The speed reference from the FIELDBUS is obtained by adding the decimal portion to the integer portion (see Word 2).

This value is included in the global speed reference of the drive (measure **M000**) along with the other reference sources if at least one of parameters **C143** to **C146** is set as 6:FieldBus.

The speed limit from FIELDBUS is significant if parameter **C147** is set as 6:FieldBus and the type of reference of the active motor (parameters **C011** / **C054** / **C097**) is set as 2:Torque with Speed Limit.

Word 2: Speed reference/limit from FIELDBUS (decimal portion)

Word 2 details the decimal portion of the speed reference (**M043**) ONLY IN FOC MODE. The value sent by the Master to the Sinus Penta as the decimal portion of the speed reference must be multiplied by 100.
In order to send a speed reference of XXX.50rpm, the low byte of the word must contain the value 50_{10} or 00110010_2 (0.50_{10} x 100 = 50_{10}).

Example: **M042**=210; **M043**=50 ⇒ speed ref. = 210.50 rpm

bit [15..8]	bit [7..0]
Speed reference decimal portion	

Word 3: Torque reference/limit from FIELDBUS

The torque reference from the FIELDBUS (**M045**) is significant if at least one of parameters **C143** to **C146** is set as 6:FieldBus and if the type of reference of the active motor (parameters **C011/C054/C097**) is set as 1:Torque or as 2:Torque with Speed Limit, or if the drive is in slave mode from digital input.

The torque limit from the FIELDBUS is significant if parameter **C147** is set as 6:FieldBus.

The value sent by the Master to the Sinus Penta as the torque reference/torque limit must be multiplied by 10.
In order to send a torque reference/torque limit of 50%, the word must contain the value 500_{10} or 111110100_2 ($50\%_{10}$ x 10 = 500_{10}).

bit [15..8]	bit [7..0]
Torque reference/limit	

Word 4: PID reference from FIELDBUS

The PID reference (**M047**) can be sent from the fieldbus if at least one of the parameters **C285** to **C287** is set as 6:Fieldbus.

The value sent by the Master to the Sinus Penta as the PID reference must be multiplied by 100.
E.g. In order to send a PID reference of 50%, the word must contain the value 5000_{10} or 111110100_2 ($50\%_{10}$ x 100 = 5000_{10}).

bit [15..8]	bit [7..0]
PID reference from FIELDBUS	

Word 5: Digital and Auxiliary Digital Inputs from FIELDBUS
The virtual digital inputs via the Fieldbus are the low byte of the word:

bit [7..0]							
MDI8	MDI7	MDI6	MDI5	MDI4	MDI3	MDI2	MDI1

The virtual auxiliary digital inputs from Fieldbus are given in the high byte of the word:

bit 15	bit [14..8]						
XMDI8/ Watchdog	XMDI7	XMDI6	XMDI5	XMDI4	XMDI3	XMDI2	XMDI1

The logic status of these bits is included in the overall status of the drive digital inputs (measure **M031**) along with the other command sources if at least one of the parameters **C140** ÷ **C142** is set as 6:FieldBus.

NOTE

Auxiliary digital input XMDI8, allocated to bit 15 of Word 5, may be controlled only if:
R016 = 0 (inactive watchdog), or
R016 > 0 (active watchdog) and **R018b** = 2.

CAUTION

If **R016** > 0 (active watchdog), bit 15 is controlled via parameter **R018b**:

- **R018b** = 0/1: see the description of the parameter
- **R018b** = 2: the bit controls input XMDI8 and is independent of the watchdog control.

Word 6: Command for Digital Outputs from FIELDBUS

Digital commands from FIELDBUS are the 4 lower bytes of the word:

bit [15...4]	bit [3..0]			
	CMD 4	CMD 3	CMD 2	CMD 1

Byte format:

Bit	Command	Position in the selection vector
0	Fbus CMD 1	D34
1	Fbus CMD 2	D35
2	Fbus CMD 3	D36
3	Fbus CMD 4	D37

Columns 2 and 3 state the name and position of the commands sent via fieldbus.
Example: to control digital output 1 via fieldbus through command 4, set the parameters below in the DIGITAL OUTPUTS MENU:

P270 = 1: Digital	Digital Output Mode
P271 = D37: Fbus CMD4	Variable A Selection
P278 = 1: True	Output Logic Level

Words 7, 8, 9: Analog Outputs controlled by FIELDBUS

Parameter **R017** needs to be properly set up to distinguish which Analog Outputs are to be controlled by the Fieldbus.

Byte format:

Bit	Analog Output controlled by the fieldbus
0	AO1
1	AO2
2	AO3

Example: **R017** = $011_2 = 3_{10} \rightarrow$ analog outputs AO1 and AO2 are controlled directly by the fieldbus, independently of their configuration in the ANALOG AND FREQUENCY OUTPUTS MENU**.**

The correspondence between the exchanged value and the actual value (in volts) of the analog outputs is as follows:

Exchanged value	Voltage (V)	Current (mA)
+ 2833	+ 10	+ 20 mA
+ 1500	0	0
+ 167	– 10	– 20 mA

Word 10: PID feedback from FIELDBUS

The PID feedback (**M049**) can be sent from the fieldbus if at least one of the parameters **C288** to **C290** is set as 6:Fieldbus.

The value sent by the Master to the Sinus Penta as the PID feedback must be multiplied by 100.
E.g. In order to send a PID feedback of 50%, the word must contain the value 5000_{10} or 111110100_2 ($50\%_{10}$ x 100 = 5000_{10}).

bit [15..8]	bit [7..0]
PID feedback from FIELDBUS	

Word 11: Type of cycle required
The word states the cycle required:

- 0x40: Write cycle
- 0x80: Read cycle

For the “Read cycle”, the field including the read address (Word 12) is to be completed beforehand.
For the “Write cycle”, the field including the write address (Word 12) as well as the field including the value to be written (Word 13) are to be completed beforehand.

NOTE At the end of each read/write cycle or between any two cycles, enter value “0x00” in Word 11.

Word 12: Modbus address of the variable to read/write
Includes the Modbus address of the variable to be read (read cycle) or written (write cycle).

NOTE The return value of the read variable will be available for Word 12 described in the From the Sinus Penta to the Master section.

NOTE In order to save a parameter to non-volatile memory, see **I009 Parameter save**.

Word 13: Value to be written
Only in case of write cycles, it includes the value to be written to the address required.

52.3.2. FROM THE SINUS PENTA TO THE MASTER

Word	1) Code	2) Description	3) Range	4) Unit of Measure	5) Scaling
1	–	Status + Alarms	–	–	–
2	M026	Output Current	0 ÷ 65000	A	x 10
3	M004	Motor Speed	– 32000 ÷ + 32000	rpm	x 1
4	–	Third measure that may be configured with **P330**	All the measures	See selected measure	See selected measure
5	–	Fourth measure that may be configured with **P331**	All the measures	See selected measure	See selected measure
6	DIN	Digital and Auxiliary Digital Inputs	–	–	–
7	DOU	Digital and Auxiliary Digital Outputs	–	–	–
8	REF	REF Analog Input (default 0÷10V)	0 ÷ 15366	–	–
9	AIN1	AIN1Analog Input (default 4÷20mA)	1529..7652	–	–
10	AIN2	AIN2 Analog Input (default 4÷20mA)	1529..7652	–	–

The words below are significant only when using the parameter exchange memory zone to read and write all the Penta drive's parameters by referring to their Modbus address.

Word	1) Code	2) Description	3) Range	4) Unit of Measure	5) Scaling
11	Return value	Return value of the cycle required	–	–	1
12	Value	Read value	–32768 ÷ +32767	–	1

Word 1: Status + Alarms

The **Status** and **Alarms** are displayed over the fieldbus in the following format:

bit [15..8]	bit [7..0]
Status	Alarms

The **Status** codes are given in Table 139

The **Alarm** codes are given in Table 137**.**

Word 2: Output Current

The output current measure (**M026**) is displayed as a value that must be divided by 10 to obtain the actual motor current.

bit [15..8]	bit [7..0]
Output Current x 10	

Word 3: Motor Speed

The output motor speed (**M004**) is displayed as follows:

bit [15..8]	bit [7..0]
Motor Speed	

Words 4 & 5: Third & Fourth measure that may be configured with P330 & P331
Words 4 & 5 may be configured with **P330** and **P331** – more details are given in the FIELDBUS PARAMETERS MENU.
Both words 4 & 5 are represented as follows:

bit [15..8]	bit [7..0]
Mxxx represented by **P330** and **P331**	

Word 6: Digital and Auxiliary Digital Inputs

Digital and Auxiliary Digital input status in the word:

bit [15..8]								bit [7..0]							
XMDI8	XMDI7	XMDI6	XMDI5	XMDI4	XMDI3	XMDI2	XMDI1	MDI8	MDI7	MDI6	MDI5	MDI4	MDI3	MDI2	MDI1

Word 7: Digital and Auxiliary Digital Outputs

Digital and Auxiliary Digital output status in the word:

bit [15..14]		bit [13..8]						bit 7	bit 6	bit [5..4]		bit [3.0]			
MPL4	MPL3	XMDO6	XMDO5	XMDO4	XMDO3	XMDO2	XMDO1		[*]	MPL2	MPL1	MDO4	MDO3	MDO2	MDO1/ FOUT

[*] Status of the Pre-charge contactor

Words 8, 9, 10: REF, AIN1, AIN2 Analog Signals
Full scale values

- 0 ÷ 15366 (0 ÷10 V input)
- –15366 ÷ 15366 (± 10 V input)
- 1529 ÷ 7652 (4..20 mA input)

are nominal values.
These values can be changed due to automatic compensation of the tolerance of the input stage.

bit [15..8]	bit [7..0]
REF / AIN1 / AIN2	

NOTE The measures of the analog inputs sent from the Sinus Penta to the Master are the unfiltered measure values detected in the A/D converter output.
For filtered measures, use **M037**, **M038** and **M039** respectively.

Word 11: Return value of the cycle required
The word includes the return value of the cycle required (bits):

bit [15..8]	bit 7	bit [6..0]
	1= active cycle	See table below

0	NO ANSWER
1	WAITING
2	ANSWER OK
3	ILLEGAL DATA VALUE
4	ILLEGAL ADDRESS VALUE
5	CONTROL IS ON
6	WRONG ACCESS LEVEL
7	MMI IS PROGRAMMING

Word 12: Read value
The word includes the value read in case of Read cycle.
This value is to be considered as legal when Word 11= 0x82 (active cycle + ANSWER OK).

NOTE The read value is to be considered as valid only if Word 11= 0x82 (active cycle + ANSWER OK).

NOTE For the read cycle activation, see Words 11 and 12 described in the From the Sinus Penta to the Master section.

52.4. Identification of Fieldbus boards

FUNCTION	MODBUS Address
NetworkType	63
ModuleType	64
ModuleSWVersionMajMin [*]	72
ModuleSWVersionBuild [**]	73
ModuleSerialNumber	75 (high) / 74 (low)

[*] B40: hexadecimal; Anybus-S: BCD [**] Anybus-S: not significant

ModuleType	
0x000B	B40
0x0101	Anybus-S
0x0102	Anybus-S Drive Profile

ModuleType = B40:

NetworkType	
0x0005	Profibus-DP®
0x0020	CANOpen®
0x0025	DeviceNet®
0x0087	EtherCAT
0x0089	Profinet IRT
0x0093	Modbus/TCP
0x009B	EtherNet/IP

ModuleType = Anybus-S

NetworkType	
0x0001	Profibus-DP®
0x0020	CANOpen®
0x0025	DeviceNet®
0x0083	Modbus/TCP

NOTE These identification data are only available with Motorola firmware version ≥ 4.202.

Example B40:

NetworkType = 0x0089	Profinet IRT
ModuleType = 0x000B	B40
ModuleSWVersionMajMin = 0x013A	
ModuleSWVersionBuild = 0x00C8	Version 1.58.200
ModuleSerialNum low = 0x4EE2	
ModuleSerialNum high = 0xA043	S/N 0xA0434EE2

Example Anybus-S:

NetworkType = 0x0001	Profibus-DP®
ModuleType = 0x0101	Anybus-S
ModuleSWVersionMajMin = 0x0120	Version 1.20
ModuleSerialNum low = 0xEE07	
ModuleSerialNum high = 0xA003	S/N 0xA003EE07

53. EXPANSION BOARD CONFIGURATION MENU

53.1. Overview

NOTE

Parameters in this menu are **Rxxx** parameters.
Once saved, they are active only when the drive is next switched on or when the control board is reset (by holding down the **RESET** key for more than 5 secs or by sending the **I014** command via serial link).

53.2. List of Parameters R021 to R023

Table 131: List of Parameters R021 to R023

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
R021	Data Logger setting	ENGINEERING	551	Disable
R023	I/O board setting	ENGINEERING	553	None

R021 Data Logger Setting

R021			
	Range	1 ÷ 3	1: Disable 2: ES851 3: Bridge Mini
	Default	1	1: Disable
	Level	ENGINEERING	
	Address	551	
	Function	This parameter enables or disables ES851 or Bridge Mini initialization (if the optional boards are fitted).	

R023 I/O Board Setting

R023			
	Range	0 ÷ 4	0: None 1: XMDI/O 2: XMDI/O + XAIN 3: XMDI/O + PT100 4: XMDI/O + XAIN + PT100
	Default	0	0: None
	Level	ENGINEERING	
	Address	553	
	Function	Based on the settings in the relevant parameter, this parameter enables controlling digital I/O (XMDI/O), analog inputs (XAIN) and PT100 probes located on optional control boards.	

NOTE

ES847 is required to control analog inputs (XAIN) and PT100 probes.
Either ES847 or ES870 can be used to control digital I/O (XMDI/O).

54. PROFIDRIVE BOARD CONFIGURATION MENU

54.1. Overview

This menu allows programming the PROFIdrive expansion board. It can be viewed only if the PROFIdrive board is connected to the control board.

NOTE Parameters in this menu are **Rxxx** parameters.
Once changed and saved, they become active only when the drive is next switched on or when its control board is reset (by holding down the **RESET** button for more than 5 seconds or by sending the **I014** command via serial link).

NOTE For the correct operation of the PROFIdrive board, please refer to the Sinus Penta's Motor Drives Accessories - User Manual and to the PROFIdrive COMMUNICATIONS BOARD - Installation and Programming Guide.

NOTE If the PROFIdrive option is present, parameter **C149 START Input** must be assigned to value 1: MDI1.

NOTE If the PROFIdrive option is fitted, alarm **A070** is allocated to bit 11 of the Control Word. **A070** trips if parameter **R016** is > 0 and bit 11 is set to 0 for a time longer than the time set in **R016**. See FIELDBUS CONFIGURATION MENU.

54.2. List of Parameters R025 to R045

Table 132: List of Parameters R025 to R045

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
R025	Slave address	ENGINEERING	547	1
R026	PZD3 OUT	ENGINEERING	548	1: DIGITAL INPUTS
R027	PZD4 OUT	ENGINEERING	549	0: NOT USED
R028	PZD5 OUT	ENGINEERING	550	0: NOT USED
R029	PZD6 OUT	ENGINEERING	554	0: NOT USED
R030	PZD7 OUT	ENGINEERING	555	0: NOT USED
R031	PZD8 OUT	ENGINEERING	556	0: NOT USED
R032	PZD9 OUT	ENGINEERING	557	0: NOT USED
R033	PZD10 OUT	ENGINEERING	558	0: NOT USED
R034	PZD3 IN	ENGINEERING	559	0: NOT USED
R035	PZD4 IN	ENGINEERING	581	0: NOT USED
R036	PZD5 IN	ENGINEERING	582	0: NOT USED
R037	PZD6 IN	ENGINEERING	583	0: NOT USED
R038	PZD7 IN	ENGINEERING	584	0: NOT USED
R039	PZD8 IN	ENGINEERING	585	0: NOT USED
R040	PZD9 IN	ENGINEERING	586	0: NOT USED
R041	PZD10 IN	ENGINEERING	587	0: NOT USED
R044	Drive Profile Communication Mode	ENGINEERING	520	0: DP V0
R045	Drive Profile Selection	ENGINEERING	521	1: VENDOR SPECIFIC 1

R025 SLAVE ADDRESS

R025	**Range**	0 ÷ 126	0 ÷ 126
	Default	1	1
	Level	ENGINEERING	
	Address	547	
	Function	This parameter sets the address for the PROFIdrive board.	

NOTE The programmed value has effect only if the board address selectors are set to zero (see the Sinus Penta's Motor Drives Accessories - User Manual and the PROFIdrive comms board User Manual).

R026 to R033 PZD3(/10) OUT

R026 to R033	**Range**	0 ÷ 6	0: NOT USED 1: DIGITAL INPUTS 2: AUXILIARY DIGITAL INPUTS (I/O expansion board) 3: DIGITAL OUTPUT COMMANDS 4: TORQUE REFERENCE 5: PID REFERENCE 6: PID FEEDBACK
	Default	1	1: DIGITAL INPUTS
	Level	ENGINEERING	
	Address	548 ÷ 550 // 554 ÷ 558	
	Function	These parameters allow selecting the inputs to be downloaded from the Master PLC to the drive through the eight process data items that can be mapped in the fast communication area between the Master and the Slave station.	

R034 to R041 PZD3(/10) IN

R034 to R041	**Range**	0 ÷ 103	See MEASURES MENU and Table 60
	Default	0	0: NOT USED
	Level	ENGINEERING	
	Address	559 // 581 ÷ 587	
	Function	These parameters allow selecting the measures to be passed to the drive from the Master PLC through the eight process data items that can be mapped in the fast communication area between the Master and the Slave station. You can select any measure from the MEASURES MENU.	

R044 DRIVE PROFILE COMMUNICATION MODE

R044	**Range**	0 ÷ 1	0: DP V0 1: DP V1
	Default	0	0: DP V0
	Level	ENGINEERING	
	Address	520	
	Function	This parameter sets the version of the PROFIdrive protocol.	

R045 DRIVE PROFILE SELECTION

R045			
	Range	0 ÷ 2	0: PROFIDRIVE 1: VENDOR SPECIFIC 1 2: VENDOR SPECIFIC 2
	Default	1	1: VENDOR SPECIFIC 1
	Level	ENGINEERING	
	Address	507	
	Function	This parameter sets the control mode (Command and Reference) for the Slave station. 0: PROFIDRIVE 1: VENDOR SPECIFIC 1 2: VENDOR SPECIFIC 2	

	Command	Reference
PROFIDRIVE	According to the PROFIdrive protocol.	According to the PROFIdrive protocol.
VENDOR SPECIFIC 1	According to the PROFIdrive protocol.	One-to-one scale of the programmed reference.
VENDOR SPECIFIC 2	The eight low bits in the CONTROL WORD represent the eight digital inputs in the control board.	One-to-one scale of the programmed reference.

NOTE Bit 11 in the control board enables or not the Fieldbus line watchdog in any of the three control modes above, provided that parameter **R016** is set higher than zero.

NOTE The watchdog activates only after the drive has received the first legal message sent from the master (see Alarm A070 (Communication Suspended), thus preventing alarm **A070** from tripping due to different power-on times between the master station and the Penta drive.

55. DAYLIGHT SAVING TIME

55.1. Overview

NOTE The Daylight Saving Time menu may be accessed only if the Data Logger board is installed (even the ES851 RTC version only) and if parameter **R021** Data Logger setting is set to 2: ES851.

NOTE If the Bridge Mini board (parameter **R021** set to 3: Bridge Mini) is installed, the daylight saving time is not to be set, as this is done automatically when the board is connected to the network.

Parameters **R050** to **R053** set the DST rules for the Clock/Calendar of the Data Logger or the ES851 RTC. See DATE AND TIME MENU.

55.2. List of Parameters R050 to R053

Table 133: List of Parameters R050 to R053

Parameter	FUNCTION	User Level	DEFAULT VALUES	MODBUS Address
R050	DST Start WDMM	ENGINEERING	5703	524
R051	DST Start HHMM	ENGINEERING	200	525
R052	DST End WDMM	ENGINEERING	5710	526
R053	DST End HHMM	ENGINEERING	200	527

R050 DST Start WDMM – Week/Day/Month

R050			
	Range	0 ÷ 9112	0 ÷ 9112
	Default	5703	5703
	Level	ENGINEERING	
	Active	This parameter can be viewed and changed only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851).	
	Address	524	
	Function	**If the first digit of the parameter is lower than 6:** The first digit (W) indicates the week of the month when the DST starts (1 = first week, 2 = second week, 3 = third week, 4 = fourth week, 5 = last week). The second digit (D) indicates the day of the week (1 = Monday, 7 = Sunday). The third and fourth digits (MM) indicate the start month (01 = January, 12 = December). Example: European Union: 5703 (last Sunday in March) USA: 2703 (second Sunday in March) Brazil: 3710 (third Sunday in October) **If the first digit of the parameter is higher than or equal to 6:** The first two digits (WD) correspond to the day of the month when the DST starts, added to 60 (61 corresponds to 1, 91 corresponds to 31). The third and fourth digit (MM) indicate the start month (01 corresponds to January, 12 corresponds to December). Example: 7504 = 15 April.	

R051 DST Start HHMM – Hour/Minutes

R051			
	Range	100 ÷ 2400	100 ÷ 2400
	Default	200	200
	Level	ENGINEERING	
	Active	This parameter can be viewed and changed only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851).	
	Address	525	
	Function	The first digit or the first two digits (if the total digits are 3 or 4 respectively) correspond to the start hours. The last two digits correspond to the minutes. Example: 200 = 2h 00m 2400 = 0h 0m (midnight between the day set in **R050** and the previous day.)	

R052 DST End WDMM – Week/Day/Month

R052			
	Range	0 ÷ 9112	0 ÷ 9112
	Default	5710	5710
	Level	ENGINEERING	
	Active	This parameter can be viewed and changed only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851).	
	Address	526	
	Function	**If the first digit of the parameter is lower than 6:** The first digit (W) indicates the week of the month when the DST ends (1 = first week, 2 = second week, 3 = third week, 4 = fourth week, 5 = last week). The second digit (D) indicates the day of the week (1 = Monday, 7 = Sunday). The third and fourth digits (MM) indicate the start month (01 = January, 12 = December). Example: European Union: 5710 (last Sunday in October) USA: 1711 (first Sunday in November) Brazil: 3702 (third Sunday in February) **If the first digit of the parameter is higher than or equal to 6:** The first two digits (WD) correspond to the day of the month when the DST starts, added to 60 (61 corresponds to 1, 91 corresponds to 31). The third and fourth digit (MM) indicate the start month (01 corresponds to January, 12 corresponds to December). Example: 6110 = 1 October.	

R053 DST End HHMM – Hour/Minutes

R053			
	Range	100 ÷ 2400	100 ÷ 2400
	Default	200	200
	Level	ENGINEERING	
	Active	This parameter can be viewed and changed only if the Data Logger ES851 is installed and activated (**R021** = 2: ES851).	
	Address	527	
	Function	The first digit or the first two digits (if the total digits are 3 or 4 respectively) correspond to the end hours. The last two digits correspond to the minutes. Example: 200 = 2h 00m 2400 = 0h 0m (midnight between the day set in **R052** and the previous day.)	

56. DATA LOGGER MENU

56.1. Overview

The Data Logger menu is to be used if the Penta drive cannot dialog with the Data Logger ES851 board through the RemoteDrive software.
Parameter **R116** imposes to ES851 the type of connection required for the communication mode being used.

NOTE

The Data Logger menu may be accessed only if the Data Logger board is installed and if parameter **R021** Data Logger setting is set to 2: ES851.
Important: The complete version of the Data Logger ES851 shall be installed (the RTC version only is not suitable for this functionality). Please refer to the Motor Drives Accessories - User Manual.

NOTE

The parameters described in this menu are **Rxxx** parameters.
Once changed and saved, they become active only when the drive is next switched on or when the control board is reset (by holding down the **RESET** key for more than 5 secs or by sending the **I014** command via serial link).

CAUTION

The parameters set from this menu are not saved to non-volatile memory of the Data Logger board.
They must be confirmed and saved using the RemoteDrive software.

56.2. List of Parameters R115 and R116

Table 134: List of Parameters R115 and R116

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
R115	SIM Card PIN	BASIC	563	“0000”
R116	Preset connection status	ENGINEERING	134	0: no active preset

R115 SIM Card PIN

R115			
	Range	0x0000 ÷ 0xAAAA	“0” ÷ “9999”
	Default	0x0000	“0000”
	Level	BASIC	
	Address	563	
	Function	This parameter indicates the digits of the PIN of the SIM card fitted in the GSM/GPRS modem. The digits must be aligned left; the # symbol, which is codified as 0xA (hex) is intended as the number terminator.	

NOTE

Max. 4 digits are allowed for the SIM card PIN.
The PIN can be composed of less than 4 digits and the # symbol can be used as the PIN terminator.

R116 Preset Connection Status (Line 2)

R116 Line 2			
	Range	0 ÷ 20	See Table 135
	Address	1337	
	Function	This parameter indicates if preset configurations are actually set up for the types of connections supported by ES851.	

R116 Preset Connections (Line 4)

R116 Line 4			
	Range	0 ÷ 20	See Table 135
	Default	0	0: no active preset
	Level	ENGINEERING	
	Address	134	
	Function	This parameter allows forcing one of the available connecting modes to the Data Logger ES851 board. The parameters used for Ethernet connections and modem connections are the ones stored in the Penta drive. Configurations 19 and 20 support both dial in and dial out.	

NOTE After imposing any of the preset values given in Table 135, the Data Logger is forced to Interlocked mode (see the Data Logger Measures Menu).

Table 135: Preset connections

Value	COM	Baudrate [bps]	Stop bit	Parity	Delay [ms]
0	No active presetting				
1	Ethernet enabled				
2	PPP null modem				
3	1(RS232)	38400	2	no	2
4	1(RS232)	38400	1	no	2
5	1(RS232)	38400	2	no	20
6	1(RS232)	38400	1	no	20
7	1(RS232)	9600	2	no	2
8	1(RS232)	9600	1	no	2
9	1(RS232)	9600	2	no	20
10	1(RS232)	9600	1	no	20
11	2(RS485)	38400	2	no	2
12	2(RS485)	38400	1	no	2
13	2(RS485)	38400	2	no	20
14	2(RS485)	38400	1	no	20
15	2(RS485)	9600	2	no	2
16	2(RS485)	9600	1	no	2
17	2(RS485)	9600	2	no	20
18	2(RS485)	9600	1	no	20
19	Dial Out analog modem				
20	Dial Out GSM modem				

57. EEPROM MENU

57.1. Overview

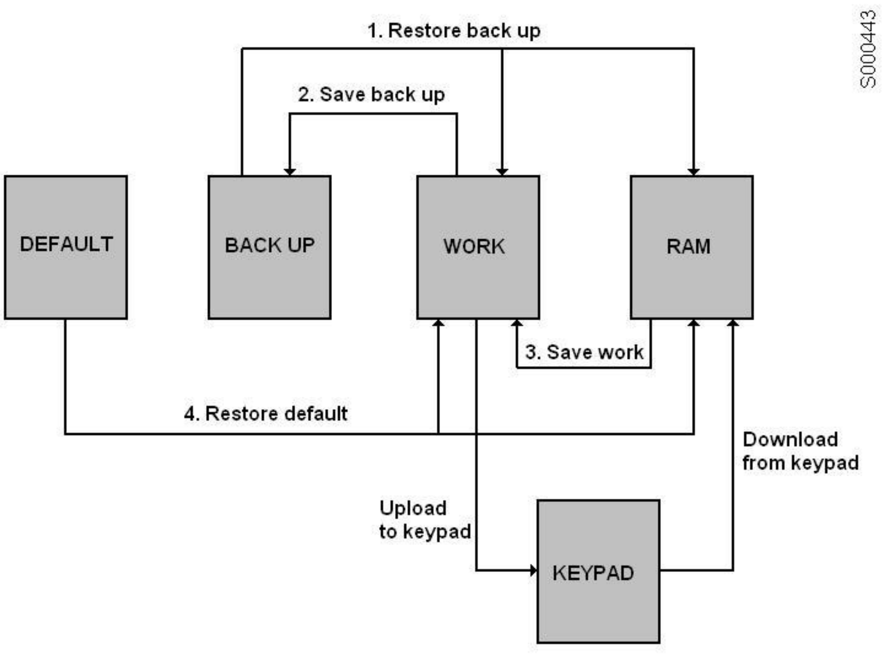
The drive has four different memory areas:

- **RAM** → Volatile memory containing the drive's current parameterization;
- **DEFAULT Area** → Non-volatile memory that cannot be accessed by the user, containing the factory-setting of the drive parameters.
- **WORK Area** → Non-volatile memory where customized parameters are saved. Whenever the drive is reset, this parameterization is loaded to the RAM.
- **BACKUP Area** → Non-volatile memory storing a new drive parameterization. Back-up parameters are modified only when the user explicitly saves the BACKUP Area.

Any parameter can be changed by the user. The drive will immediately use the new parameter value.
The user may save the parameter value in the Work area. If no new value is saved for a given parameter, the drive will use the parameter value stored in the Work area when next turned on.

- **"P"** parameters can be written at any moment.
- According to factory-setting, "**C"** parameters may be written when the equipment is on stand-by or when the motor is not running and the equipment is fluxing. See **P003** to modify them only when the **ENABLE-A** and **ENABLE-B** commands are deactivated (terminal **MDI2** open).
- "**R"** parameters have the same features as "C" parameters, but the new parameter value, once written and saved, will be used only at next power on. To use the new parameter value immediately, turn the drive off and on or reset it (by holding down the **RESET** key for more than 5 secs or by sending the **I014** command via serial link).

The WORK area may be copied to the BACKUP area through **I012** included in this menu and described in the section below.
I012 input also allows copying the BACKUP area to the WORK area in order to restore the parameter values stored in the WORK area.
I012 input also allows restoring the factory-setting values for all parameters in the WORK area.



57.2. List of Inputs I009 to I014

Table 136: List of Inputs I009 to I014

Input	FUNCTION	User Level	MODBUS Address
I009	Parameter save	BASIC	1396
I012	EEPROM control	BASIC	1399
I013	Alarm control	BASIC	1400
I014	Inverter Reset	BASIC	50

I009 Parameter save

I009			
	Range	131 ÷ 2466	131 ÷ 2466
	Default	This is not a parameter: **I009** is set to zero at power on and whenever the command is executed.	
	Level	BASIC	
	Address	1396	
	Function	Allows only one parameter to be saved to EEPROM. The value to be saved must be the same as the value set in the Address field of the parameter concerned.	

I012 EEPROM Control

I012			
	Range	0, 2, 4, 5, 11	0: No Command 2: Restore Backup 4: Save Backup 5: Save Work 11: Restore Default
	Default	This is not a parameter: **I012** is set to zero at power on and whenever the command is executed.	
	Level	BASIC	
	Address	1399	
	Function	This parameter saves and restores the entire set of parameters that can be accessed by the user: **2: Restore Backup**: the parameters stored in the BACKUP area are copied and stored in the WORK area. They represent the new RAM parameterization; the previous RAM parameters are cleared. **BACKUP → RAM → WORK;** **4: Save Backup**: the parameters in the WORK zone are saved to a copy of the BACKUP area. **WORK → BACKUP;** **5: Save Work**: the current values of the parameters stored in the RAM area are saved to non-volatile memory in the WORK area. All the parameters are saved with this command. **RAM → WORK**; **11: Restore Default**: factory-setting values are restored for all parameters; each factory-setting value is stored to non-volatile memory in the WORK area. **DEFAULT → RAM → WORK**.	

I013 Alarm Control

I013	**Range**	1, 777	1: Trips alarm **A040** 777: Resets the alarms tripped
	Default	This is not a programming parameter: the input is set to zero whenever the drive is powered on and whenever the command is executed.	
	Level	BASIC	
	Address	1400	
	Function	**1: Trips alarm A040 (User alarm)**. It may be helpful to test the system. **777: Resets the alarms tripped**. Resets any alarm tripped (not only **A040**).	

I014 Inverter Reset

I014	**Range**	34	34: Inverter reset
	Default	This is not a programming parameter: the input is set to zero whenever the drive is powered on and whenever the command is executed.	
	Level	BASIC	
	Address	50	
	Function	**34: Inverter Reset**. Allows reinitializing the inverter. It is useful, for instance, to activate **Rxxx** parameters without having to shut down and power on the inverter.	

58. ALARMS AND WARNINGS

CAUTION If a protection trips or the drive enters the emergency mode, the drive is locked and the motor starts idling!

58.1. What Happens When a Protection Trips

NOTE Before operating the drive in emergency conditions, carefully read this section and the following section What To Do When an Alarm Trips.

The drive alarms are detailed below.

When a protection / alarm trips:
1) the **ALARM** LED on the keypad comes on;
2) the page displayed on the keypad is the root page of the **FAULT LIST**;
3) the **FAULT LIST** is refreshed.

NOTE In factory-setting, when the drive is switched on after an alarm has tripped—which has not been reset—it is kept in emergency condition.
If the drive is in emergency mode when switched on, this could be due to an alarm tripped before the drive was reset.
To avoid storing the alarms tripped before the drive is switched off, set parameter **C257** in the AUTORESET MENU**.**

The drive stores the moment when an alarm trips to the **FAULT LIST** (supply–time and operation–time). The drive status when the alarm tripped and some measures sampled when the alarm tripped are also stored to the Fault List.
The readout and storage of the fault list can be very useful to detect the cause responsible for the alarm and its possible solution (see also the Fault List Menu).

NOTE Alarms **A001** to **A039** relate to the main microcontroller (DSP Motorola) of the control board, which detected a fault on the control board itself. No fault list is available for Alarms **A001** to **A039** and no Reset command can be sent via serial link; alarms can be reset through the **RESET** terminal on the terminal board or the **RESET** key on the keypad. No software for the keypad interface is available; the drive parameters and measures cannot be accessed via serial link.
Avoid resetting alarms **A033** and **A039**, as they trip when the flash memory is not provided with its correct software. Alarms **A033** and **A039** can be reset only when proper software is downloaded for the inverter flash memory.

CAUTION Before resetting an alarm, deactivate the **ENABLE-A** and **ENABLE-B** signals on terminal **MDI2** to disable the inverter and prevent the connected motor from running at uncontrolled speed, unless parameter **C181**=1 (the Safety Start function is active): after resetting an alarm or after supplying the inverter, this will start only if the **ENABLE-A** and **ENABLE-B** contacts are opened and closed again.

58.2. What To Do When an Alarm Trips

⚠	**CAUTION**	If a protection trips or the drive is in emergency condition, the drive is locked and the motor starts idling!
⚠	**CAUTION**	Before resetting an alarm, disable the **ENABLE-A** and **ENABLE-B** signals on terminal **MDI2** to disable the drive and to prevent the connected motor from running at uncontrolled speed.

Proceed as follows:

1. Disable the **ENABLE-A** and **ENABLE-B** signals on terminal **MDI2** to disable the drive and to lock the motor, unless parameter **C181**=1 (the Safety Start function is active): after resetting an alarm or after supplying the drive, this will start only if the **ENABLE-A** and **ENABLE-B** contacts are open and closed.
2. If the motor is idling, wait until it stops.

Check the **FAULT LIST** carefully for any information about the alarm tripped, in order to determine the cause responsible for the alarm and its possible solutions.

Any information stored to the FAULT LIST is also required when contacting Enertronica Santerno's Customer Service.

3. In the following sections, find the relative alarm code and follow the instructions.
4. Solve any external problems that may have been responsible for the protection trip.
5. If the alarm tripped due to the entry of wrong parameter values, set new correct values and save them.
6. Reset the alarm.
7. If the alarm condition persists, please contact Enertronica Santerno Customer Service.

A **RESET** command must be sent to reset the alarms tripped. Do one of the following:

- Enable the **RESET** signal in the hardware terminal board (**MDI3** as factory default);
- Press the **RESET** key on the keypad;
- Enable the **RESET** signal in one of the virtual terminal boards enabled as remote command sources (see the CONTROL METHOD MENU).

To activate the **Autoreset** function, enable parameter **C255** (see the AUTORESET MENU); the drive will automatically try to reset the alarms tripped.

58.3. Alarm List

Table 137: List of the possible alarms

Alarm	Alarm Message	Description
A001 ÷ A032	…	*Control board failure*
A033	TEXAS VER KO	Incompatible Texas Software Version
A039	FLASH KO	Texas Flash not programmed
A040	User Fault	Alarm caused by the user
A041	PWMA Fault	General hardware fault from IGBT
A042	Illegal XMDI in DGI	Illegal configuration of XMDI in the Digital Inputs menu
A043	False Interrupt	*Control board failure*
A044	SW OverCurrent	Software overcurrent
A045	Bypass Circuit Fault	Fault of the precharge By–Pass
A046	Bypass Connector Fault	Precharge By–Pass connector fault
A047	UnderVoltage	Dc bus voltage lower than Vdc_min
A048	OverVoltage	Dc bus voltage exceeding Vdc_max
A049	RAM Fault	*Control board failure*
A050	PWMA0 Fault	Hardware Fault from IGBT converter
A051	PWMA1 Fault	Hardware overcurrent
A052	Illegal XMDI in DGO	Illegal configuration of XMDI in the Digital Outputs menu
A053	PWMA Not ON	Hardware failure, IGBT A power on impossible
A054	Optional Board not in	Failure in detecting preset optional I/O board
A055	PTC Alarm	External PTC tripped
A056	PTC Short Circuit	External PTC in short circuit
A057	Illegal XMDI in MPL	Illegal configuration of XMDI in the Virtual Digital Outputs (MPL) menu
A059	Encoder Fault	Error of motor speed measure
A060	NoCurrent Fault	Current is zero in FOC control
A061	Ser WatchDog	Watchdog tripped in serial link 0 (9-pole D connector)
A062	SR1 WatchDog	Watchdog tripped in serial link 1 (RJ45)
A063	Generic Motorola	*Control board failure*
A064	Mains Loss	No power is supplied from the mains
A065	AutoTune Fault	Autotune failed
A066	REF < 4mA	REF Current input (4÷20mA) lower than 4mA
A067	AIN1 < 4mA	AIN1 Current input (4÷20mA) lower than 4mA
A068	AIN2 < 4mA	AIN2 Current input (4÷20mA) lower than 4mA
A069	XAIN5 < 4mA	XAIN5 Current input (4÷20mA) lower than 4mA
A070	Fbs WatchDog	Fieldbus Watchdog tripped
A071	1ms Interrupt OverTime	*Control board failure*
A072	Parm Lost Chk	Parameter download/upload error
A073	Parm Lost COM1	Parameter download/upload error
A074	Drive OverHeated	Drive thermal protection tripped
A075	Motor OverHeated	Motor thermal protection tripped
A076	Speed Alarm	Motor speed too high
A078	MMI Trouble	*Control board failure*
A079	Encoder not conf.	FOC control but Encoder not properly configured
A080	Tracking Error	Encoder speed tracking error
A081	KeyPad WatchDog	Communication watchdog via keypad
A082	Illegal Encoder Cfg	Functions programmed for MDI6 and MDI7 or encoder B selected and encoder board not detected.
A083	External Alarm 1	External alarm 1
A084	External Alarm 2	External alarm 2
A085	External Alarm 3	External alarm 3
A086	XAIN5 > 20mA	XAIN5 Current input (4÷20mA or 0÷20mA) greater than 20mA
A087	±15V LOSS	± 15V Loss
A088	ADC Not Tuned	*Control board failure*
A089	Parm Lost COM2	Parameter download/upload error
A090	Parm Lost COM3	Parameter download/upload error
A091	Braking Resistor Overload	Overvoltage tripped with braking resistor activated due to continuous operation time exceeding the max. programmed time

Alarm	Alarm Message	Description
A092	SW Version KO	*Control board failure*
A093	Bypass Circuit Open	By-Pass relay open
A094	HeatSink Overheated	IGBT heatsink temperature too high
A095	Illegal Drive Profile Board	Drive Profile board not correctly configured
A096	Fan Fault	Fault of the cooling fans
A097	Motor Not Connected	Motor not connected
A098	Illegal Motor Selected	Illegal motor selected via MDI
A099	2nd Sensor Fault	Fault of fan sensor 2
A100	MDI6 Illegal Configuration	Function programmed for MDI6 along with frequency input A
A101	MDI8 Illegal Configuration	Function programmed for MDI8 along with frequency input B
A102	REF > 20mA	REF Current input (4÷20mA or 0÷20mA) greater than 20mA
A103	AIN1 > 20mA	AIN1 Current input (4÷20mA or 0÷20mA) greater than 20mA
A104	AIN2 > 20mA	AIN2 Current input (4÷20mA or 0÷20mA) greater than 20mA
A105	PT100 Channel 1 Fault	Hardware input out of measure range of the drive
A106	PT100 Channel 2 Fault	Hardware input out of measure range of the drive
A107	PT100 Channel 3 Fault	Hardware input out of measure range of the drive
A108	PT100 Channel 4 Fault	Hardware input out of measure range of the drive
A109	Amb.Overtemp.	Ambient overtemperature
A110	Fieldbus Board Fault	Fault occurring in the Fieldbus board
A111 ÷ A120	…	*Control board failure*
A129	No Output Phase	Output phase loss
A140	Torque Off not Safe	Malfunctioning of ENABLE-A and ENABLE-B inputs for STO function
A141	Illegal Hardware	SW version incompatible with the drive hardware

A001 ÷ A032, A043, A049, A063, A071, A078, A088, A092, A111÷A120 Control Board Failure

A001 ÷ A032 A043 A049 A063 A071 A078 A088 A092 A111 ÷ A120	**Description**	Control board failure
	Event	There may be several causes: the board autodiagnostics file constantly checks its operating conditions.
	Possible cause	• Strong electromagnetic disturbance or radiated interference. • Possible failure of the microcontroller or other circuits on the control board.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A033 Texas Software KO

A033	**Description**	Incompatible Software Texas version
	Event	When switched on, DSP Motorola detected an incompatible version of the software downloaded to Flash Texas (software version incompatible with Motorola).
	Possible cause	The wrong software was downloaded.
	Solution	1. Download the correct DSP Texas software version. 2. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A039 Texas Flash not Programmed

A039	**Description**	Texas Flash not programmed
	Event	When switched on, DSP Motorola detected that Flash Texas is not correctly programmed.
	Possible cause	A prior attempt to download DSP Texas software failed.
	Solution	1. Download the correct DSP Texas software version. 2. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A040 User Alarm

A040	**Description**	Alarm trip caused by the user (as a system testing procedure)
	Event	The user has forced the alarm to trip.
	Possible cause	Value 1 was entered to address MODBUS 1400 via serial link.
	Solution	Reset the alarm: send a **RESET** command.

A041 IGBT Fault Side A

A041	**Description**	General hardware fault from IGBT
	Event	Power converter generated a general alarm.
	Possible cause	• Electromagnetic disturbance or radiated interference. • Overcurrent, IGBT overtemperature, IGBT fault.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A042 Illegal XMDI in DGI

A042	**Description**	Illegal configuration of XMDI in the Digital Inputs menu.
	Event	• The drive checked if at least one XMDI input from ES847 or ES870 I/O optional board is available in the DIGITAL INPUTS MENU; • The drive checked if **R023** (I/O Board setting) is set to 0 in the EXPANSION BOARD CONFIGURATION MENU
	Possible cause	Wrong settings.
	Solution	Check settings and enter correct settings.

A044 SW Overcurrent

A044	**Description**	SW Overcurrent
	Event	Immediate current limit tripped
	Possible cause	• Abrupt variations of the connected load • Output short-circuit or ground short-circuit • Strong electromagnetic disturbance or radiated interference. If alarm **A044** tripped while accelerating: • Too short acceleration ramp; If alarm **A044** tripped while decelerating: • Too short deceleration ramp. • Excessive gain of the current regulator (**P155**) or too short integral time (**P156**) when using the **FOC** control algorithm. • Excessive gain of the speed regulator (**P128**) or too short integral time (**P126**) when using the **VTC** control algorithm.
	Solution	1. Check if the drive and the motor are properly dimensioned with respect to the connected load. 2. Make sure that no output short-circuit is to be found between two phases or between one phase and the grounding (terminals **U, V, W**). (Remove voltage from the motor, set IFD control and operate the drive in no-load conditions.) 3. Check if the command signals are sent to the drive using screened cables where required (see Sinus Penta's Installation Guide). Detect external sources for electromagnetic disturbance, check wiring and make sure that antidisturbance filters are installed on the coils of contactors and electrovalves (if fitted inside the cabinet). 4 If necessary, set longer acceleration times (see the RAMPS MENU). 5 If necessary, set longer deceleration times (see the RAMPS MENU). 6. If necessary, decrease the values set in the LIMITS MENU.

A045 Bypass Circuit Fault

A045	**Description**	Bypass precharge Fault
	Event	The drive forced to close its relay or contactor for the short-circuit of the precharge resistors in DC-link capacitors (DC bus), but it <u>did not detect the relevant closing signal</u> while precharging. See also **A046**.
	Possible cause	• Disconnection of auxiliary signal. • Precharge relay/contactor failure.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A046 Bypass Connector Fault

A046	**Description**	Precharge bypass connector fault.
	Event	Auxiliary signal for the closing of the bypass connector of the short-circuit precharge resistor is considered as closed before the relevant closing command is sent. See also **A045**.
	Possible cause	• Precharge bypass connector reversed. • Precharge relay/contactor failure.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A047 Undervoltage

A047	**Description**	DC bus Voltage lower than minimum voltage.
	Event	Voltage measured in DC bus capacitors has dropped below the min. value allowed for a proper operation of the drive class being used.
	Possible cause	• Supply voltage has dropped below 200 V–15% (2T Class), 380 V–15% (4T Class), 500 V –15% (5T Class), 600 V –15% (6T Class). • Alarm **A047** can trip even when voltage temporarily drops below the allowable min. value (which is caused for example by the direct starting of the connected load). • If the drive is powered directly by the bus bar, the bus feeder is responsible for the alarm. • Failure in DC bus voltage measure circuit.
	Solution	1. Check voltage in terminals **R**, **S**, **T**. Check mains voltage value **M030** and DC bus voltage value **M029**. Also check the values of **M030** and **M029** sampled in the **FAULT LIST** when the alarm tripped. 2. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A048 Overvoltage

A048	**Description**	Overvoltage in DC bus (voltage in DC-link).
	Event	Voltage measured in DC bus (DC-link) capacitors has exceeded the max. value allowed for a proper operation of the drive class being used.
	Possible cause	• Check that voltage does not exceed 240 V +10% (2T Class), 500 V +10% (4T Class), 600 V +10% (5T Class), 690 V +10% (6T Class). • Very inertial loads and a too short deceleration ramp (see the RAMPS MENU). • Alarm **A048** can trip even when the motor is pulled by the load (eccentric load). • If the drive is powered directly by the bus bar, the bus feeder is responsible for the alarm trip. • Failure in DC bus voltage measure circuit.
	Solution	1. Check voltage in terminals **R**, **S**, **T**. Check mains voltage value **M030** and DC bus voltage value **M029**. Also check the values of **M030** and **M029** sampled in the **FAULT LIST** when the alarm tripped. 2. In case of very inertial loads and if the alarm tripped when decelerating, try to set a longer deceleration ramp. If short stop times are needed or if the motor is pulled by the load, activate the resistive braking unit. 3. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A050 IGBT Fault A

A050	**Description**	Hardware fault from IGBT converter or brake overcurrent
	Event	The IGBT drivers of power converter have detected IGBT failure or overcurrent conditions in the brake circuit (models S14, S22, S32 5T/6T only)
	Possible cause	• Strong electromagnetic disturbance or radiated interference. • Overcurrent, IGBT overtemperature, IGBT fault. • Unsuitable braking resistor (models S14, S22, S32 5T/6T only).
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A051 Overcurrent HW A

A051	**Description**	Hardware overcurrent
	Event	Hardware overcurrent detected by the drive output current circuit.
	Possible cause	See **A044 SW Overcurrent**.
	Solution	See **A044 SW Overcurrent**.

A052 Illegal XMDI in DGO

A052	**Description**	Illegal configuration of XMDI in the Digital Outputs menu.
	Event	• The drive checked if at least one XMDI input from ES847 or ES870 I/O optional board is available in the DIGITAL INPUTS MENU; • The drive checked if **R023** (I/O Board setting) is set to 0 in the EXPANSION BOARD CONFIGURATION MENU
	Possible cause	Wrong settings.
	Solution	Check settings and enter correct settings.

A053 Not PWONA

A053	**Description**	Hardware failure; IGBT A power on failure.
	Event	The control board requested IGBT A power on, but this has failed.
	Possible cause	Control board failure.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A054 Optional Board not in

A054	**Description**	ES847 or ES870 not in.
	Event	The control board detects no ES847 or ES870 I/O expansion boards after parameter **R023** (I/O Board Setting) is set as ≠ 0.
	Possible cause	Optional board not in or faulty.
	Solution	1. Check consistency of parameter **R023** (see the EXPANSION BOARD CONFIGURATION MENU). 2. Reset the alarm: send a **RESET** command. 3. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A055 PTC Alarm

A055	**Description**	External PTC resistor tripped.
	Event	The drive detected the opening of the PTC connected to **AIN2** input (R > 3600 ohm)
	Possible cause	• Opening of the PTC due to motor overheating. • Incorrect wiring of PTC. • Incorrect setting of **SW1** hardware switch on the control board (see Installation Guide).
	Solution	1. Allow the motor to cool, then reset the alarm. 2. Make sure that the PTC is correctly connected to **AIN2** analog input (see Installation Guide). 3. Make sure that **SW1** hardware switch is correctly set.

A056 PTC Short Circuit

A056	**Description**	External PTC resistor short circuit.
	Event	Detected the short circuit of the PTC connected to **AIN2** input (R < 10 ohm).
	Possible cause	• Short circuit in the PTC. • Incorrect wiring of PTC. • Incorrect setting of **SW1** hardware switch on the control board (see Installation Guide).
	Solution	1. Make sure that the PTC is correctly connected to **AIN2** analog input (see Installation Guide). 2. Make sure that **SW1** hardware switch is correctly set.

A057 Illegal XMDI in MPL

A057	**Description**	Illegal configuration of XMDI in the Virtual Digital Outputs (MPL) Menu.
	Event	• The drive checked if at least one XMDI input from ES847 or ES870 I/O optional board is available in the VIRTUAL DIGITAL OUTPUTS (MPL) MENU; • The drive checked if **R023** (I/O Board setting) is set to 0 in the EXPANSION BOARD CONFIGURATION MENU
	Possible cause	Wrong settings.
	Solution	Check settings and enter correct settings.

A059 Encoder Fault

A059	**Description**	Motor speed measure error.
	Event	During the encoder tune, a speed error measure occurred with respect to the estimated speed, although the sign of the measured speed is consistent with the estimated speed.
	Possible cause	• Incorrect parameterization of the encoder concerning the type and number of pulses/rev. • Voltage removed from one of the two encoders. • Incorrect mounting of the encoders. • Encoder failure.
	Solution	1. Check that the encoder parameters are correct (see the ENCODER/FREQUENCY INPUTS MENU). 2. Check that both encoders are properly connected. 3. Check mounting of the encoders. 4. Using an oscilloscope, check that the encoder signals are correct.

A060 No Current Fault (FOC)

A060	**Description**	The error detected in FOC control by the current loop exceeds the max. allowable value.
	Event	The FOC control detected a current regulation error.
	Possible cause	• One motor cable is disconnected. • Failure in the current measure circuit. • Wrong setting of current regulator parameters for FOC control.
	Solution	1. Check motor connections (terminals **U, V, W**). 2. Check parameterization of current regulators for FOC control (see the FOC REGULATORS MENU). Perform a new current regulator autotune (see AUTOTUNE MENU). 3. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A061, A062 Serial Link Watchdog

A061 (Serial Link 0) A062 (Serial Link 1)	**Description**	**A061**: Serial Link Watchdog 0 tripped **A062**: Serial Link Watchdog 1 tripped
	Event	The serial link watchdog has tripped. Communication failure: no read/write query sent to serial link for a time longer than the time set in the parameters relating to serial link watchdog (see the SERIAL LINKS MENU). This alarm does not trip if, due to parameters in the CONTROL METHOD MENU or due to the status of the source selection or LOC/REM inputs (DIGITAL INPUTS MENU), the information sent from serial link is not currently used for the commands or the references.
	Possible cause	• Serial link is disconnected. • Communication failure on remote master side. • Watchdog operating times too short.
	Solution	1. Check serial link. 2. Make sure that the remote master constantly sends read/write queries with max. intervals between two queries lower than the preset watchdog operating time. 3. Set longer watchdog operating times (see **R005** for serial link 0 and **R012** for serial link 1).

A064 Mains Loss

A064	**Description**	Mains loss
	Event	Mains loss.
	Possible cause	• One supply cable is disconnected. • Mains supply too weak. • Mains gap.
	Solution	1. Check voltage in terminals **R**, **S**, **T**. Check mains voltage value **M030**. Also check the value of **M030** sampled in the **FAULT LIST** when the alarm tripped. 2. This protection may be disabled or delayed (see the POWER DOWN MENU).

A065 Autotune KO

A065	**Description**	Autotune failed.
	Event	Autotune aborted or failed.
	Possible cause	• The **ENABLE** contact was disabled before autotune was over. • Autotune aborted, maybe because the parameter values were inconsistent with the motor ratings.
	Solution	1. Reset the alarm: send a **RESET** command. 2. Check the motor parameters and make sure that they are consistent with the motor ratings (see the MOTOR CONFIGURATION MENU) and perform a new autotune procedure. 3. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A066, A067, A068, A069 Current input < 4mA

A066 (REF) **A067 (AIN1)** **A068 (AIN2)** **A069 (XAIN5)**	**Description**	**A066**: REF Current input (4÷20mA) lower than 4mA **A067**: AIN1 Current input (4÷20mA) lower than 4mA **A068**: AIN2 Current input (4÷20mA) lower than 4mA **A069:** XAIN5 current input (4÷20mA) lower than 4mA
	Event	A current value lower than 4 mA has been detected over one input (REF, AIN1, AIN2, XAIN5) set with the following range: 4÷20mA.
	Possible cause	• Wrong setting of **SW1** on the control board (except for **A069**). • Signal cable disconnected. • Failure in the current signal source.
	Solution	1. Check setting of **SW1** (except for **A069**). 2. Check that the signal cable is properly connected to its terminal. 3. Check the current signal source.

NOTE The alarms above trip only if the relevant inputs have been selected (see CONTROL METHOD MENU and PID CONFIGURATION MENU).

A070 Fieldbus WatchDog

A070	**Description**	Watchdog Fieldbus tripped.
	Event	The watchdog fieldbus tripped and communication is suspended. Communication is interrupted: the Master did not send any valid message for a time longer than the time set in the parameter relating to the value set with parameter **R016** of the fieldbus watchdog time (see the FIELDBUS CONFIGURATION MENU). This alarm does not trip if, due to parameters in the CONTROL METHOD MENU or due to the status of the source selection or LOC/REM inputs (DIGITAL INPUTS MENU), the information sent from fieldbus is not currently used for the commands or the references.
	Possible cause	• Voltage removed from Fieldbus. • No communication from Master. • Watchdog times too short.
	Solution	1. Check fieldbus connections. 2. Check that the master ensures a constant sequence of legal messages (FIELDBUS CONFIGURATION MENU) with max. time intervals lower than the preset watchdog time. 3. Set longer watchdog times (see **R016**). 4. To reset alarm **A070**, force communication between the Master and the Penta drive with bit 15 of the digital input word (bit 11 of the Control Word when using the PROFIdrive) as required by parameter **R018b** and reset the drive control board. If communication between the Master and the Slave (Penta) cannot be restored, alarm **A070** is restored after setting parameter R016 to zero and after resetting the Penta drive. When the drive is next powered on, the alarm reset will affect the drive control board.

A072-3, A089-90 Parameter Upload/Download Error from Keypad to Drive

A072 A073 A089 A090	**Description**	Upload/download failed, one of the controls of the parameter consistency detected a fault.
	Event	A communication error occurred while uploading/downloading the programming parameters from the keypad to the drive.
	Possible cause	Temporary interruption to the serial link between keypad and control board.
	Solution	Check the connection between the keypad and the control board, reset the alarm and perform a new upload/download procedure.

A074 Overload

A074	**Description**	Drive thermal protection tripped.
	Event	The output current has been exceeding the drive rated current for long periods.
	Possible cause	• Current equal to **Ipeak** + 20% for **3 seconds**, or • Current equal to **Imax** for **120 seconds** (S05÷S30 2T/4T), • Current equal to **Imax** for **60 seconds** (S41÷S90 2T/4T and all the 5T/6T models)
	Solution	Check the drive current output during ordinary operation (**M026** in the **Measure Menu**); check the mechanical conditions of the connected load (load locked / overload).

A075 Motor Overheated

A075	**Description**	Motor thermal protection tripped.
	Event	The software motor thermal protection tripped. Output current has been exceeding the motor rated current for long periods.
	Possible cause	• Poor mechanical conditions of the connected load. • Wrong setting of parameters in the Thermal Protection Menu.
	Solution	1. Check mechanical conditions of the connected load. 2. Check parameters **C265**, **C266**, **C267** (and equivalent parameters for motors 2 and 3) in the MOTOR THERMAL PROTECTION MENU**.**

A076 Limit Speed

A076	**Description**	The motor speed is too high.
	Event	The motor speed is higher than the current value set in parameter **C031** (for motor 1, or equivalent parameters for motors 2 and 3). If **C031** = 0, the limit speed protection is disabled. If the encoder is disabled, the variable used for this software protection is: • The current speed setpoint for IFD. • The estimated motor speed for VTC control.
	Possible cause	• Value of parameter **C031** too low. • Torque reference too high for **SLAVE** mode.
	Solution	1. Check the compatibility of the parameter with respect to the maximum speed parameter. 2. In **SLAVE** mode, check the torque reference value.

A079 Encoder Not Configured

A079	**Description**	FOC control, but encoder not correctly configured.
	Event	The FOC control is active, but no encoder has been enabled with parameter **C012** (for motor 1, or equivalent parameters for motors 2 and 3). Otherwise, no incremental encoder enabled for speed measure with parameter **C189** (see the ENCODER/FREQUENCY INPUTS MENU). Otherwise, no position sensor on the expansion board has been configured via parameters **R023a, R023b, R092** to **R097** (see EXPANSION BOARD CONFIGURATION MENU).
	Possible cause	• **C012** = 0 (for motor 1, or equivalent parameters for motors 2 and 3). See the MOTOR CONFIGURATION MENU. • The value set in **C189** does not enable any encoder for speed measure. • The **FOC** control has been improperly enabled. • Parameters **R023a, R023b, R092** to **R097** are not correctly set.
	Solution	Set parameters correctly.

A080 Speed Tracking

A080	**Description**	Speed measurement error.
	Event	The system detected an error between the measured speed and the speed setpoint. Speed has been exceeding the value set in parameter **C193** for a time longer than the value set in parameter **C192**. In case of speed feedback from encoder (encoder properly configured, FOC active and **C012**, **C055**, **C098** = Yes), speed is measured from the encoder. In case of VTC control, speed is estimated based on a model of the asynchronous motor. This protection is enabled only if parameter **C194** is not set at zero.
	Possible cause	• Wrong setting in parameters **C192, C193, C194** (see the ENCODER/FREQUENCY INPUTS MENU). • Torque limit too low. • Connected load too heavy. • Encoder failure, encoder mechanical joint broken down, disconnection of one of the signal cables of the encoder.
	Solution	1. Set parameters **C192, C193** correctly. 2. Check torque limit value (see the INPUTS FOR REFERENCES MENU and the CONTROL METHOD MENU). 3. Check the mechanical load. 4. Make sure that the encoder works properly, check its mechanical connection to the motor and check that the encoder signal cables are properly connected to the terminals.

A081 Keypad Watchdog

A081	**Description**	Watchdog for the communication to the keypad.
	Event	Communication failed when the keypad was enabled as a reference source or a command source or when it was in Local mode (Watchdog time is equal to approx. 1.6 seconds)
	Possible cause	• Keypad cable disconnected. • Failure of one of the two connectors of the keypad. • Strong electromagnetic disturbance or radiated interference. • Keypad failure. • Incorrect setting in parameters relating to serial link 1 (see the SERIAL LINKS MENU).
	Solution	1. Check the connection of the keypad cable. 2. Make sure that the keypad cable connectors are intact (on both drive side and keypad side). 3. Check communication parameters of serial link 1.

A082 Encoder Configuration

A082	**Description**	Functions programmed for **MDI6** and **MDI7**, or **Encoder B** selected and encoder board not detected.
	Event	• **Encoder A** has been selected for speed measure or as a reference source, but different digital command functions are programmed for terminals **MDI6** and **MDI7**. • **Encoder B** has been selected for the speed measure or as a reference source, but the control board did not detect any optional encoder board.
	Possible cause	• Incorrect setting of the use of the encoders in parameter **C189**. • Incorrect programming of digital input functions. • Optional board for Encoder B is not fitted, has been improperly mounted or is faulty. Possible connector failure.
	Solution	1. Check and adjust the value set in **C189** (see the ENCODER/FREQUENCY INPUTS MENU). 2. Check and adjust the control function programming for digital inputs **MDI6** and **MDI7** (see the DIGITAL INPUTS MENU). 3. Check if optional encoder board is fitted and properly mounted.

A083, A084, A085 External Alarm

A083 (EXT1) **A084 (EXT2)** **A085 (EXT3)**	**Description**	**A083**: External alarm 1 **A084**: External alarm 2 **A085**: External alarm 3
	Event	The External Alarm (1, 2, 3) function has been programmed, but the relevant digital input is disabled (see the DIGITAL INPUTS MENU). If multiple digital command sources are programmed, alarms **A083**-**A085** trip if one of the terminals in the active sources is disabled (see the CONTROL METHOD MENU).
	Possible cause	The cause for the alarm trip does not depend on the drive; check for the reason why the contact connected to terminal **MDI*x*** where the External Alarm function is programmed opens.
	Solution	Check external signal.

A087 ±15V Loss

A087	**Description**	Loss of ±15V.
	Event	• The voltage level of ±15V is inadequate.
	Possible cause	• Possible failure of the control board or other circuits in the Penta Drive.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A091 Braking Resistor Overload

A091	**Description**	Overvoltage due to the overload of the braking resistor that has been operating for a time equal to the maximum time due to settings in **C211** and **C212.**
	Event	The braking resistance command was inhibited because the maximum ON time was expired and the energy caused by regeneration (that can no longer be dissipated) has led to overvoltage.
	Possible cause	This application requires an intense use of the Braking Resistor, for example in hoisting applications, where a long downstroke is required when the load is connected to the motor.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the power dissipated by the braking resistance allows for a heavier use, set **C211** with a greater ON time.

A093 Precharge: Bypass open

A093	**Description**	Bypass relay open.
	Event	The control board requested the closure of the bypass relay (or contactor) for the short-circuit of the DC-link capacitor precharge resistors, **but no closing signal is sent** (auxiliary of the relay) during functioning (precharge already closed).
	Possible cause	Failure in the relay control circuit or in the auxiliary signal circuit detecting relay closing.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A094 Heatsink Overheated

A094	**Description**	IGBT heatsink temperature too high.
	Event	IGBT power heatsink overheated even if the cooling fan is on (see also **A096** and **A099**).
	Possible cause	• Ambient temperature exceeding 40 °C. • Too high motor current. • Excessive carrier frequency for the application required.
	Solution	1. Check ambient temperature. 2. Check motor current. 3. Decrease IGBT carrier frequency (see the CARRIER FREQUENCY MENU).

A095 Illegal Drive Profile Board

A095	**Description**	An illegal Drive Profile board is implemented.
	Event	Incorrect configuration of the optional Drive Profile board.
	Possible cause	• The Drive Profile board is configured for a different drive. • The Drive Profile board is not configured. • Faulty Drive Profile board.
	Solution	1. Make sure that the Drive Profile board is correctly configured for the Sinus Penta drive. 2. Replace the Drive Profile board.

A096 Fan Fault

A096	**Description**	Fan alarm.
	Event	Power heatsink overheated with fan locked or disconnected or faulty (see also **A094** and **A099**).
	Possible cause	Fan locked or disconnected or faulty.
	Solution	Replace fan.

A097 Motor Cables KO

A097	**Description**	Motor not connected.
	Event	This protection trips during autotune or DC Brake if the motor is not connected to the drive or if its current value is not compatible with the drive model.
	Possible cause	• One cable of the motor is disconnected. • The motor size is too small if compared to the drive size.
	Solution	1. Check that motor cables are properly connected to terminals **U**, **V**, **W**. 2. Check the motor parameters; perform autotune procedure again (VTC and FOC controls).

A098 Illegal Motor

A098	**Description**	A disabled motor has been selected.
	Event	• Motor 2 is enabled, but only one motor can be enabled: **C009**=1 (see the MOTOR CONFIGURATION MENU). • Motor 3 is enabled, but only 1 or 2 motors can be enabled: **C009**=1 or 2 (see the MOTOR CONFIGURATION MENU).
	Possible cause	• Incorrect setting in parameter **C009**. • Incorrect setting of the digital input parameters enabling the selection functions for motor 2 (**C173**) and/or motor 3 (**C174**).
	Solution	1. Check and enter the correct value for **C009**. 2. Check and enter the correct value for **C173**, **C174**. 3. Check the status of the digital commands for terminals **C173** and **C174**. If remote command sources are selected, check the status of the commands that have been sent.

A099 Sensor 2 Fault

A099	**Description**	Sensor 2 fault.
	Event	Power heatsink overheated with cooling fan off (see also **A094** and **A096**).
	Possible cause	Failure in temperature control device and/or cooling system.
	Solution	Please contact ENERTRONICA SANTERNO's Customer Service.

A100 MDI6 Illegal Configuration

A100	**Description**	Function programmed to **MDI6** and **frequency input A** as well.
	Event	**MDI6** terminal is programmed with a digital function command and as frequency input **A**.
	Possible cause	Incorrect programming of a command function for **MDI6,** because frequency input A is already set in parameter **C189** (FinA) (see the DIGITAL INPUTS MENU and the ENCODER/FREQUENCY INPUTS MENU).
	Solution	Check and adjust programming of the digital input functions and of parameter **C189**.

A101 MDI8 Illegal Configuration

A101	**Description**	Function programmed to **MDI8** and **frequency input B** as well.
	Event	**MDI8** terminal is programmed with a digital function command and as frequency input **B**.
	Poss ible cause	Incorrect programming of a command function for **MDI8,** because frequency input B is already set in parameter **C189** (FinB) (see the DIGITAL INPUTS MENU and the ENCODER/FREQUENCY INPUTS MENU).
	Solution	Check and adjust programming of the digital input functions and of parameter **C189**.

A102, A103, A104, A086 Current input > 20 mA

A102 (REF) **A103 (AIN1)** **A104 (AIN2)** **A086 (XAIN5)**	**Description**	**A102:** REF Current input (4÷20mA or 0÷20mA) greater than 20mA **A103:** AIN1 Current input (4÷20mA or 0÷20mA) greater than 20mA **A104:** AIN2 Current input (4÷20mA or 0÷20mA) greater than 20mA **A086:** XAIN5 Current input (4÷20mA or 0÷20mA) greater than 20mA
	Event	A current value greater than 20mA has been detected over one input (REF, AIN1, AIN2, XAIN5) set with the following ranges: 4÷20mA or 0÷20mA.
	Possible cause	• Wrong setting of **SW1** on the control board (except for **A086**). • Failure in the current signal source.
	Solution	1. Check setting of SW1(except for **A086**). 2. Check the current signal source.

A105, A106, A107, A108 PT100 Channel 1,2,3,4 Fault

A105 (Channel 1) **A106 (Channel 2)** **A107 (Channel 3)** **A108 (Channel 4)**	**Description**	**A105**: PT100 Channel 1 fault **A106**: PT100 Channel 2 fault **A107**: PT100 Channel 3 fault **A108**: PT100 Channel 4 fault
	Event	Hardware input out of the measure range of the drive.
	Possible cause	• Wrong setting of SW1 or SW2 on optional control board ES847 • Failure in the current signal source.
	Solution	1. Check setting of SW1 and SW2. 2. Check the current signal source.

A109 Ambient Overtemperature

A109	**Description**	The ambient temperature is too high.
	Event	The control board has detected a too high ambient temperature.
	Possible cause	Inverter or cabinet overheated; failure of control board NTC.
	Solution	1. Open the cabinet and check its conditions. Also check measure **M062**. 2. Reset the alarm: send a **RESET** command. 3. If the alarm persists, please contact ENERTRONICA SANTERNO’s Customer Service.

A110 Fieldbus Board Fault

A110	**Description**	Fault occurring in the fieldbus
	Event	The fieldbus board has detected a severe network failure.
	Possible cause	Wrong configuration of the fieldbus network and/or Fieldbus Master.
	Solution	1. Reset the Penta drive 2. Establish a connection to the fieldbus, making sure that the Fieldbus Master configuration is correct 3. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A129 No Output Phase

A129	**Description**	Output phase loss
	Event	The output current from one of phases U, V, W is close to zero, while the other phases are properly operating. Output phase loss is detected only if: • it is enabled with **C236**; • IFD control is selected (**C010**=0); • output frequency exceeds 1 Hz; • parameter **C225** is set greater than 0.
	Possible cause	One or more motor connections (phases U, V, W) are disconnected.
	Solution	1. Check continuity between the drive and the motor. 2. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A140 Torque Off not Safe

A140	**Description**	Malfunctioning of **ENABLE-A** and **ENABLE-B** inputs for the STO function
	Event	The redundant circuitry for the drive enable (simultaneous activation of the **ENABLE-A** and **ENABLE-B** inputs) is no longer active, so opening those inputs does not guarantee that the STO function is properly implemented. For more details, please consult the Safe Torque Off Function - Application Manual.
	Possible cause	Fault in the circuitry dedicated to the Safe Torque Off function.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ENERTRONICA SANTERNO's Customer Service.

A141 Illegal Hardware

A141	**Description**	Penta Drive hardware incompatible with Penta SW
	Event	The Penta SW downloaded to the control board is incompatible with the Penta drive hardware.
	Possible cause	Illegal software downloaded.
	Solution	Download the correct release of the PD software. Please contact ENERTRONICA SANTERNO's Customer Service.

58.4. Warnings

Warning messages are displayed on the display/keypad.
They are flashing messages that appear in line 1 or 2 of the first three lines of the display.

NOTE Warnings are neither protections nor alarms and are not stored to the fault list.

NOTE Once a Warning appears, if any key on the display/keypad is pressed, the flashing message disappears for 60 s to allow reading of the line below.

Some warnings simply state what's happening or suggest what to do when using the keypad.
However, most of the warning messages are **Coded warnings**: they are displayed with letter **"W" followed by two digits** stating which warning is active at that moment. Example:

W	3	2		O	P	E	N		E	N	A	B	L	E

Warning messages are detailed in the following section.

58.5. Warning List

Table 138: Warning list

Warning	Alarm Message	Description
W03	SEARCHING…	The user interface is searching the data of the next page to display.
W04	DATA READ KO	Software warnings concerning data reading.
W06	HOME SAVED	The page displayed has been saved as the home page displayed at power on.
W07	DOWNLOADING	The keypad is **writing** to the drive the WORK zone parameters saved on its own flash memory.
W08	UPLOADING	The keypad is **reading** from the drive the WORK zone parameters that will be saved on its own flash memory.
W09	DOWNLOAD OK	Parameters were successfully downloaded (**written**) from the keypad to the drive.
W11	UPLOAD OK	Parameters were successfully uploaded (**read**) from the drive to the keypad.
W12	UPLOAD KO	The keypad interrupted parameter upload to the drive. Parameter **reading** has failed.
W13	NO DOWNLOAD	A Download procedure was queried, but no parameter is saved to the flash memory.
W16	PLEASE WAIT…	Wait until the system completes the operation required.
W17	SAVE IMPOSSIBLE	Parameter save is not allowed.
W18	PARAMETERS LOST	The keypad interrupted parameter download to the drive. Parameter **writing** has failed. As a result, not all parameters have been updated (parameter inconsistency).
W19	NO PARAMETERS LOAD	UPLOAD impossible.
W20	NOT NOW	The required function is not available at the moment.
W21	CONTROL ON	The required function is inhibited because the drive is running: **ENABLE-A** and **ENABLE-B** are active.
W23	DOWNLOAD VER. KO	Download failed because parameters saved to keypad memory relate to a SW version or product ID incompatible with the drive SW version or product ID.
W24	VERIFY DATA	Download preliminary operation underway, the system is checking the integrity and compatibility of the parameters saved in the keypad memory.
W28	OPEN START	Open and close the **START** signal to start the drive.
W31	ENCODER OK	Encoder tuning procedure finished: the encoder is correctly connected.
W32	OPEN ENABLE	Open and close the **ENABLE-A** and **ENABLE-B** signals to enable the drive.
W33	WRITE IMPOSSIBLE	Writing procedure impossible.
W34	ILLEGAL DATA	Illegal value entered, operation failed.
W35	NO WRITE CONTROL	Writing procedure impossible because Control is active and the drive is running.
W36	ILLEGAL ADDRESS	Illegal address entered, operation failed.
W37	ENABLE LOCKED	The drive is disabled and does not acknowledge the **ENABLE-A** and **ENABLE-B** commands because it is writing a **Cxxx** parameter. **CAUTION**: **The drive will start up as soon as writing is over!!!**
W38	LOCKED	Editing mode cannot be accessed because parameter modification is disabled: **P000** is different from **P002**.
W39	KEYPAD DISABLED	Editing mode cannot be accessed because the keypad is disabled.
W40	FAN FAULT	Fan locked or disconnected or faulty.
W41	SW VERSION KO	Download impossible because of different SW Versions.
W42	IDP KO	Download impossible because of different IDPs (Identification Products).
W43	PIN KO	Download impossible because of different PINs (Part Identification Numbers).
W44	CURRENT CLASS KO	Download impossible because of different current classes.
W45	VOLTAGE CLASS KO	Download impossible because of different voltage classes.
W46	DOWNLOAD KO	Download impossible (generic cause).
W48	OT Time over	The preset threshold for the drive Operation Time has been exceeded.
W49	ST Time over	The preset threshold for the drive Supply Time has been exceeded.
W50	NTC Fault	NTC sensor for heatsink temperature disconnected or faulty.

58.6. State List

Table 139: State list

Number	State	Description
0	ALARM!!!	Alarm tripped
1	STARTING UP	The drive is starting up
2	MAINS LOSS	Mains loss
3	TUNING	The drive is tuning
4	SPEED SEARCHING	Searching for motor speed
5	DCB at START	DC Braking at start
6	DCB at STOP	DC Braking at stop
7	DCB HOLD	DC current for Hold function
8	MANUAL DCB	Manual DC Braking
9	LIMIT WHILE ACCEL.	Current/torque limit while accelerating
10	LIMIT WHILE DECEL.	Current/torque limit while decelerating
11	LIMIT AT ST. SPD	Current/torque limit at constant rpm
12	BRAKING	Braking module startup or deceleration ramp extension
13	RUN AT ST. SPEED	Drive running at speed set point
14	ACCELERATING	Drive running with motor in acceleration stage
15	DECELERATING	Drive running with motor in deceleration stage
16	INVERTER OK	Drive on Stand-by with no alarms tripped
17	FLUXING	Motor fluxing stage
18	FLUXED MOTOR	Motor fluxed
19	FIRE MODE RUN	Constant rpm in Fire Mode
20	FIRE MODE ACC.	Acceleration in Fire Mode
21	FIRE MODE DEC.	Deceleration in Fire Mode
22	INVERTER OK*	Drive on Stand-by with no alarms tripped; void warranty due to alarm trip in Fire Mode
25	SPARE	Board in Spare mode
27	WAIT NO ENABLE	Waiting for opening **ENABLE-A** and **ENABLE-B** commands
28	WAIT NO START	Waiting for opening **START** command
29	PIDOUT min DISAB	Drive disabled due to PID output < Min.
30	REF min DISABLED	Drive disabled due to REF < Min.
31	IFD WAIT REF.	Drive enabled with IFD control waiting for reference in order to start
32	IFD WAIT START	Drive enabled with IFD control waiting for START in order to start
33	DISABLE NO START	When fluxing, the RUN command was not given within the max. time set in **C183**. The drive is kept disabled until the RUN command is given.

59. CUSTOM PARAMETERS

In the table below, you can write down settings that are different from the default values.

PAR.-Meaning	Default values	Modified values	PAR.-Meaning	Default Values	Modified values
P00x Access Level					
P001-AcsLev	0: Basic		**P003**-ModCmode	1:[StandBy+Fluxing]	
Product					
P263-Lang	1: ENGLISH				
P26x Display					
P264-ModNav	0: Menu		**P264a**-ModNavMenu	1: Yes	
P264b-ModMenu	0: Standard		**P265**-FirstPage	3: [Start Up]	
P266-kpd_type	1: Active Ref.				
P267-umis1_PID	0: Disable		**P267a**- Custom PID unit of measures	[%]	
P267b-umis1_PID2	0: Disable		**P267c**- Custom PID2 unit of measures	[%]	
P268-Measure n.1 Status Page	M004		**P268y**-Scaling Measure n.1 Status Page	100.00%	
P268a-Measure n.2 Status Page	M000		**P268z**-Scaling Measure n.2 Status Page	100.00%	
P268b-Measure n.1 Keypad Page	M006		**P268c**-Measure n.2 Keypad Page	M026	
P268d-Measure n.3 Keypad Page	M004		**P268e**-Measure n.4 Keypad Page	M000	
P268s-umisSpeed	rpm		**P268t**-kmisSpeed	100.00%	
P268u-umisTorque	Nm		**P268v**-kmisTorque	100.00%	
P269-DisabLOC/REM	0: No		**P269**-DisabFWD/REV	0: No	
P269b-EscKeyFunc	0: No				
P00x-P03x Ramps					
P009-Tup1	[*]		**P010**-Tdn1	[*]	
P012-Tup2	[*]		**P013**-Tdn2	[*]	
P014-Un.Meas1-2	[*]		**P015**-Tup3	[*]	
P016-Tdn3	[*]		**P018**-Tup4	[*]	
P019-Tdn4	[*]		**P020**-Un.Meas3-4	[*]	
P021a-Rnd.Sel1	1: On		**P021b**-Rnd.Sel2	1: On	
P021c-Rnd.Sel3	1: On		**P021d**-Rnd.Sel4	1: On	
P022-RndStartAcc	[*]		**P023**-RndStopAcc.	[*]	
P024-RndStartDec	[*]		**P025**-RndStopDec	[*]	
P026-T Tup	5.00 s		**P027**-T Tdn	5.00 s	
P028-T Un.Mea	1: 0.1 s		**P029**-J Tup	1 s	
P030-J Tdn	1 s		**P031**-SpdAccReset	1: Yes	
P032-TupFireM	[*]		**P033**-TdnFireM	[*]	
P034-Anti-sway_Enable	0: Off		**P035**-Friction_Coeff	0.100	
P036-Rope_Length	0.000 m				
P05x-P07x Reference					
P050-REF	3: 0-10V		**P051**-REFMIN	0.0 V	
P051a-REFMIN_%	100%		**P052**-REFMAX	10.0 V	
P052a-REFMAX_%	100%		**P053**-REFOFFS	0.000 V	
P054-TauFilt REF	5 ms		**P055**-AIN1	2: 4-20mA	
P056-AIN1MIN	4.0 mA		**P056a**-AIN1MIN_%	100%	
P057-AIN1MAX	20.0 mA		**P057a**-AIN1MAX_%	100%	
P058-AIN1OFFS	0.000 mA		**P059**-TauFilt AIN1	5 ms	
P060-AIN2	2: 4-20mA		**P061**-AIN2MIN	4.0 mA	
P061a-AIN2MIN_%	100%		**P062**-AIN2MAX	20.0 mA	
P062a-AIN2MAX_%	100%		**P063**-AIN2OFFS	0.000 mA	
P064-TauFilt AIN2	5 ms		**P065**-SpdDisab	0 rpm	
P066-SpdDisabTime	0 s		**P067**-U/D Ramp	Square	
P068-U/D Mem	1: Yes		**P068a**-U/D1-StopRes	0: No	
P068b-U/D2-StopRes	0: No		**P068c**-U/D1SwSRes	0: No	
P068d-U/D2SwSRes	0: No		**P069**-U/D Range	1: Unipolar	
P070-Jog Ref	0 %		**P071**-PulseMin	10000 Hz	
P071a-PulseMin_%	100%		**P072**-PulseMax	100000 Hz	
P072a-PulseMax_%	100%		**P073**-EncMin	0 rpm	
P073a-EncMin_%	100%		**P074**-EncMax	1500 rpm	
P074a-EncMax_%	100%				

PAR.-Meaning	Default values	Modified values	PAR.-Meaning	Default values	Modified values
P08x-P10x Multispeeds					
P080-Mspd.use	0:Preset Speed		**P081**-Spd1	0.00 rpm	
P083-Spd2	0.00 rpm		**P085**-Spd3	0.00 rpm	
P087-Spd4	0.00 rpm		**P088**-Spd5	0.00 rpm	
P089-Spd6	0.00 rpm		**P090**-Spd7	0.00 rpm	
P091-Spd8	0.00 rpm		**P092**-Spd9	0.00 rpm	
P093-Spd10	0.00 rpm		**P094**-Spd11	0.00 rpm	
P095-Spd12	0.00 rpm		**P096**-Spd13	0.00 rpm	
P097-Spd14	0.00 rpm		**P098**-Spd15	0.00 rpm	
P099-FireM_Spd	750.00 rpm		**P100**-Un.Meas	0: 0.01 rpm	
P101-P103 PID Multitorque					
P101-Trq1	0.0 %		**P102**-Trq2	0.0 %	
P103-Trq3	0.0 %				
P08x-P09x PID Multireference					
P080a-Mref.use PID	0:Preset Ref		**P081a**-Ref 1 PID	0.00	
P082a-Ref 2 PID	0.00		**P083a**-Ref 3 PID	0.00	
P084a-Ref 4 PID	0.00		**P085a**-Ref 5 PID	0.00	
P086a-Ref 6 PID	0.00		**P087a**-Ref 7 PID	0.00	
P099a-FireM_Ref PID	0.00				
P10x Prohibit Speeds					
P105-Velbp1	0 rpm		**P106**-Velbp2	0 rpm	
P107-Velbp3	0 rpm		**P108**-Bwbps	0 rpm	
P11x-P12x % Var. Ref.					
P115-VarPerc1	0.0 %		**P116**-VarPerc2	0.0 %	
P117-VarPerc3	0.0 %		**P118**-VarPerc4	0.0 %	
P119-VarPerc5	0.0 %		**P120**-VarPerc6	0.0 %	
P121-VarPerc7	0.0 %				
P12x-P15x Speed Loop					
P125-Ti min M1	0.500 s		**P126**-Ti max M1	0.500 s	
P128-Kp min M1	10.00		**P129**-Kp max M1	10.00	
P130-Err.min M1	1.00 %		**P131**-Err.max M1	1.00 %	
P135-Ti min M2	0.500 s		**P136**-Ti max M2	0.500 s	
P138-Kp min M2	10.00		**P139**-Kp max M2	10.00	
P140-Err.min M2	1.00 %		**P141**-Err.max M2	1.00 %	
P145-Ti min M3	0.500 s		**P146**-Ti max M3	0.500 s	
P148-Kp min M3	10.00		**P149**-Kp max M3	10.00	
P150-Err.min M3	1.00 %		**P151**-Err.max M3	1.00 %	
P152-curr_symm.	0 %		**P153**-Tauw	10 ms	
P15x-P17x FOC Regulator					
P155-Curr_Kp M1	3.00		**P156**-Curr_Ti M1	20.0 ms	
P158-Flux_Kp M1	0.00		**P159**-Flux_Ti M1	33 ms	
P162-Curr_Kp M2	3.00		**P163**-Curr_Ti M2	20.0 ms	
P165-Flux_Kp M2	0.00		**P166**-Flux_Ti M2	33 ms	
P169-Curr_Kp M3	3.00		**P170**-Curr_Ti M3	20.0 ms	
P172-Flux_Kp M3	0.00		**P173**-Flux_Ti M3	33 ms	
P175xx VTC Regulator					
P175h1-FluxBoost_M1	0.0 %		**P175i1**-BoostThLow_M1	15.0 %	
P175j1-BoostThHigh_M1	30.0 %		**P175t1**-Kp_M1	500.0	
P175u1-Taui_M1	50 ms				
P175h2-FluxBoost_M2	0.0 %		**P175i2**-BoostThLow_M2	15.0 %	
P175j2-BoostThHigh_M2	30.0 %		**P175t2**-Kp_M2	500.0	
P175u2-Taui_M2	50 ms				
P175h3-FluxBoost_M3	0.0 %		**P175i3**-BoostThLow_M3	15.0 %	
P175j3-BoostThHigh_M3	30.0 %		**P175t3**-Kp_M3	500.0	
P175u3-Taui_M3	50 ms				
P175a-IthDTc	5.00 %		**P175b**-DTperc	80.0 %	
P175c-Dtsplit	50.0 %				
P175k-ExtraFlux	110.0 %		**P175l**-PsiMinPerc	10.0 %	
P175o-TauFluxR	300 ms		**P175w**-VtcCtrlAtStop	Speed	
P17x-P21x Analog Outputs					

PAR.-Meaning	Default values	Modified values	PAR.-Meaning	Default values	Modified values
P176-AO1 Mode	1: +/-10V		**P177**-AO1 Sel	1: Motor Speed	
P178-AO1 Min	-1500.000 rpm		**P179**-AO1 Max	1500.000 rpm	
P180-AO1 Offset	0.000 V		**P181**-AO1 Filt	0.000 s	
P182-AO1 Out_min	-10.0 V		**P183**-AO1 Out_max	10.0 V	
P184-AO2 Mode	1: +/-10V		**P185**-AO2 Sel	2: Speed Ref.	
P186-AO2 Min	-1500.000 rpm		**P187**-AO2 Max	1500.000 rpm	
P188-AO2 Offset	0.000 V		**P189**-AO2 Filt	0.000 s	
P190-AO2 Out_min	-10.0 V		**P191**-AO2 Out_max	10.0 V	
P192-AO3 Mode	1: +/-10V		**P193**-AO3 Sel	5:Motor Current	
P194-AO3 Min	0.000 A		**P195**-AO3 Max	36.000 A	
P196-AO3 Offset	0.000 V		**P197**-AO3 Filt	0.000 s	
P198-AO3 Out_min	-10.0 V		**P199**-AO3 Out_max	10.0 V	
P200-PulsOut Mode	0: Disabled		**P201**-PlsOut Sel	1: Motor Speed	
P202-Pls Out Min	0 rpm		**P203**-Pls Out Max	0 rpm	
P204-Pls Out Fmax	10.00 kHz		**P205**-Pls Out Fmin	100.00 kHz	
P206-Pls Out Filt	0.000 s		**P207**-AO1Gain	RESERVED	
P208-AO2Gain	RESERVED		**P209**-AO3Gain		
P210-AO1Address			**P211**-AO2Address		
P212-AO3Address			**P213**-Sin Amp	100.0 %	
P214-Sin Freq	1.00 Hz		**P215**-Saw Freq	1.000 Hz	

PAR.-Meaning	Default Values	Modified values	PAR.-Meaning	Default Values	Modified values
P21x-P22x Timers					
P216-T1 delay On	0.0 s		**P217**-T1 delay Off	0.0 s	
P218-T2 delay On	0.0 s		**P219**-T2 delay Off	0.0 s	
P220-T3 delay On	0.0 s		**P221**-T3 delay Off	0.0 s	
P222-T4 delay On	0.0 s		**P223**-T4 delay Off	0.0 s	
P224-T5 delay On	0.0 s		**P225**-T5 delay Off	0.0 s	
P226a-Timer MDI1	0		**P226b**-Timer MDI2	0	
P226c-Timer MDI3	0		**P226d**-Timer MDI4	0	
P227a-Timer MDI5	0		**P227b**-Timer MDI6	0	
P227c-Timer MDI7	0		**P227d**-Timer MDI8	0	
P228a-Timer MDO1	0		**P228b**-Timer MDO2	0	
P228c-Timer MDO3	0		**P228d**-Timer MDO4	0	
P229a-Timer MPL1	0		**P229b**-Timer MPL2	0	
P229c-Timer MPL3	0		**P229d**-Timer MPL4	0	
P23x-P26x PID Parameters					
P236-PID Out Max	100.00 %		**P237**-PID Out Min	100.00 %	
P237a-Wake Up Mode	0: Disabled		**P237b**-Wake Up Level	0.00 %	
P238-Integ Max	100.00 %		**P239**-Der Max	100.00 %	
P240-PID Kp	1.000		**P241**-PID KpMult	0: 1	
P242-PID Ti(Tc)	500 Tc		**P243**-PID Td(Tc)	0 mTc	
P244-PID Tc	5 ms		**P245**-PID Ref Min	0.00 %	
P246-PID Ref Max	100.00 %		**P247**-PID Fdbk Min	0.00 %	
P248-PID Fdbk Max	100.00 %		**P249**-PID Tup	0.00 s	
P250-PID Tdn	0.00 s		**P251**-PID U.Mea.	1: 0.1 s	
P252-Rnd start	50 %		**P253**-Rnd stop	50 %	
P254-Thresh Int	0.0 %|Refmax|		**P255**-Disab Time	Disabled	
P256-Trate Lim	1 ms		**P257**-GainScale	1.000	
P260-GainAWUP	1.00				
P27x-P30x Digital Outputs					
P270-Out1Mode	3: Analog		**P271**-Out1Sel1	A01: Speed	
P272-Out1Sel2	A01: Speed		**P273**-Out1 Test1	0: >	
P274-Out1 Test2	3: ≤		**P275**-D01 ValTst1	50.000 rpm	
P276-D01 ValTst2	10.000 rpm		**P277**-Out1Func	1: (A) Set (B) Reset	
P277a-Out1Sel1	D0: Disable		**P277b**-Out1Func	0: f(A,B) OR (C)	
P278-Out1Logic	1: True		**P279**-Out2Mode	6: Brake	
P280-Out2Sel1	A11: Torque output		**P281**-Out2Sel2	A01: Speed	
P282-Out2 Test1	0: >		**P283**-Out2 Test2	3: ≤	
P284-D02 ValTst1	20.000 %		**P285**-D02 ValTst2	50.000 rpm	
P286-Out2Func	1: (A) Set (B) Reset		**P286a**-Out2Sel1	D0: Disable	
P286b-Out2Func	0: f(A,B) OR (C)		**P287**-Out2Logic	1: True	
P288-Out3Mode	1: Digital		**P289**-Out3Sel1	D3: Inverter Alarm	
P290-Out3Sel2	D3: Inverter Alarm		**P291**-Out3 Test1	0: >	
P292-Out3 Test2	0: >		**P293**-D03 ValTst1	0.000	
P294-D03 ValTst2	0.000		**P295**-Out3Func	0: (A) OR (B)	
P295a-Out3Sel1	D0: Disable		**P295b**-Out3Func	0: f(A,B) OR (C)	
P296-Out3Logic	0: False		**P297**-Out4Mode	1: Digital	
P298-Out4Sel1	D1: Inverter Run Ok		**P299**-Out4Sel2	D1: Inverter Run Ok	
P300-Out4 Test1	0: >		**P301**-Out4 Test2	0: >	
P302-D04 ValTst1	0.000		**P303**-D04 ValTst2	0.000	
P304-Out4Func	0: (A) OR (B)		**P304a**-Out4Sel1	D0: Disable	
P304b-Out4Func	0: f(A,B) OR (C)		**P305**-Out4Logic	1: True	

PAR.-Meaning	Default Values	Modified values	PAR.-Meaning	Default Values	Modified values
P306-P317 Aux Digital Outputs					
P306-Out1Sel	D0: Disable		**P307**-Out1Logic	1: True	
P308-Out2Sel	D0: Disable		**P309**-Out2Logic	1: True	
P310-Out3Sel	D0: Disable		**P311**-Out3Logic	1: True	
P312-Out4Sel	D0: Disable		**P313**-Out4Logic	1: True	
P314-Out5Sel	D0: Disable		**P315**-Out5Logic	1: True	
P316-Out6Sel	D0: Disable		**P317**-Out6Logic	1: True	
P32x PT100 Settings					
P320-Mea1 Type	0:Disable		**P321**-Offset Mea1	0	
P322-Mea2 Type	0:Disable		**P323**-Offset Mea2	0	
P324-Mea3 Type	0:Disable		**P325**-Offset Mea3	0	
P326-Mea4 Type	0:Disable		**P327**-Offset Mea4	0	
P33x Fieldbus Parameters					
P330-fbs_meas3	M012 Torq.Out.%		**P331**-fbs_meas4	M022 PID Out%	
P35x-P38x MPL					
P350-Out1Mode	0: Disable		**P351**-Out1Sel1	D0: Disable	
P352-Out1Sel2	D0: Disable		**P353**-Out1 Test1	0: >	
P354-Out1 Test2	0: >		**P355**-D01 ValTst1	0	
P356-D01 ValTst2	0		**P357**-Out1Func	0: (A) OR (B)	
P357a-Out1Sel1	D0: Disable		**P357b**-Out1Func	0: f(A,B) OR (C)	
P358-Out1Logic	1: True		**P359**-Out2Mode	0: Disable	
P360-Out2Sel1	D0: Disable		**P361**-Out2Sel2	D0: Disable	
P362-Out2 Test1	0: >		**P363**-Out2 Test2	0: >	
P364-D02 ValTst1	0		**P365**-D02 ValTst2	0	
P366-Out2Func	0: (A) OR (B)		**P366a**-Out2Sel1	D0: Disable	
P366b-Out2Func	0: f(A,B) OR (C)		**P367**-Out2Logic	1: True	
P368-Out3Mode	0: Disable		**P369**-Out3Sel1	D0: Disable	
P370-Out3Sel2	D0: Disable		**P371**-Out3 Test1	0: >	
P372-Out3 Test2	0: >		**P373**-D03 ValTst1	0	
P374-D03 ValTst2	0		**P375**-Out3Func	0: (A) OR (B)	
P375a-Out3Sel1	D0: Disable		**P375b**-Out3Func	0: f(A,B) OR (C)	
P376-Out3Logic	1: True		**P377**-Out4Mode	0: Disable	
P378-Out4Sel1	D0: Disable		**P379**-Out4Sel2	D0: Disable	
P380-Out4 Test1	0: >		**P381**-Out4 Test2	0: >	
P382-D04 ValTst1	0		**P383**-D04 ValTst2	0	
P384-Out4Func	0: (A) OR (B)		**P384a**-Out4Sel1	D0: Disable	
P384b-Out4Func	0: f(A,B) OR (C)		**P385**-Out4Logic	1: True	
P39x Auxiliary Reference					
P390-XAIN4	3: 0-10V		**P391**-XAIN4MIN	0.0 V	
P391a-XAIN4MIN_%	100%		**P392**-XAIN4MAX	10.0 V	
P392a-XAIN4MAX_%	100%		**P393**-XAIN4OFFS	0.000 V	
P394-TauFilt XAIN4	100 ms		**P395**-XAIN5	2: 4-20mA	
P396-XAIN5MIN	4.0 mA		**P396a**-XAIN5MIN_%	100%	
P397-XAIN5MAX	20.0 mA		**P397a**-XAIN5MAX_%	100%	
P398-XAIN5OFFS	0.000 mA		**P399**-TauFilt XAIN5	100 ms	
P43x-P46x PID2 Parameters					
P436-PID2 Out Max	100.00 %		**P437**-PID2 Out Min	100.00 %	
P437a-Wake Up Mode	0: Disabled		**P437b**-Wake Up Level	0.00 %	
P438-Integ Max	100.00 %		**P439**-Der Max	100.00 %	
P440-PID2 Kp	1.000		**P441**-PID2 KpMult	0: 1	
P442-PID2 Ti(Tc)	500 Tc		**P443**-PID2 Td(Tc)	0 mTc	
P444-PID2 Tc	5 ms		**P445**-PID2 Ref Min	0.00 %	
P446-PID2 Ref Max	100.00 %		**P447**-PID2 Fdbk Min	0.00 %	
P448-PID2 Fdbk Max	100.00 %		**P449**-PID2 Tup	0.00 s	
P450-PID2 Tdn	0.00 s		**P451**-PID2 U.Mea.	1: 0.1 s	
P452-Rnd start	50 %		**P453**-Rnd stop	50 %	
P454-Thresh Int	0.0 %|Refmax|		**P455**-Disab Time	Disabled	
P456-Trate Lim	1 ms		**P457**-GainScale	1.000	
P460-GainAWUP	1.00				

PAR.-Meaning	Default values	Modified values	PAR.-Meaning	Default values	Modified values
C00x-C00x Carrier Freq					
C001-Minimun Carrier	[*]		**C002**-Maximum Carrier	[*]	
C003- Pulse Number	1: 24		**C004**-Silent Modulation	[*]	
C00x-C04x Motor Control M1					
C008-VmainsNom	[**]		**C009**-Mot.Numb.	1	
C010-Ctrl.Type M1	0: IFD		**C011**-RefMode M1	0: Speed	
C011c-TrqFllwr M1	0: No		**C012**-EncEnab M1	0: No	
C013-v_f_mode1	[*]		**C014**-Phase Rot. Mot1	0: No	
C015-Fmot M1	50.0 Hz		**C016**-n mot M1	1420 rpm	
C017-Pmot M1	[*]		**C018**-Imot M1	[*]	
C019-Vmot M1	[**]		**C020**-P0 M1	0.0 %	
C021-i0 M1	0 %		**C022**-Rstat M1	[*]	
C023-Ld M1	[*]		**C024**-Lm M1	250.00 mH	
C025-TauRot M1	0 ms		**C026**-vdcFiltM1	0ms	
C028-nmin M1	0 rpm		**C029**-nmax M1	1500 rpm	
C030-spddeflux M1	Disabled		**C030a**- taui_defluxM1	500ms	
C031-nsa M1	Disabled		**C032**-red_Trq1	30.0 %	
C033-spd_redTrq1	20 %		**C034**-Preboost M1	[*]	
C035-Boost0 M1	[*]		**C035a**- FrqBst0 M1	5%	
C036-Boost M1	[*]		**C037**-FrqBst	[*]	
C038-AutoBst	[*]		**C039**-SlipComp. M1	Disabled	
C040-DV_M1	Disabled		**C041**-TFLM1	[*]	
C042-Vout Sat M1	100%				
	100%				
C04x-C05x Limits M1					
C043-Iacclim M1	150%		**C044**-Irunlim M1	150%	
C045-Ideclim M1	[*]		**C046**-defilimRed M1	0: Disabled	
C047-TminMot M1	0.0 %		**C048**-TmaxMot M1	120%	
C049-TmaxBrk M1	120%		**C050**-fRedLimAcc M1	0: Enabled	
C05x-C08x Motor Control M2					
C053-Ctrl.Type M2	0: IFD		**C054**-RefMode M2	0: Speed	
C054c-TrqFllwr M2	0: No		**C055**-EncEnab M2	0: No	
C056-v_f_mode2			**C057**-Phase Rot. Mot2	0: No	
C058-Fmot M2			**C059**-n mot M2	1420 rpm	
C060-Pmot M2			**C061**-Imot M2	[*]	
C062-Vmot M2			**C063**-P0 M2	0.0 %	
C064-i0 M2			**C065**-Rstat M2	[*]	
C066-Ld M2			**C067**-Lm M2	250.00 mH	
C068-TauRot M2			**C069**-vdcFiltM2	0ms	
C071-nmin M2			**C072**-nmax M2	1500 rpm	
C073-spddeflux M2			**C073a**- taui_defluxM2	500ms	
C074-nsa M2	Disabled		**C075**-red_Trq2		
C076-spd_redTrq2	20 %		**C077**-Preboost M2		
C078-Boost0 M2	[*]		**C078a**-FrqBst0 M2		
C079-Boost M2	[*]		**C080**-FrqBst M2		
C081-AutoBst	[*]		**C082**-SlipComp. M2		
C083-DV_M2	Disabled		**C084**-TFLM2		
C085-Vout Sat M2	100%				
C08x-C09x Limits M2					
C086-Iacclim M2	150%		**C087**-Irunlim M2	150%	
C088-Ideclim M2	[*]		**C089**-defilimRed M2	0: Disabled	
C090-TminMot M2	0.0 %		**C091**-TmaxMot M2	120%	
C092-TmaxBrk M2	120%		**C093**-fRedLimAcc M2	0: Enabled	

PAR.-Meaning	Default Values	Modified values	PAR.-Meaning	Default Values	Modified values
C09x-C12x Motor Control M3					
C096-Ctrl.Type M3	0: IFD		**C097**-RefMode M3	0: Speed	
C097c-TrqFllwr M3	0: No		**C098**-EncEnab M3	0: No	
C099-v_f_mode3	[*]		**C100**-Phase Rot. Mot3	0: No	
C101-Fmot M3	50.0 Hz		**C102**-n mot M3	1420 rpm	
C103-Pmot M3	[*]		**C104**-Imot M3	[*]	
C105-Vmot M3	[**]		**C106**-P0 M3	0.0 %	
C107-i0 M3	0 %		**C108**-Rstat M3	[*]	
C109-Ld M3	[*]		**C110**-Lm M3	250.00 mH	
C111-TauRot M3	0 ms		**C112**-vdcFiltM3	0ms	
C114-nmin M3	0 rpm		**C115**-nmax M3	1500 rpm	
C116-spddeflux M3	Disabled		**C116a**- taui_defluxM3	500ms	
C117-nsa M3	Disabled		**C118**-red_Trq3		
C119-spd_redTrq3	20 %		**C120**-Preboost M3		
C121-Boost0 M3	[*]		**C121a**- FrqBst0 M3		
C122-Boost M3	[*]		**C123**-FrqBst M3		
C124-AutoBst	[*]		**C125**-SlipComp. M3		
C126-DV_M3	Disabled		**C127**-TFLM3		
C128-Vout Sat M3	100%				
C12x-C13x Limits M3					
C129-Iacclim M3	150%		**C130**-Irunlim M3	150%	
C131-Ideclim M3	[*]		**C132**-defilimRed M3	0: Disabled	
C133-Tmin Mot M3	0.0 %		**C134**-TmaxMot M3	120%	
C135-TmaxBrk M3	120%		**C136**-fRedLimAcc M3	0: Enabled	
C14x Control Method					
C140-Sel Comm 1	1: Terminals		**C141**-Sel Comm 2	1: Terminals	
C142-Sel Comm 3	0: Disabled		**C143**-Sel InRef 1	1: REF	
C144-Sel InRef 2	2: AIN1		**C145**-Sel InRef 3	0: Disabled	
C146-Sel InRef 4	0: Disabled		**C147**-Sel Lim	0: Disabled	
C148-RemLoc_mode	0: StandBy + Fluxing				
C15x-C18x Digital Inputs					
C149-Start	1: MDI1		**C149a**-StartB	0: None	
C150-Stop	0: None		**C150a**-StopB	0: None	
C151-Rev	0: None		**C151a**-RevB	0: None	
C152-Enable SW	0: None		**C153**-Disable	0: None	
C154-Reset Alarm	3: MDI3		**C154a**-Ena Term	0: No	
C155-Mltsp 0	4: MDI4		**C156**-Mltsp 1	5: MDI5	
C157-Mltsp 2	0: None		**C158**-Mltsp 3	0: None	
C159-Cw-CCw	8: MDI8		**C160**-DCB	0: None	
C161-Up	0: None		**C162**-Down	0: None	
C163-U/D Reset	0: None		**C164**-ExtAlrm 1	0: None	
C164a-ExtAlr1Delay	0 ms		**C165**-ExtAlrm 2	0: None	
C165a-ExtAlr2Delay	0 ms		**C166**-ExtAlrm 3	0: None	
C166a-ExtAlr3Delay	0 ms		**C167**-MltRmp 0	0: None	
C168-MltRmp 1	0: None		**C169**-Jog	0: None	
C169a-reg_speed_switch	0: None				
C170-Master/Slave	0: None		**C171**-PID disab.	0: None	
C171a-PID sel. control	0: Disabled		**C172**-Keypad lock	0: None	
C173-2nd Mot.	0: None		**C174**-3rd Mot.	0: None	
C175-PercSpd 0	0: None		**C176**-PercSpd 1	0: None	
C177-PercSpd 2	0: None		**C178**-PIDud_res	0: None	
C179-SourceSel	0: MDI6		**C179a**-CmdSel	0:None	
C179b-RefSel	0: None		**C180**-Loc/Rem	0: MDI7	
C180a-Loc/RemType	2: Pushbutton+Storage		**C181**-Safe Start	0: Disabled	
C182-MultiProg	0: Disabled		**C183**-Tflux_dis	AlwaysON	
C184-StartFlux	0: No		**C184a**-TrqRedFluxing	0: No	
C185-StartFrWheel	0: Dec. Ramp		**C186**-FireMode	0: None	
C187-DisabExtTlim	0: None		**C187a**-Mtrq0	0: None	
C187b-Mtrq1	0: None		**C188a**-MrefPID 1	0: None	
C188b-MrefPID 2	0: None		**C188c**-MrefPID 3	0: None	

PAR.-Meaning	Default Values	Modified values	PAR.-Meaning	Default Values	Modified values
C18x-C19x Encoder/Frequency Input					
C189-UseEnc	0: A / B Unused		**C190**-pulsEncA	1024	
C191-pulsEncB	1024		**C192**-SpdAlrTime	5.00 s	
C193-SpdErr	300 rpm		**C194**-TrackAlrEn	1: Enable	
C195-tauFiltFdbk	5.0 ms		**C196**-tauFiltRef	5.0 ms	
C197-nCH ENCA	0:.2Ch. Quad		**C198**-nCH ENCB.	0: 2Ch. Quad	
C199-EncSign	0: Fdbk.NO Ref.NO				
C21x Braking Unit					
C210-Enab/Spd BrakeOn	[*]		**C211**-BrakeTon	2.00 s	
C212-BrkDutyCycle	10 %		**C213**-FreqBoost	0%	
C213a-KpVdcTrqRed	0.020		**C213b**-KiVdcTrqRed	0.010	
C213c-VdcTrqRedOvfxRef	100.0%		**C213d**-VdcTrqRedFluxRed	0.0%	
C21x-C22x DC Braking					
C215-Enab dcb stop	0: No		**C216**-Enab dcb start	0: No	
C217-Tdcb stop	0.5 s		**C218**-Tdcb start	0.5 s	
C219-dcb speed	50 rpm		**C219a**-TWRamp	500 ms	
C220-I dcb	100 %		**C220a**-TauIDCB	300 ms	
C220b-KpIDCB	20		**C220c**-TauiIDCB	100 ms	
C221-I dcb hold	0 %		**C222**-Tdefl M1	[*]	
C223-Tdefl M2	[*]		**C224**-Tdefl M3	[*]	
C22x-C23x Power Down					
C225-pwd type	3: Alarm		**C226**-Tpdd	10 ms	
C227-Tpddec	20 s		**C228**-Pddecboost	0.10 %	
C229-Pddcder	1		**C230**-Vpddel	[**]	
C231-Kpvdclc	0.050		**C232**-Kivdclc	0.500s	
C234-stopmode	0: Stop		**C235**-stoplev	0 rpm	
C236-En_phase_lack	0: Disable				
C24x Speed Searching					
C245-Enab SpdSch	0: No		**C246**-tssd	1 s	
C247-SpsRate	10 %		**C248**-Is	75 %	
C249-SpsSpd	0: Last Speed		**C250**-SpdSch_En	0:Disable	
C25x AutoReset					
C255-nPulsRes	Disable		**C256**-T ResCyc	300 s	
C256a-T Del_Autores	0 s		**C257**-PowOnRes	0: No	
C258-UvMlStore	0: No				
C26x-C27x Thermal Protection					
C264-FanTemp	50 °C		**C265**-ThermProt M1	3: Yes B	
C266-ThermCurr M1	105 %		**C267**-ThermConstM1	720s	
C268-ThermProt M2	3: Yes B		**C269**-ThermCurr M2	105 %	
C270-ThermConstM2	720s		**C271**-ThermProt M3	3: Yes B	
C272-ThermCurr M3	105 %		**C273**-ThermConstM3	720s	
C274-PTC ThermProt	0:Disable				
C27x Maintenance					
C276-Set OP Time	0h		**C276**-Set SP Time	0h	
C28x-C29x PID Configuration					
C285-Sel InPID 1	2: AIN1		**C286**-Sel InPID 2	0: Disabled	
C287-Sel InPID 3	0: Disabled		**C288**-Sel Fdbk 1 PID	3: AIN2/PTC	
C289-Sel Fdbk 2 PID	0: Disable		**C290**-Sel Fdbk 3 PID	0: Disable	
C291-PID Mode	0: Disable		**C291a**-PID Control mode	0: Standard SUM	
C291b-PID Mode	0: Disable		**C292**-Der Mode	0: Measure	
C293-PID Struct	0: No		**C294**-PID Act	1: Reference	
C30x Crane					
C300-StartTrq ref.pos.	0.0 %		**C301**-t_StartTrq ref.pos.	0 ms	
C300a-StartTrq ref.neg.	0.0 %		**C301a**-t_StartTrq ref.neg.	0 ms	
C302-Brk_On	0: None		**C303**-Brk_Off_on_track_err	1: Yes	

PAR.-Meaning	Default Values	Modified values	PAR.-Meaning	Default Values	Modified values
C31x Date and Time					
C310-ModWeekday	1: Monday		**C311**-ModDay	1	
C312-ModMonth	1: January		**C313**-ModYear	0	
C314-ModHour	0		**C315**-ModMin	0	
C316-Modify Date					
C33x-C35x Timed Flags					
C330-TFL1: T on h	0		**C331**-TFL1: T on m	0	
C332-TFL1: T on s	0		**C333**-TFL1: T off h	0	
C334-TFL1: T off m	0		**C335**-TFL1: T off s	0	
C336-TFL1: WeekDays	0		**C337**-TFL2: T on h	0	
C338-TFL2: T on m	0		**C339**-TFL2: T on s	0	
C340-TFL2: T off h	0		**C341**-TFL2: T off m	0	
C342-TFL2: T off s	0		**C343**-TFL2: WeekDays	0	
C344-TFL3: T on h	0		**C345**-TFL3: T on m	0	
C346-TFL3: T on s	0		**C347**-TFL3: T off h	0	
C348-TFL3: T off m	0		**C349**-TFL3: T off s	0	
C350-TFL3: WeekDays	0		**C351**-TFL4: T on h	0	
C352-TFL4: T on m	0		**C353**-TFL4: T on s	0	
C354-TFL4: T off h	0		**C355**-TFL4: T off m	0	
C356-TFL4: T off s	0		**C357**-TFL4: WeekDays	0	

PAR.-Meaning	Default Values	Modified values	PAR.-Meaning	Default Values	Modified values
R00x-R01x Serial Link					
R001-com_slaveaddr	1		**R002**-com_answdelay	5 ms	
R003-sc0_baudrate	38400 bps		**R004**-com_4time_delay	2 ms	
R005-ser_wdg_time	0.0 s		**R006**-parity sc0	1: No, 2 Stop Bit	
R008-cm1_slaveaddr	1		**R009**-cm1_answdelay	5 ms	
R010-sc1_baudrate	38400 bps		**R011**-cm1_4time_delay	2 ms	
R012-sr1_wdg_time	0.0 s		**R013**-parity sc1	1: No, 2 Stop Bit	
R01x Fieldbus Configuration					
R016-fbs_wdg_time	0 ms		**R017a**-AO1_fb_sel	0: No	
R017b-AO2_fb_sel	0: No		**R017c**-AO3_fb_sel	0: No	
R018-fb_Address	0		**R018a**-fb_BaudRate	125k	
R018b-fb_TypeWD	0 → bit 15 to 1				
R02x Expansion Board Settings					
R021-Data Logger Setting	0: None		**R023**- I/O Board setting	0:None	
R02x-R04x PROFIdrive Settings					
R025-SlaveAddr	1		**R026**-PZD3_O_Addr	1: Digital Inputs	
R027-PZD4_O_Addr	0: not used		**R028**-PZD5_O_Addr	0: not used	
R029-PZD6_O_Addr	0: not used		**R030**-PZD7_O_Addr	0: not used	
R031-PZD8_O_Addr	0: not used		**R032**-PZD9_O_Addr	0: not used	
R033-PZD10_O_Addr	0: not used		**R034**-PZD3_I_Addr	0: not used	
R035-PZD4_I_Addr	0: not used		**R036**-PZD5_I_Addr	0: not used	
R037-PZD6_I_Addr	0: not used		**R038**-PZD7_I_Addr	0: not used	
R039-PZD8_I_Addr	0: not used		**R040**-PZD9_I_Addr	0: not used	
R041-PZD3_I_Addr	0: not used		**R044**-DP com.mode	0: DP V0	
R045-DP sel.	1: VENDOR SPECIFIC 1				
R05x Daylight Saving Time					
R050-DSTOn WDMM	5703		**R051**-DSTOn HHMM	200	
R052-DSTOff WDMM	5710		**R053**-DSTOff HHMM	200	
R11x Data Logger					
R115-PIN card SIM	“0000”		**R116**-Preset Connections	0: Disable	

Key:
[*] Parameter depending on the current size.
[**] Parameter depending on the voltage class.

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