• 15Q0102B200 •

SINUS PENTA

MULTIFUNCTION AC DRIVE

GUIDE TO THE SYNCHRONOUS MOTOR APPLICATION

English

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REVISION INDEX

The following subjects covered in this User Manual (revision R. 03, **SW version 4.22x** issued on **28/07/2023**) have been added, changed or suppressed with respect to the previous version (revision R. 02, **SW version 4.21x** issued on **10/01/2022**).

Parameters for control of anisotropic (IPM) motors added. Autotuning modified accordingly.
Parameter **C049** for splitting the torque limits in speed control added.

OTHER MANUALS MENTIONED IN THIS GUIDE

15R0102B200 SINUS PENTA – Programming Guide
15P0102B1 SINUS PENTA – Installation Guide
15W0102B500 Motor Drives Accessories – User Manual
15J0901B100 RemoteDrive – User Manual

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1. 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.

2. OVERVIEW

Special software that can be used for particular applications is supplied with the drives of the Sinus Penta series. 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 your application.
This manual covers the parameters relating to the Synchronous Motor application only.
Accessory boards are covered in the Motor Drives Accessories – User Manual.
The parameters shared with the standard Sinus Penta are covered in the SINUS PENTA – Programming Guide.

The FIRMWARE UPGRADE section explains how to download the files for the Sinus Penta applications to the standard drive: this download procedure is to be performed only when a drive programmed with standard firmware needs updating.
The procedure above is not required if the drive is factory set with the firmware for the Synchronous Motor application.

2.1. SYNCHRONOUS MOTOR APPLICATION

The Sinus Penta drive featuring the Synchronous Motor application enables torque control and speed control of isotropic (SPM) and anisotropic (IPM) permanent magnet synchronous motors (PMSM).

Controlling a synchronous motor requires a transducer (encoder, resolver, etc.). Also, the offset angle between the sensor and the rotor must be known, because the power supply current fed to the stator windings must be kept in phase with the rotor magnetic field generated by permanent magnets. The “alignment procedure” permits to estimate the offset angle. Using absolute sensors avoids repeating the alignment procedure every time the drive is powered on.

The SYN Sensorless control mode does not require any transducer, because this offset angle is estimated internally by using special algorithms.

The Sinus Penta application for synchronous motors covers all the issues typical of synchronous motors and features a number of procedures to pinpoint the electromechanical characteristics of the motor to be controlled and to perform autotuning of the fundamental control parameters.

DANGER

The field weakening allows the motor to work at very high speeds. As these machines are with permanent magnets, high rotations lead to the generation of high voltages. If the inverter stops switching (alarm, emergency, opening ENABLE), overvoltages will be generated that can destroy the inverter. The use of a braking resistor is mandatory if the resulting BEMF reaches dangerous values for the inverter.

3. SOFTWARE DOWNLOAD FOR APPLICATION PROGRAMMING

The Remote Drive software and the PXxxxxF0.mot, PXxxxxF1.mot files of the Synchronous Motor application are required to download the Synchronous Motor application to a Sinus Penta drive. The download procedure is detailed in the following section.

For different applications, please refer to the relevant manuals and to the updates available on Enertronica Santerno's website:

santerno.com

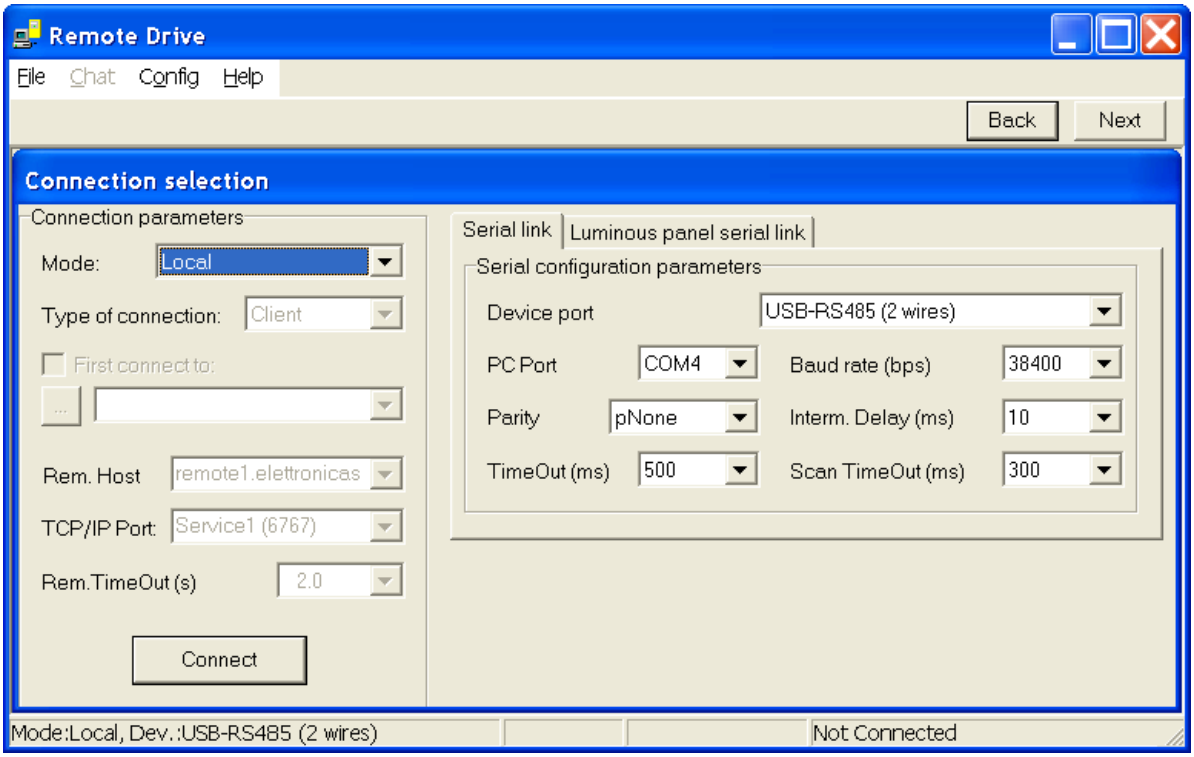
NOTE Please refer to the RemoteDrive – User Manual for more details.

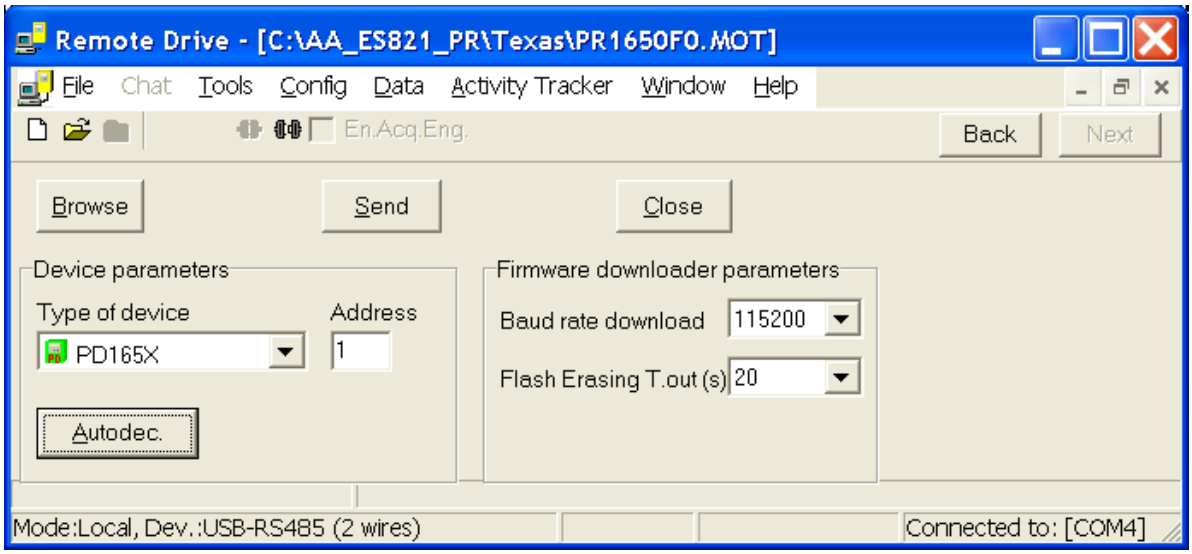
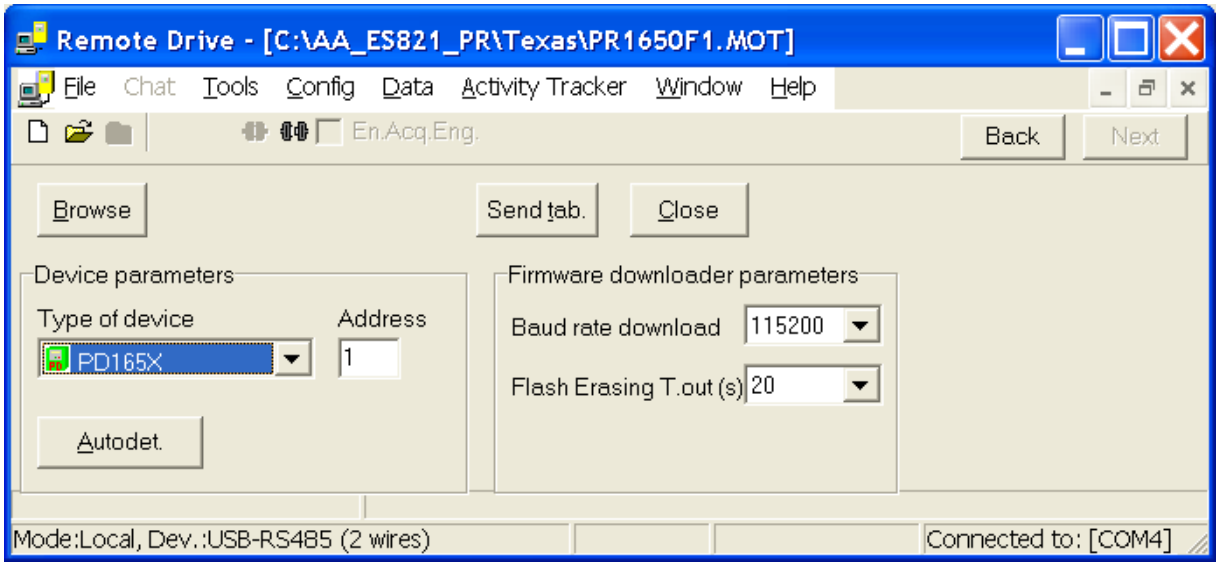
The software of the Sinus Penta drives consists of two files, one containing the firmware and one containing the MMI table for the keypad interface. Both files use hexadecimal files with the MOT format. The filenames ending with "F0" relate to the firmware; the filenames ending with "F1" relate to the MMI table.

3.1. FIRMWARE UPGRADE

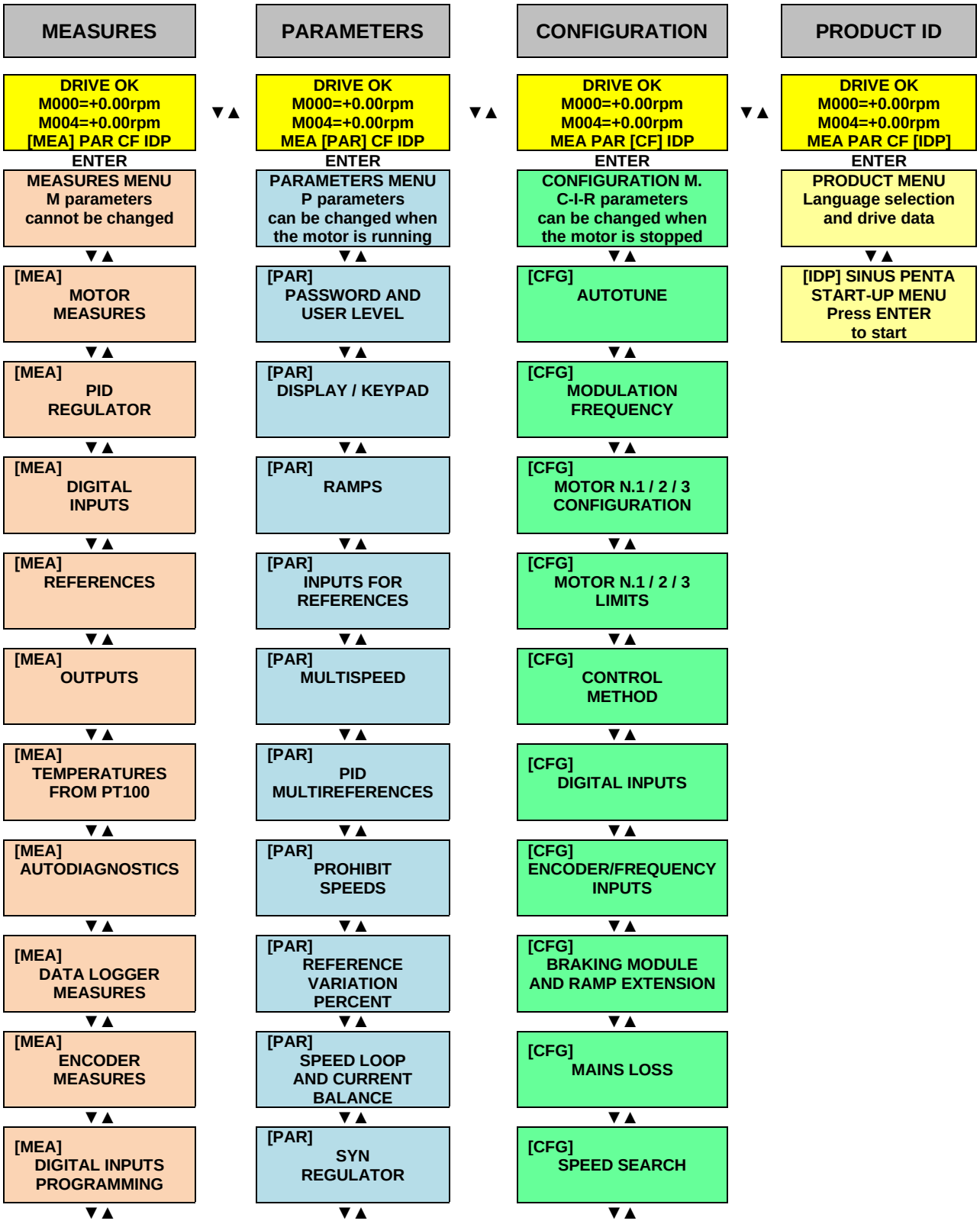
This section covers firmware upgrade and application download.

NOTE In case of multidrop connection (RS485), only the equipment to be upgraded shall be connected to the network.

1	Launch the Remote Drive.
2	Select the dialog language (click a flag) and press Next.
3	In the “Connection Parameters” window, select the Local mode. In the “Serial Configuration Parameters” window, set the interface device, the COM port being used and the baud rate (38400bps); click “Connect”, then click “Next”. In the example below, USB-RS485 converter is used. 
4	Select “Firmware Upgrade” from the “File” drop-down menu. Enter the path for the PXxxxxF0.mot and PXxxxxF1 files to be downloaded. If only one of the firmware files or MMI tables is to be updated, go to step 7. If an application shall be downloaded to a PXxxxx, select the PXxxxxF0.mot file and click the “Open” button.

5	Send the “Autodet.” command to allow the Remote Drive to detect the type of equipment. Once the product is detected, PXxxxx will appear in the Equipment Type window.  Press the “Send” button; confirmation for the Flash clearing will appear. Click “Yes” to start downloading. Once download is complete, go to step 6.
6	Click “Browse” to select the PxxxxF1.mot file  Click “SendTab”. Once this file is downloaded, the application download is complete (end of the download procedure).
7	Click “Browse” to select the file to be updated, PXxxxxF0.mot for the firmware and PxxxxF1.mot for the MMI table; first click “Open”, then click “Send” or “SendTab”. Confirm flash clearing. The Upgrade procedure is finished.

4. MENU TREE OF THE SYNCHRONOUS MOTOR APPLICATION



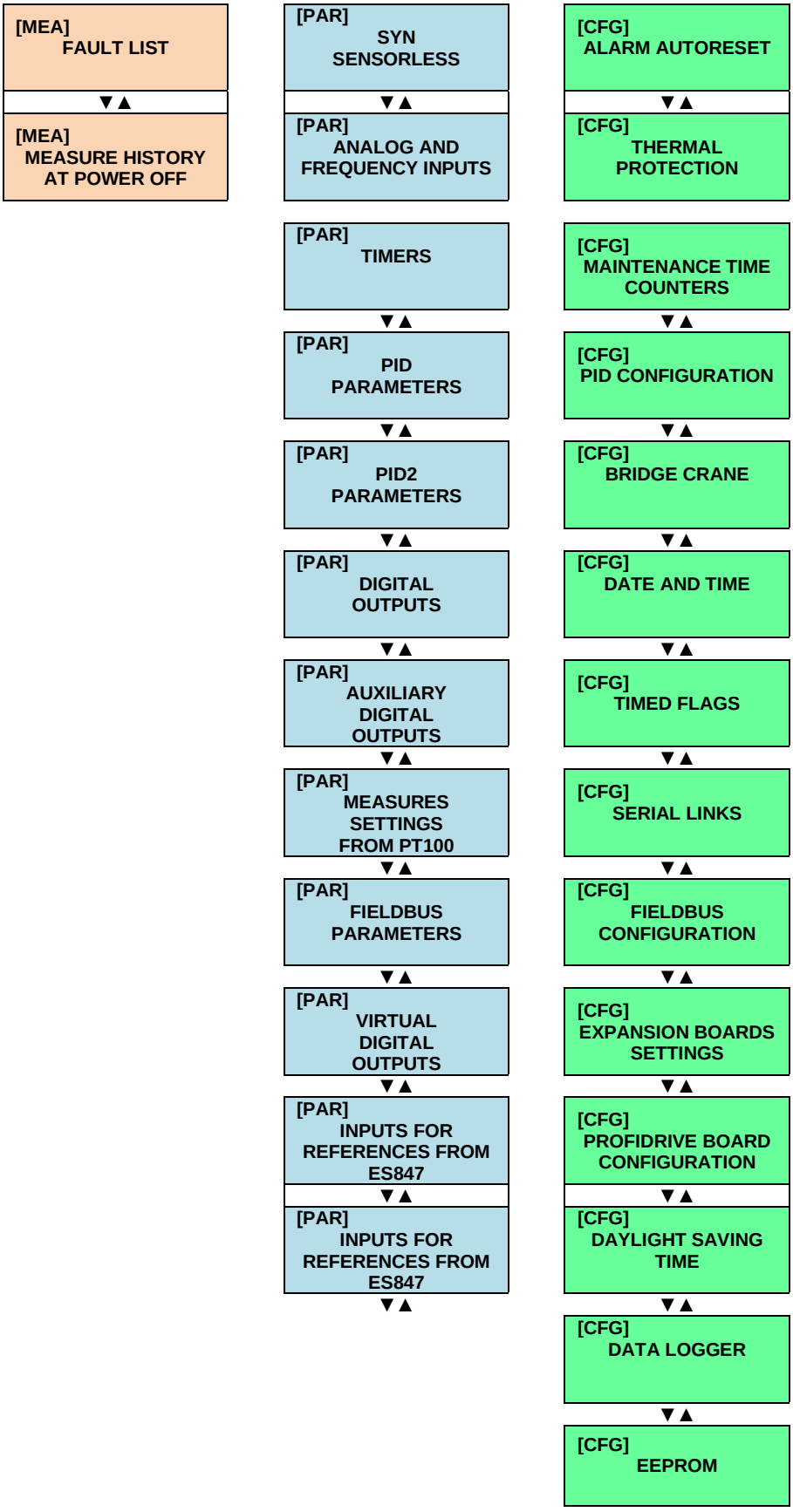


Figure 1: Menu tree of the Synchronous Motor application

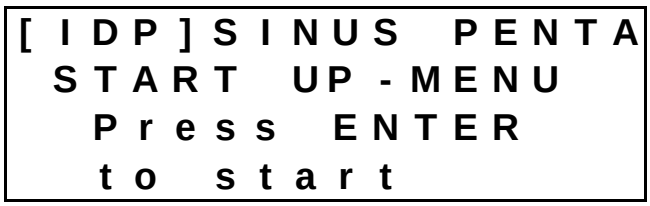
5. START-UP MENU

5.1. Overview

For easier start-up of the Sinus 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 PROCEDURE (SYNCHRONOUS MOTOR) 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 in the SINUS PENTA – Programming Guide) and power on the Penta drive again.

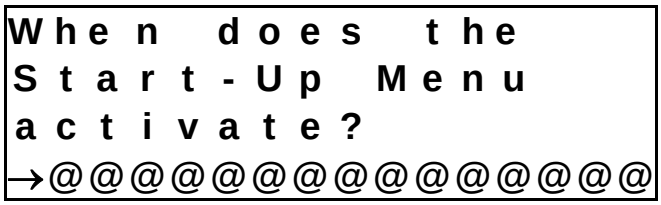
The following is the root page of the Start-Up menu:



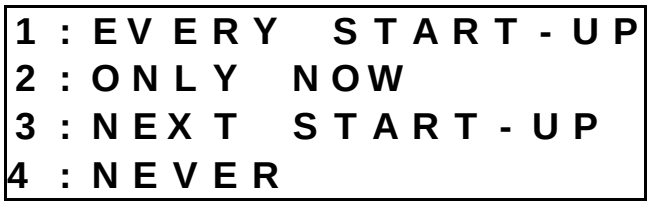
Press **ENTER** to enter the wizard.

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

Then you are asked to choose the display mode of the Start-up Menu:



Choose one of the following:

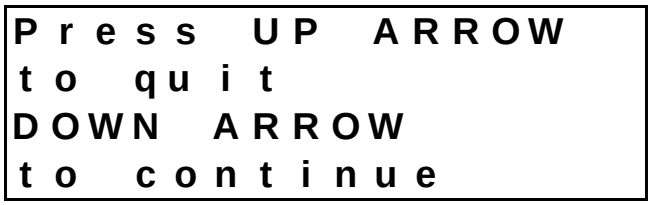


If you select “EVERY START-UP”, the wizard appears whenever the Sinus Penta drive is powered on;
if you select “ONLY NOW”, you can scroll through the menu and the wizard is disabled as soon as you quit the menu;
if you select “NEXT START-UP”, the menu is displayed only when the Penta drive is next started 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	
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	
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 SYN is active]
C049	Torque limit brake	[only if SYN is active]
C189	Encoder operating mode	[only if SYN with active sensor]
C190	Encoder A pls/rev	[only if SYN with active sensor]
C191	Encoder B pls/rev	[only if SYN with active sensor]
I073	Autotuning selection	[only if SYN is 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 screen appears:



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

6. FIRST STARTUP PROCEDURE (SYNCHRONOUS MOTOR)

6.1. SYN SENSORLESS

1) Wiring: Follow the instructions stated in the “Caution Statements” and “Installation” sections (SINUS PENTA – Installation Guide).

2) Power on: Power on the drive and do not close the link to the **START** input and the **ENABLE-A** and **ENABLE-B** inputs to prevent the motor from running.

3) Parameter modifications: Access parameter **P000** (Key parameter) and enter its code (default value = 00001). Set user level **P001** = Eng. Use the **ESC**, ▲,▼ and **SAVE/ENTER** keys to access the programming parameters. Also refer to the MENU TREE.

4) Supply voltage: Set the real supply voltage for the drive. You can set either the mains voltage range or the DC supply stabilized by a Regenerative Penta drive. To set the type of power supply for the drive, access the MOTOR CONTROL MENU and set configuration parameter **C008** to the value corresponding to the installation concerned.

5) Motor parameters: For the description of the following parameters, please refer to the SINUS PENTA – Programming Guide.
Access the MOTOR CONTROL MENU and set **C010** (Control Algorithm) as 1:SYN Sensorless (SYN Sensorless Synchronous Motor).
Set parameter **C012** (Type of Speed Feedback from Encoder) to No.

Set the motor ratings as follows:
- **C015** (fmot1) rated motor frequency, computed as follows:
  fmot1 = **rpmnom**/60 * **p**, where:
  rpmnom is the rated motor speed in rpm
  p is the number of pole pairs of the motor. Example:
  rpmnom = 3000 rpm
  p = 3 pole pairs (6 poles)
  fmot1=3000/60*3=150 Hz
- **C016** (rpmnom1) rated rpm
- **C017** (Pmot1) rated power
- **C018** (Imot1) rated current
- **C019** (Vmot1) rated voltage
- **C029** (Speedmax1) desired maximum speed

If it is known, also set the following parameter:
- C015a (BEMF) (it may also be obtained during autotuning).

6) Autotune of stator resistance, phase inductances, current loop, BEMF: Open the **ENABLE-A** and **ENABLE-B** inputs, then access the AUTOTUNE MENU and set **I073**= [1: Motor Tune] and **I074**= [3: SYN Autotune]. Press **ESC** to confirm. Close the **ENABLE-A**, **ENABLE-B** and **START** inputs and wait until tune is complete (Warning “**W32** Open Enable” is displayed). The drive has computed and saved the values for: **C015a, C022**, **C022a**, **C022z, P174b1, P174c1, P174g1** and **P174h1**.
If the values of parameters **C015a**, **C022**, **C022a** and **C022z** are known, they may be entered manually. By setting **I074** = [1: SYN Update Current Loop], only parameters **P174b1, P174c1, P174g1** and **P174h1** will be defined.
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 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) Speed loop autotune:

This procedure is optional. It enables calculating the speed loop gains; before performing the speed loop autotune, set up parameters **C022b** and **C022c** (Load Inertia, MOTOR CONTROL MENU) – these parameters are expressed in kgm^2. Parameters **P126** and **P128** may also be entered while performing a manual tune procedure.

Open the **ENABLE-A** and **ENABLE-B** inputs, then access the AUTOTUNE MENU and set **I073**= [1: Motor Tune] and **I074** = [2: SYN Update Speed Loop]. Press **ESC** to confirm. Close the **ENABLE-A** and **ENABLE-B** inputs and wait until tune is complete (Warning "**W32** Open Enable" is displayed). The drive has calculated and saved the values of **P126, P128**.

NOTE Later on, it could be necessary to manually change parameters **P126**, **P128** above to optimize the dynamic response of the motor.

8) BEMF autotune:

If the value of the motor BEMF is known, set it in parameter **C015a** – this parameter is expressed in V/kRPM.

If the value found with **I074** = [3: SYN Autotune] (step 7) is not satisfactory, it may be tuned automatically.

CAUTION **This procedure will make the motor run. Make sure that the motor can rotate freely (no mechanical constraints or heavy loads).**

Open the **ENABLE-A** and **ENABLE-B** inputs, then access the AUTOTUNE MENU and set **I073**= [1: Motor Tune] and **I074** = [4: SYN BEMF Tune]. Press **ESC** to confirm. Close the **ENABLE-A, ENABLE-B** and **START** inputs and wait for **W32** "Open Enable". The drive has calculated and saved the values of **C015a**.

9) Startup:

Activate the **ENABLE-A, ENABLE-B** inputs (terminals 15 and 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 rotating.

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 15 minutes, swap two of the motor phases.

10) Speed regulator adjustment:

If overshoot occurs when the speed setpoint is attained or if system instability is detected (the motor does not run smoothly), adjust the parameters relating to the speed loop (SPEED LOOP AND CURRENT BALANCING MENU). Set parameter **P126** (integral time**)** as [Disabled] and set a low value for the proportional gain **(P128**). Then increase **P128** until overshoot takes place when the setpoint is achieved. Decrease **P128** by approx. 30%, then decrease the high values set for integral time in **P126** until an acceptable setpoint response is obtained. Check to see if the motor runs smoothly at constant speed.

6.2. SYNCHRONOUS WITH A SENSOR

1) Wiring: Follow the instructions stated in the “Caution Statements” and “Installation” sections (SINUS PENTA – Installation Guide).

2) Power on: Power on the drive and do not close the link to the START input and the **ENABLE-A** and **ENABLE-B** inputs to prevent the motor from running.

3) Parameter modifications: Access parameter **P000** (Key parameter) and enter its code (default value = 00001). Set user level **P001** = Eng. Use the **ESC**, ▲,▼ and **SAVE/ENTER** keys to access the programming parameters. Also refer to the MENU TREE.

4) Supply voltage: Set the real supply voltage for the drive. You can set either the mains voltage range or the DC supply stabilized by a Regenerative Penta drive. To set the type of power supply for the drive, access the MOTOR CONTROL MENU and set configuration parameter **C008** to the value corresponding to the installation concerned.

5) Encoder parameters: **Available type of encoder/board:**

A) Incremental encoders on optional boards ES836 or ES913 (slot A) or terminal boards (MDI6, MDI7)

In the EXPANSION BOARD CONFIGURATION MENU, set parameters **R023a** and **R023b** to 0. Reset the board.
Access the ENCODER/FREQUENCY INPUTS MENU; in **C189**, set the source of the encoder signal used as the speed feedback (Encoder A in the terminal board, Encoder B in optional board **ES836** or **ES913**), enter the number of pulses per revolution (**C190** and **C191**) and the number of encoder channels (**C197** – refer to the relevant section in the Motor Drives Accessories – User Manual for more details).

B) Incremental encoders on optional boards ES861, ES950, ES966 (slot C)

In the EXPANSION BOARD CONFIGURATION MENU, set parameter **R023a** to 0 and **R023b** to 1 (for **ES950** or **ES966**, any value ≠ 3 is sufficient). Reset the board.
Access the ENCODER/FREQUENCY INPUTS MENU; in **C189**, set the source of the encoder signal used as the speed feedback in Encoder A (e.g. 1: A Feedback B Unused), enter the number of pulses per revolution (**C190** and **C191**) and the number of encoder channels (**C197** - consult the relevant section in the Motor Drives Accessories – User Manual for more details).

C) Absolute digital encoders (EnDat, BiSS, HIPERFACE)

In the ENCODER/FREQUENCY INPUTS MENU, set **C189** to 0 (A and B Unused) if a single-turn encoder is used. If a multi-turn encoder is used, set **C189** to 1 (A Feedback, B Unused).
In the EXPANSION BOARD CONFIGURATION MENU, set parameter **R023a** to 2, 3, 4 (EnDat, BiSS, HIPERFACE) and set **R023b** to 0. Set the other parameters relating to the type of encoder being used. Reset the board every time R0xx parameters are changed.

D) SinCos encoder

3-channel SinCos encoder:
In the EXPANSION BOARD CONFIGURATION MENU, set parameter **R023b** to 3 and parameter **R023a** to 0. Reset the board. Access the ENCODER/FREQUENCY INPUTS MENU; in **C189**, set the source of the encoder signal used as the speed feedback in Encoder B (e.g. 3: A Unused, B Feedback). In **C191**, set the number of pulses per revolution. For more details, refer to the relevant section in the Motor Drives Accessories – User Manual.

Five-channel SinCos encoder:
In the EXPANSION BOARD CONFIGURATION MENU, set parameter **R023b** to 0 and parameter **R023a** to 5. In **R097**, set the number of sinusoids per revolution
(e.g. 3: A Unused, B Feedback). In **C191**, set the number of pulses per revolution.
Reset the board.

E) Resolver

In the EXPANSION BOARD CONFIGURATION MENU, set parameter **R023a** to 1 (Resolver). Reset the board.
Access the ENCODER/FREQUENCY INPUTS MENU, properly set parameter **C201** (Excitation Frequency), **C202** and **C203** (Excitation Signal Amplitude Adjustment). An indicative value for both **C202** and **C203** may be "75", but optimum values are found by connecting the drive to the Remote Drive application. Access the ENCODER/FREQUENCY INPUTS MENU and monitor the status of the two LEDs of measure **M100**-Resolver Signal Status. When the optimum value is set for **C202** and **C203**, the two LEDS turn green, otherwise they turn red.

6) Motor parameters:

See the SINUS PENTA – Programming Guide for the description of the following parameters.
Access the MOTOR CONTROL MENU and set **C010** (Control Algorithm) as 2: SYN (Synchronous Motor with a Sensor).
Parameter **C012** (Type of Speed Feedback from Encoder) will automatically be set to Yes.

Set the motor ratings as follows:
- **C015** (fmot1) rated motor frequency, computed as follows:
  fmot1 = **rpmnom**/60 * **p**, where:
  rpmnom is the rated motor speed in rpm
  p is the number of pole pairs of the motor. Example:
  rpmnom = 3000 rpm
  p = 3 pole pairs (6 poles)
  fmot1=3000/60*3=150 Hz
- **C016** (rpmnom1) rated rpm
- **C017** (Pmot1) rated power
- **C018** (Imot1) rated current
- **C019** (Vmot1) rated voltage
- **C029** (Speedmax1) desired maximum speed

If it is known, also set the following parameter:
- **C015a** (BEMF) (it may also be obtained during autotuning).

7) Autotune of stator resistance, phase inductances, current loop, BEMF:

Open the **ENABLE-A** and **ENABLE-B** inputs, then access the AUTOTUNE MENU and set **I073**= [1: Motor Tune] and **I074** = [3: SYN Autotune]. Press **ESC** to confirm. Close the **ENABLE-A**, **ENABLE-B** and **START** inputs and wait until tune is complete (Warning "**W32** Open Enable" is displayed). The drive has computed and saved the values for: **C015a, C022**, **C022a**, **C022z, P174b1, P174c1, P174g1** and **P174h1**.
If the values of parameters **C015a**, **C022**, **C022a** and **C022z** are known, they may be entered manually. By setting **I074** = [1: SYN Update Current Loop], only parameters **P174b1, P174c1, P174g1** and **P174h1** will be defined.
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 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) Alignment procedure:

<u>This procedure is mandatory in the following cases:</u>
- absolute sensor installed on the motor (resolver or EnDat, BiSS, Hiperface or 5-channel SinCoS encoders):
  - only once at first startup;
  - if alarm **A132** trips;
  - if a mechanical displacement between the motor and the sensor shafts has occurred.
- incremental sensor installed on the motor (incremental or 3-channel SinCos encoders):
  - as in the cases above;
  - every time the drive is powered on or reset.

CAUTION **This procedure will make the motor run. Make sure that the motor can rotate freely (no mechanical constraints or heavy loads).**

Access the AUTOTUNE MENU. Set **I027**=1: Encoder Align.
Close the **ENABLE-A**, **ENABLE-B** and **START** inputs.
Wait for "**W32** Open Enable"; open the **ENABLE-A**, **ENABLE-B** and **START** inputs.

NOTE Digital signal **D67** indicates when the motor is correctly aligned. See Table 2 in the DIGITAL OUTPUTS MENU.

9) Speed loop autotune:

This procedure is optional. It enables calculating the speed loop gains; before performing the speed loop autotune, set up parameters **C022b** and **C022c** (Load Inertia, MOTOR CONTROL MENU) – these parameters are expressed in kgm^2. Parameters **P126** and **P128** may also be entered while performing a manual tune procedure.

Open the **ENABLE-A**, **ENABLE-B** inputs, then access the AUTOTUNE MENU and set **I073**= [1: Motor Tune] and **I074**= [2: SYN Update Speed Loop]. Press **ESC** to confirm. Close the **ENABLE-A** and **ENABLE-B** inputs and wait until tune is complete (Warning "**W32** Open Enable" is displayed). The drive has calculated and saved the values of **P126, P128**.

NOTE Later on, it could be necessary to manually change parameters **P126**, **P128** above to optimize the dynamic response of the motor.

10) BEMF autotune:

If the value of the motor BEMF is known, set it in parameter **C015a** – this parameter is expressed in V/kRPM.

If the value found with **I074** = [3: SYN Autotune] (step 7) is not satisfactory, it may be tuned automatically.

CAUTION **This procedure will make the motor run. Make sure that the motor can rotate freely (no mechanical constraints or heavy loads).**

Open the **ENABLE-A** and **ENABLE-B** inputs, then access the AUTOTUNE MENU and set **I073**= [1: Motor Tune] and **I074** = [4: SYN BEMF Tune]. Press **ESC** to confirm. Close the **ENABLE-A**, **ENABLE-B** and **START** inputs and wait for **W32** "Open Enable". The drive has calculated and saved the values of **C015a**.

11) Startup:

Activate the **ENABLE-A, ENABLE-B** inputs (terminals 15 and 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 rotating.

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 15 minutes, swap two of the motor phases.

12) Speed regulator adjustment:

If overshoot occurs when the speed setpoint is attained or if system instability is detected (the motor does not run smoothly), adjust the parameters relating to the speed loop (SPEED LOOP AND CURRENT BALANCING MENU). Set parameter **P126** (integral time**)** as [Disabled] and set a low value for the proportional gain **(P128**). Then increase **P128** until overshoot takes place when the setpoint is achieved. Decrease **P128** by approx. 30%, then decrease the high values set for integral time in **P126** until an acceptable setpoint response is obtained. Check to see if the motor runs smoothly at constant speed.

7. SINUS PENTA PARAMETERS FOR SYNCHRONOUS MOTOR APPLICATION

This section covers only the parameters related to the Synchronous Motor application.
For any other information, please refer to the SINUS PENTA – Programming Guide.

7.1. MEASURES MENU

7.1.1. OVERVIEW

This section covers the specific measures of the Synchronous Motor application.
For any other information, please refer to the SINUS PENTA – Programming Guide.

7.1.2. ENCODER MEASURES MENU

M120 Incremental Encoder A Value

M120	**Range**	0 ÷ 65535	0 ÷ 65535 Note: The actual range of this measure may depend on the type of encoder being used.
	Active	Always active	
	Address	1743	
	Function	This is the count value of encoder A (see ENCODER/FREQUENCY INPUTS MENU).	

M121 Incremental Encoder B Value

M121	**Range**	0 ÷ 65535	0 ÷ 65535 Note: The actual range of this measure may depend on the type of encoder being used.
	Active	Always active	
	Address	1744	
	Function	This is the count value of encoder B (see ENCODER/FREQUENCY INPUTS MENU).	

M122 Absolute Encoder Value

M122	**Range**	0 ÷ 65535	0 ÷ 65535 Note: The actual range of this measure may depend on the type of encoder being used.
	Active	Active only if the absolute encoder is enabled via parameter **R023a**.	
	Address	1747	
	Function	This is the count value of absolute encoder (or encoder M) (see ENCODER/FREQUENCY INPUTS MENU).	

M123 Absolute Encoder Value – Single-turn (ST)

M123	**Range**	0 ÷ 65535	0 ÷ 65535 Note: The actual range of this measure may depend on the type of encoder being used.
	Active	Active only if the absolute encoder is enabled via parameter **R023a**.	
	Address	**M123a** (LO - first 16 bits): 3367 **M123b** (HI - second 16 bits): 3368	
	Function	Shows the values of the least significant word (LO – first 16 bits) and the most significant word (HI – second 16 bits) of the single turn measure of the absolute encoder.	

M124 Absolute Encoder Value – Multi-turn (ST)

M124	**Range**	0 ÷ 65535	0 ÷ 65535 Note: The actual range of this measure may depend on the type of encoder being used.
	Active	Active only if the absolute encoder is enabled via parameter **R023a**.	
	Address	**M124a** (LO - first 16 bits): 3369 **M124b** (HI - second 16 bits): 3370	
	Function	Shows the values of the least significant word (LO – first 16 bits) and the most significant word (HI – second 16 bits) of the single turn measure of the absolute encoder.	

M125 Resolver Signal Status

M125	**Range**	Bit-controlled measure	See Table 1
	Active	Active only if the absolute encoder is enabled via parameter **R023a**.	
	Address	3251	
	Function	Quality of the sensor signal. The sensor operation is correct if both signals DOS (degradation of signal) and LOT (loss of tracking) are OK (KO if the signals are poor quality).	

Table 1: Coding of M125

Bit n.	Description	Notes
0	Degradation of Signal (DOS)	0 = OK 1 = KO
1	Loss of Tracking (LOT)	

M126 Shaft Absolute Position

M126	**Range**	–3.1416 ÷ 3.1416	–3.1416 ÷ 3.1416 rad
	Active	Active for the SYN control	
	Address	2619 (float)	
	Function	This is the absolute position of one turn of the rotor, adopted for the control of the synchronous motor. The measure is expressed in radiants.	

M127 Motor Aligned

M127	**Range**	0 ÷ 1	0: No 1: Yes
	Active	Active for the SYN control	
	Address	224	
	Function	Status of the “motor aligned” flag. If the value is 0, alarm **A132** (Motor not aligned) will trip when the **ENABLE-A** and **ENABLE-B** inputs close. The system sets the flag to 1 when the alignment procedure is complete.	

M128 Phases Swapped

M128	**Range**	0 ÷ 1	0: No 1: Yes
	Active	Active for the SYN control	
	Address	225	
	Function	Status of the “phases swapped” flag. When the alignment procedure is complete (see section FIRST STARTUP PROCEDURE (SYNCHRONOUS MOTOR)), the flag is set to 1:Yes if the phases are swapped so that the direction of rotation of the motor and the encoder is the same.	

M129 Alignment Value

M129	**Range**	–3.1416 ÷ 3.1416	–3.1416 ÷ 3.1416 rad
	Active	Active for the SYN control	
	Address	2031 (float)	
	Function	This is the offset value between the rotor and the encoder detected during the alignment stage. The measure is expressed in radiants.	

7.1.3. STATUS LIST

The Status List is the same as the standard Sinus Penta’s (see the Status List table in the SINUS PENTA – Programming Guide), except for the following:

- 36: SYN ALIGNING: alignment in progress
- 37: SYN RUN OK
- 38: DRIVE ENABLED (replaces status 18: MOTOR FLUXED)
- 39: DRIVE OK (replaces status 16: INVERTER OK)

7.2. SPEED LOOP AND CURRENT BALANCING MENU

Please refer to the SINUS PENTA – Programming Guide. What is related to the VTC and FOC controls in the Programming Guide also applies to the SYN Sensorless and SYN controls.

7.3. SYN REGULATORS MENU

7.3.1. OVERVIEW

NOTE This menu may be accessed only if one of the two motors is set up as SYN Sensorless or SYN (**C010**=1 or 2 for motor n.1, **C053**=1 or 2 for motor n.2, **C096**=1 or 2 for motor n.3).

This menu includes the parameters for PI current regulators and the command to perform the motor alignment procedure, which is required if the motor is not provided with an absolute transducer.

7.3.2. LIST OF PARAMETERS P174B1 TO P174H3

Table 2: List of Parameters P174b1 to P174h3

Parameter		FUNCTION	User Level	DEFAULT VALUE	MODBUS Address
P174b1	**M1**	Proportional Constant of Current Regulator D-axis	ENGINEERING	3.00	761
P174b2	**M2**				772
P174b3	**M3**				1252
P174c1	**M1**	Integral Time of Current Regulator D-axis	ENGINEERING	2.0 ms	762
P174c2	**M2**				773
P174c3	**M3**				1253
P174g1	**M1**	Proportional Constant of Current Regulator Q-axis	ENGINEERING	3.00	1214
P174g2	**M2**				723
P174g3	**M3**				724
P174h1	**M1**	Integral Time of Current Regulator Q-axis	ENGINEERING	2.0 ms	733
P174h2	**M2**				734
P174h3	**M3**				722
P174d1	**M1**	Field Weakening Enable	ENGINEERING	0	1217
P174d2	**M2**				1220
P174d3	**M3**				1223
P174e1	**M1**	Proportional Constant of Field Weakening Regulator	ENGINEERING	0.1	1215
P174e2	**M2**				1218
P174e3	**M3**				1221
P174f1	**M1**	Integral Time of Field Weakening Regulator	ENGINEERING	2.0 ms	1216
P174f2	**M2**				1219
P174f3	**M3**				1222

P174b1 (P174b2, P74b3) Proportional Constant of Current Regulator D-axis

P174b1 (Mot1) **P174b2 (Mot2)** **P174b3 (Mot3)**	**Range**	0 ÷ 65000	0.00 ÷ 650.00
	Default	300	3.00
	Level	ENGINEERING	
	Address	761, 772, 1252	
	Control	SYN	
	Function	Proportional coefficient **Kp** of **PI** current regulator D-axis for motor n.1 (**P174b2** and **P174b3** are the equivalent parameters for motor 2 and motor 3). The regulator has the typical structure: *error* = *set_point – feedback*; *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 execution time of the regulator (may range from 200 to 400 microseconds based on the carrier frequency).	

NOTE The parameter above is **automatically computed and saved** with the Autotune procedure (see AUTOTUNE MENU).

P174c1 (P174c2, P74c3) Integral Time of Current Regulator D-axis

P174c1 (Mot1) **P174c2 (Mot2)** **P174c3 (Mot3)**	**Range**	1 ÷ 32000	1.0 ÷ 3200.0 [Disabled] ms
	Default	20	2.0 ms
	Level	ENGINEERING	
	Address	762, 773, 1253	
	Control	SYN	
	Function	Integral time **Ti** of **PI** current regulator D-axis for motor n.1 (**P174c2** and **P174c3** are the equivalent parameters for motor 2 and motor 3). The regulator has the typical structure: *error* = *set_point – feedback*; *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 execution time of the regulator (may range from 200 to 400 microseconds based on the carrier frequency).	

NOTE The parameter above is **automatically computed and saved** with the Autotune procedure (see AUTOTUNE MENU).

P174h1 (P174h2, P74h3) Proportional Constant of Current Regulator Q-axis

P174h1 (Mot1) **P174h2 (Mot2)** **P174h3 (Mot3)**	**Range**	0 ÷ 65000	0.00 ÷ 650.00
	Default	300	3.00
	Level	ENGINEERING	
	Address	1214, 723, 724	
	Control	SYN	
	Function	Proportional coefficient **Kp** of **PI** current regulator Q-axis for motor n.1 (**P174h2** and **P174h3** are the equivalent parameters for motor 2 and motor 3). The regulator has the typical structure: *error* = *set_point – feedback*; *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 execution time of the regulator (may range from 200 to 400 microseconds based on the carrier frequency).	

NOTE The parameter above is **automatically computed and saved** with the Autotune procedure (see AUTOTUNE MENU).

P174h1 (P174h2, P74h3) Integral Time of Current Regulator Q-axis

P174h1 (Mot1) **P174h2 (Mot2)** **P174h3 (Mot3)**	**Range**	1 ÷ 32000	1.0 ÷ 3200.0 [Disabled] ms
	Default	20	2.0 ms
	Level	ENGINEERING	
	Address	733, 734, 722	
	Control	SYN	
	Function	Integral time **Ti** of **PI** current regulator Q-axis for motor n.1 (**P174h2** and **P174h3** are the equivalent parameters for motor 2 and motor 3). The regulator has the typical structure: *error* = *set_point – feedback*; *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 execution time of the regulator (may range from 200 to 400 microseconds based on the carrier frequency).	

NOTE The parameter above is **automatically computed and saved** with the Autotune procedure (see AUTOTUNE MENU).

P174d1 (P174d2, P174d3) Field Weakening Enable

P174d1 (Mot1) **P174d2 (Mot2)** **P174d3 (Mot3)**	**Range**	0 ÷ 1	0: No 1: Yes
	Default	0	0: No
	Level	ENGINEERING	
	Address	1217, 1220, 1223	
	Control	SYN	
	Function	The field weakening function allows the motor to reach speeds higher than the rated one at the expense of torque. The weakening threshold is obtained automatically by calculating the minimum between the available DC bus voltage and the rated motor voltage (**C019**, **C062** or **C105**).	

NOTE

The field weakening can be enabled only if **C011b** (**C054b** for motor 2 and **C097b** for motor 3) is disabled.

DANGER

The field weakening allows the motor to work at very high speeds. As these machines are with permanent magnets, high rotations lead to the generation of high voltages. If the inverter stops switching (alarm, emergency, opening enable), overvoltages will be generated that can destroy the inverter. The use of a braking resistor is mandatory if the resulting BEMF reaches dangerous values for the inverter.

P174e1 (P174e2, P174e3) Proportional Constant of Field Weakening Regulator

P174e1 (Mot1) **P174e2 (Mot2)** **P174e3 (Mot3)**	**Range**	0 ÷ 65000	0.00 ÷ 650.00
	Default	300	3.00
	Level	ENGINEERING	
	Address	761, 772, 1252	
	Control	SYN	
	Function	Proportional coefficient **Kp** of field weakening regulator **PI** for motor n.1 (**P174b2** and **P174b3** are the equivalent parameters for motor 2 and motor 3). The regulator has the typical structure: *error* = *set_point – feedback*; *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 execution time of the regulator (may range from 200 to 400 microseconds based on the carrier frequency).	

NOTE

The parameter above is **automatically computed and saved** with the Autotune procedure (see AUTOTUNE MENU).

P174f1 (P174f2, P174f3) Integral Time of Field Weakening Regulator

P174f1 (Mot1) **P174f2 (Mot2)** **P174f3 (Mot3)**	**Range**	1 ÷ 32000	1.0 ÷ 3200.0 [Disabled] ms
	Default	20	2.0 ms
	Level	ENGINEERING	
	Address	762, 773, 1253	
	Control	SYN	
	Function	Integral time **Ti** of field weakening regulator **PI** for motor n.1 (**P174c2** and **P174c3** are the equivalent parameters for motor 2 and motor 3). The regulator has the typical structure: *error* = *set_point – feedback*; *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 execution time of the regulator (may range from 200 to 400 microseconds based on the carrier frequency).	

NOTE The parameter above is **automatically computed and saved** with the Autotune procedure (see AUTOTUNE MENU).

7.4. SYN SENSORLESS MENU

7.4.1. DESCRIPTION

NOTE This menu may be accessed only if the SYN Sensorless control has been set up for one of the two motors (**C010**=1 for motor n.1, **C053**=1 motor n.2, **C096**=1 for motor n.3).

7.4.2. LIST OF PARAMETERS P176A1 TO P176G3

Table 3: List of Parameters P176a1 to P176g3

Parameter		FUNCTION	User Level	DEFAULT VALUE	MODBUS Address
P176a1	**M1**	Observer time constant D-axis for sensorless synchronous motor control	ENGINEERING	20 ms	758
P176a2	**M2**				770
P176a3	**M3**				774
P176g1	**M1**	Observer time constant Q-axis for sensorless synchronous motor control	ENGINEERING	20 ms	709
P176g2	**M2**				918
P176g3	**M3**				919
P176b1	**M1**	PLL time constant for sensorless synchronous motor control	ENGINEERING	200 ms	759
P176b2	**M2**				771
P174b3	**M3**				775
P176c		Filter time constant over speed estimated by observer	ENGINEERING	20 ms	743
P176d		Id current for I/F control	ENGINEERING	100 %Inom	732
P176e		Enable threshold for I/F control	ENGINEERING	15 %Wnom	742
P176f		Gain for Id increment/decrement before or after I/F control	ENGINEERING	2	763

P176a1 (P176a2, P176a3) Observer Time Constant D-axis

P176a1 (Mot1) **P176a2 (Mot2)** **P176a3 (Mot3)**	**Range**	0 ÷ 30000	0 ÷ 3000 ms
	Default	200	20 ms
	Level	ENGINEERING	
	Address	758, 769, 774	
	Control	SYN SENSORLESS	
	Function	Time proportional to the observer estimation time (D-axis currents estimation). It is defined by the autotune procedure to ensure stability of the system. It also depends on **Rs** and **Ld** motor parameters.	

P176g1 (P176g2, P176g3) Observer Time Constant Q-axis

P176g1 (Mot1) **P176g2 (Mot2)** **P176g3 (Mot3)**	**Range**	0 ÷ 30000	0 ÷ 3000 ms
	Default	200	20 ms
	Level	ENGINEERING	
	Address	758, 769, 774	
	Control	SYN SENSORLESS	
	Function	Time proportional to the observer estimation time (Q-axis currents estimation). It is defined by the autotune procedure to ensure stability of the system. It also depends on **Rs** and **Lq** motor parameters.	

P176b1 (P176b2, P176b3) PLL Time Constant

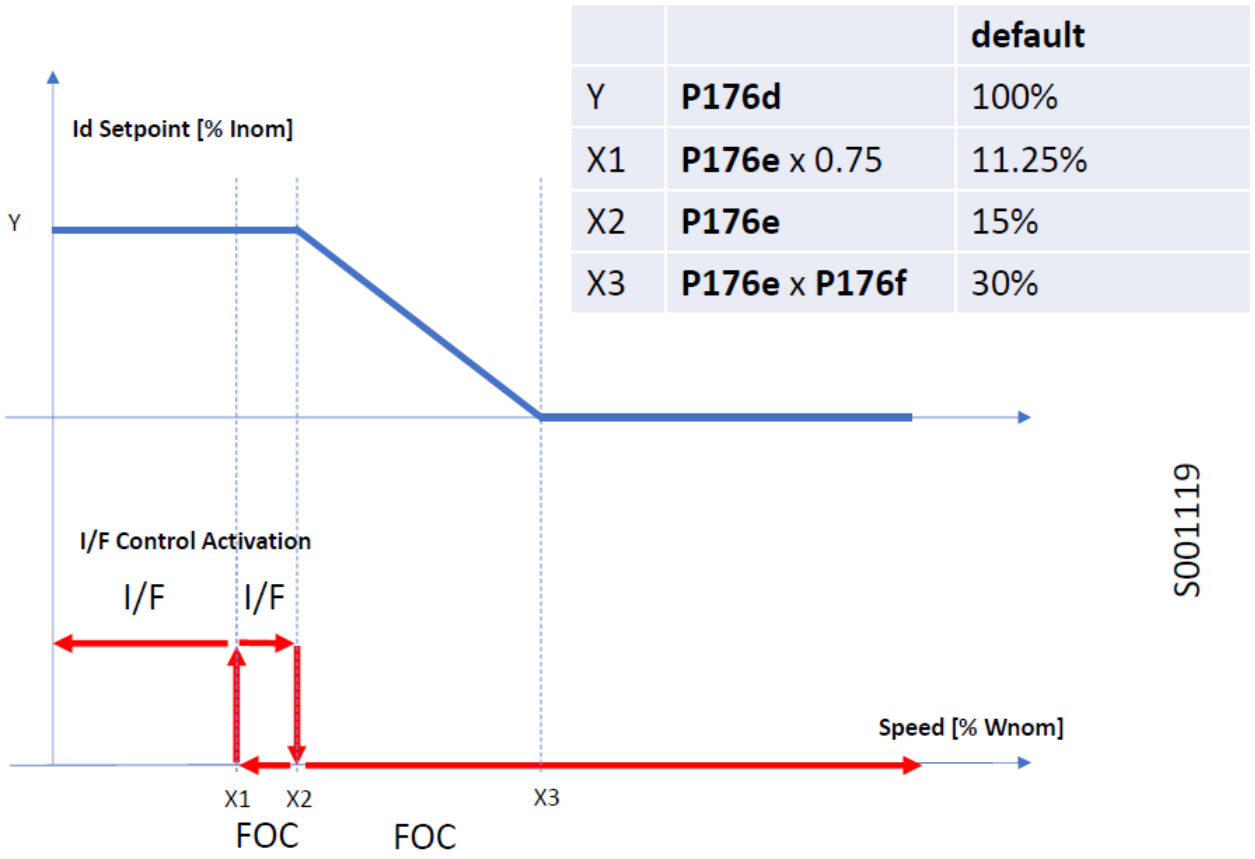
P176b1 (Mot1) **P176b2 (Mot2)** **P176b3 (Mot3)**	**Range**	0 ÷ 30000	0 ÷ 3000 ms
	Default	2000	200 ms
	Level	ENGINEERING	
	Address	759, 770, 775	
	Control	SYN SENSORLESS	
	Function	Time proportional to the PLL estimation time (speed and position estimation). It is defined by the autotune procedure to ensure stability of the system and to make PLL dynamics slower than the observer's dynamics.	

P176c Filter Time Constant over Speed Estimated by Observer

P176c	**Range**	0 ÷ 30000	0 ÷ 3000 ms
	Default	200	20 ms
	Level	ENGINEERING	
	Address	743	
	Function	Filter time constant over the speed estimated by the PLL. It shall be greater than **C195** [Filter time constant over value of feedback from encoder] because the speed dynamics required by the sensorless control is typically slower than the motor control with a sensor.	

P176d Id Current for I/F Control

P176d			
	Range	30 ÷ 200	30 ÷ 200 %Inom
	Default	100	100 %Inom
	Level	ENGINEERING	
	Address	732	
	Function	d-axis current setpoint when the I/F control is enabled. It is expressed as a percentage of the rated current. See Figure 2.	



		default
Y	**P176d**	100%
X1	**P176e** x 0.75	11.25%
X2	**P176e**	15%
X3	**P176e** x **P176f**	30%

Figure 2: I/F Control parameters

NOTE In the figure above, “FOC” stands for Field-Oriented Control for synchronous motors. The entire figure shows the transition of the I/F control applied at start at low speed and the field-oriented control applied once the drive is started.

P176e Enable Threshold for I/F Control

P176e			
	Range	5 ÷ 50	5 ÷ 50 %Wnom
	Default	15	15 %Wnom
	Level	ENGINEERING	
	Address	742	
	Function	Speed at which the I/F control is disabled when speed is increasing. The same parameter multiplied by 0.75 indicates the speed at which the I/F control is enabled when speed is decreasing. It is expressed as a percentage of the rated speed. See Figure 2.	

P176f Gain for Id Increment/Decrement before/after I/F Control

P176f			
	Range	0 ÷ 30000	0 ÷ 3000
	Default	20	2
	Level	ENGINEERING	
	Address	763	
	Function	Factor which, if multiplied by **P176e**, defines the minimum speed for which the d-axis current setpoint is null. See Figure 2.	

7.5. DIGITAL OUTPUTS MENU

This section covers only the selection options different from the ones given in the “Digital Outputs Menu” in the SINUS PENTA – Programming Guide.

Namely, selection option **D67: Mot. Aligned** is available for SYN control only and is related to the status in which the motor has correctly performed the alignment procedure and needs not to perform it again in order to start running. See FIRST STARTUP PROCEDURE (SYNCHRONOUS MOTOR).

Table 4: List of the selectable digital signals and analog variables

Selectable digital signals (BOOLEAN):

Selection option	Description
D67: Mot. Aligned	The motor has correctly performed the alignment procedure
Any other option	The same as detailed in the SINUS PENTA – Programming Guide

Selectable analog variables:

Selection option	Description
Any other option	The same as detailed in the SINUS PENTA – Programming Guide

7.6. AUTOTUNE MENU

7.6.1. OVERVIEW

NOTE See the FIRST STARTUP PROCEDURE (SYNCHRONOUS MOTOR) 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 CONTROL MENU and ENCODER/FREQUENCY INPUTS MENU.

The selected motor may be tuned in order to obtain the equipment ratings or the parameterization required for the correct operation 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** = Motor Tune - describes the type of autotune which is performed.
In addition, the input **I027** necessary to align the encoder to the d-axis of the motor is also available.

Because the values set in **I073**, **I074** and **I027** cannot be permanently changed and are automatically reset after each autotune, the **ENABLE** signal must be disabled and the **ESC** key must be used to accept the new value.

7.6.1. LIST OF INPUTS I073, I074 AND I027 AND PARAMETERS P174A1 TO P174A3

Table 5: List of Inputs I073, I074 and I027 and Parameters P174a1 ÷ P174a3

Parameter/ Input		FUNCTION	User Level	DEFAULT VALUE	MODBUS Address
I073		Autotune Enable	BASIC	–	1460
I074		Type of Motor Tuning	BASIC	–	1461
I027		SYN Commands	BASIC	–	1414
P174a1	**M1**	Maximum Time for Encoder Alignment	ENGINEERING	10 s	760
P174a2	**M2**				771
P174a3	**M3**				1251

I027 SYN Controls

I027			
	Range	0 ÷ 1	0: Disable 1: Encoder Align
	Default	This is not a parameter: the input is set to zero whenever the drive is powered on and whenever the command is executed.	
	Level	BASIC	
	Address	1414	
	Function	Selects the command for the synchronous motor: [1: Encoder Align] → The motor alignment procedure is required. The rotor is run in order to detect the offset angle between the encoder and the motor phases. This procedure is mandatory in the following cases: - absolute sensor installed on the motor (resolver or EnDat, BiSS, Hiperface or 5-channel SinCoS encoders): - only once at first startup; - if alarm **A132** trips; - if a mechanical displacement between the motor and the sensor shafts has occurred. - incremental sensor installed on the motor (incremental or 3-channel SinCos encoders): - as in the cases above; - every time the drive is powered on or reset. After setting **I027** to 1, close the **ENABLE-A**, **ENABLE-B** and **START** inputs to start the alignment procedure. Wait for **W32** "Open Enable", then open the **ENABLE-A**, **ENABLE-B** and **START** inputs. The offset angle is displayed in measure **M129**. Digital signal **D67** indicates when the motor is correctly aligned. See Table 2 in the DIGITAL OUTPUTS MENU.	

CAUTION **The alignment procedure will make the motor run. Make sure that the motor can rotate freely (no mechanical constraints or heavy loads).**

P174a1 (P174a2, P174a3) Maximum Time for Encoder Alignment

P174a1 (Mot1) P174a2 (Mot2) P174a3 (Mot3)			
	Range	1 ÷ 180	1 ÷ 180 s
	Default	10	10 s
	Level	ENGINEERING	
	Address	760, 771, 1251	
	Control	SYN	
	Function	Duration of the alignment procedure for synchronous motors. The alignment algorithm will perform the procedure within the set time. If the alignment procedure time is increased, the rotor will run more slowly, thus reducing acceleration and load stress. The time set in this parameter shall be exceedingly longer than the mechanical motor+load time constant.	

7.6.2. 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. Please refer to the MOTOR CONTROL MENU and ENCODER/FREQUENCY INPUTS MENU.

Table 6: Programmable "Motor Tune" functions

I074 Setting	Motor Rotation	Type of Tune
0: IFD Control Auto no rotation/ All Ctrl no rot	No	**Automatic estimation** of the stator resistance and the leakage inductance, that can be performed only on asynchronous motors controlled via IFD algorithm. If no-load current (**C021**) is zero, no-load current values are computed based on the rated power of the connected motor. This tuning mode is required for the correct operation of the slip compensation, autoboost and speed search functions.
1: SYN Update current loop/ SYN curr no rot	No	**Automatic autotune** of the current loop. Tuning mode required for the correct operation of the SYN Sensorless and SYN algorithms. During autotune, it is possible to monitor the reference current and the reference obtained on analog output AO2 and AO1. In order to perform the procedure, close the ENABLE signal after setting **I074** accordingly. When the procedure is complete, parameters **P174b1**, **P174c1, P174g1, P174h1, P174e1** and **P174f1** (motor 2: **P174b2**, **P174c2, P174g2, P174h2, P174e2** and **P174f2**; motor 3: **P174b3**, **P174c3, P174g3, P174h3**, **P174e3** and **P174f3**) will automatically be updated.
2: SYN Update speed loop/ SYN spd no rot	No	**Automatic autotune** of the speed loop (SYN Sensorless and SYN algorithms). This procedure automatically calculates parameters **P125**, **P126**, **P127**, **P128**, **P129** (motor 2: **P135** to **P139**; motor 3: **P145** to **P149**). Because the result depends on the load inertia, make sure that parameters **C022b** and **C022c** (motor 2: **C065b** and **C065c**; motor 3: **C108b** and **C108c**) are properly set. If those parameters are not known, parameters for speed loop are to be manually set up. Manual adjustment might be required anyway. In order to perform the procedure, close the ENABLE signal after setting **I074**.
3: SYN autotune/ SYN tune no rot	No	**Automatic estimation** of the BEMF, stator resistance and the phase inductances of the synchronous motor (SYN Sensorless and SYN algorithms) + **automatic tune** of the parameters for current loop (this is the same as the one obtained with 1: SYN Update current loop). In order to perform the procedure, close the ENABLE and the START signals after setting **I074** accordingly. When the procedure is complete, parameters **P174b1**, **P174c1, P174g1, P174h1, P174e1, P174f1, C015a, C022, C022a, C022z** (motor 2: **P174b2**, **P174c2, P174g2, P174h2, P174e2**, **P174f2, C058a, C065, C065a, C065z**; motor 3: **P174b3**, **P174c3, P174g3, P174h3, P174e3, P174f3, C101a, C108, C108a, C108z**) will automatically be updated.
4: SYN BEMF tune/ SYN BEMF + rot	Yes	**Automatic tune** exclusively for the **BEMF**. This procedure causes the motor to rotate at high speed and enables estimating parameter **C015a** (**C058a** and **C101a** respectively for motor 2 and motor 3). In order to perform the procedure, close the ENABLE and the START signasl after setting **I074** accordingly.

7.6.3. CHECKING THE ENCODER OPERATION

NOTE

The procedure described below applies only to incremental encoders which are acquired through the **ES836** or **ES913** boards, or which are connected directly to MDI6, MDI7 inputs.
It does not apply to absolute encoders acquired through the following boards: **ES860** (Sin Cos), **ES861** (Resolver), **ES950** (EnDat/BiSS), **ES966** (Hiperface).

Set **I073** as Encoder Tune to check the correct operation of the 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.**
Refer to the MOTOR CONTROL MENU and ENCODER/FREQUENCY INPUTS MENU.

Once **I073** is set as Encoder Tune and the **ENABLE-A** and **ENABLE-B** terminals are 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 real speed of rotation of the motor. Check if 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 optional board **ES836** or **ES913** (see Motor Drives Accessories – User Manual).
If **W31 Encoder OK** appears: the speed feedback from encoder is correct.

In addition, the autotune sets the encoder signal as feedback with parameter **C199**.

7.7. CARRIER FREQUENCY MENU

The parameters in this menu are the same as given in the SINUS PENTA – Programming Guide.

7.7.1. SYN SENSORLESS CONTROL AND SYN CONTROL

The SYN Sensorless control and SYN control use a frequency carrier which is:

- The maximum allowable carrier frequency for the drive size being used if < 8 kHz (see relevant Tables in the SINUS PENTA – Programming Guide);
- The greater of **C002** and 8 kHz if the maximum allowable carrier frequency for the drive size being used is > 8 kHz. In other words: the value set in **C002** is used only if exceeding 8 kHz.

The value set for parameter **C001** does not affect carrier frequency computation.

CAUTION Please refer to SINUS PENTA – Installation Guide to check current derating when applying carrier frequency as mentioned above.

7.8. MOTOR CONTROL MENU

This section covers only the parameters related to the Synchronous Motor application.
For any other information, please refer to the SINUS PENTA – Programming Guide.

7.8.1. OVERVIEW

The Sinus Penta with Synchronous Motor application 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**
- ✓ **SYN SENSORLESS**
- ✓ **SYN**

The **IFD (Voltage/Frequency) Motor control** allows controlling an **asynchronous motor** by producing voltage depending on frequency.
The **SYN Sensorless Motor control** allows controlling a **permanent magnet synchronous motor** torque and speed with no sensor.
The **SYN Motor control** allows controlling a **permanent magnet synchronous motor** torque and speed using a sensor.

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 via parameters **C173** and **C174**, Digital Input for Motor 2 Activation and Digital Input for Motor 3 Activation respectively (see also the DIGITAL INPUTS MENU in the SINUS PENTA – Programming Guide).
The parameters included in the Motor Control Menus are detailed in Table 7.

NOTE Different SYN control parameter sets must refer to the same physical motor. Controlling multiple motors with the same drive is not possible.

Table 7: Description of the parameters classified by motor

Parameter Contents	Motor Control 1	Motor Control 2	Motor Control 3
• Rated Mains Voltage	**C008**	————————	————————
• Number of configured motors	**C009**	————————	————————
• Control algorithm being used	**C010**	**C053**	**C096**
• Type of reference being used (speed / torque) (SYN control only)	**C011 / C011c**	**C054 / C054c**	**C097 / C097c**
• Compensations (SYN control only)	**C011a / C011b**	**C054a / C054b**	**C097a / C097b**
• Presence of the speed feedback from encoder/resolver (SYN with sensor control only)	**C012**	**C055**	**C098**
• Phase rotation	**C014**	**C057**	**C100**
• Electric ratings of the connected motor	**C015 ÷ C024**	**C058 ÷ C067**	**C101 ÷ C110**
• Load characteristics (SYN control only)	**C022b ÷ C022d**	**C065b ÷ C065d**	**C108b ÷ C108d**
• Minimum and maximum speed, overspeed alarm enable and threshold	**C028 ÷ C031**	**C071 ÷ C074**	**C114 ÷ C117**
• V/f pattern parameters (IFD control only)	**C013 / C032 ÷ C038**	**C056 / C075 ÷ C081**	**C099 / C118 ÷ C124**
• Slip compensation activation (IFD control only)	**C039**	**C082**	**C125**
• Voltage drop at rated current	**C040**	**C083**	**C126**
• Output Voltage saturation	**C042**	**C085**	**C128**

The parameters that can be modified depend on the type of control that has been selected.

7.8.2. TORQUE CONTROL (SYN ONLY)

The SYN algorithm enables 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** (see the LIMITS MENU in the SINUS PENTA – Programming Guide) for motor 1 (minimum and maximum torque expressed as a percentage of the rated motor torque). For motors 2 and 3, the parameters relating to the minimum and maximum torque (**C090**, **C091** and **C133**, **C134**) are included in the Limits Menu 2 and Limits Menu 3.

When using a Sinus Penta drive model “0020” connected to a 15kW motor, **C048** is factory-set to 120% of the rated motor torque. If the max. reference is applied (**C143** = REF), the torque reference will be 120%.

If a 7.5kW motor is connected, **C048** may exceed 200%; torque values exceeding 200% may be obtained based on the value set in **C048**.

The rated motor torque results from the following formula:

$$C = P/\omega$$

where P is the rated power expressed in W and ω is the rated speed of rotation expressed in radiants/sec.

Example: the rated torque of a 15kW motor at 1420rpm is equal to:

$$C = \frac{15000}{1420 \cdot 2\pi/60} = 100.9 \text{ Nm}$$

The starting torque is:
rated torque * 120% = 121.1 Nm

7.8.3. LIST OF PARAMETERS C008 TO C128

All the parameters in the menu are listed below, but only the parameters applicable to the SYN control are described in detail. Please refer to the SINUS PENTA – Programming Guide for the description of the remaining parameters, which are show in grey in the table below.

Table 8: 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	1: SYN Sensorless
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	
C011a	M1	Forward Actions over Torque Control	ADVANCED	634	0: No
C054a	M2		ENGINEERING	636	
C097a	M3			638	
C011b	M1	BEMF Compensation	ADVANCED	635	0: No
C054b	M2		ENGINEERING	637	
C097b	M3			639	
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 pattern	BASIC	1013	Depending on the model. See tables in the SINUS PENTA – Programming Guide.
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	
C015a	M1	BEMF constant	ENGINEERING	753	0.1 V/kRPM
C058a	M2			764	
C101a	M3			1236	
C016	M1	Motor rpm	BASIC	1016	1500 rpm
C059	M2		ENGINEERING	1059	
C102	M3			1102	
C017	M1	Rated motor power	BASIC	1017	Depending on the model. See tables in the SINUS PENTA – Programming Guide.
C060	M2		ENGINEERING	1060	
C103	M3			1103	

Parameter		FUNCTION	User Level	Modbus Address	Parameter
C018	M1	Rated motor current	BASIC	1018	Depending on the model. See tables in the SINUS PENTA – Programming Guide.
C061	M2		ENGINEERING	1061	
C104	M3			1104	
C019	M1	Rated motor voltage	BASIC	1019	Depends on the inverter voltage class
C062	M2		ENGINEERING	1062	
C105	M3			1105	
C020	M1	No-load motor power	ADVANCED	1020	0.0%
C063	M2		ENGINEERING	1063	
C106	M3			1106	
C021	M1	No-load motor power	ADVANCED	1021	0%
C064	M2		ENGINEERING	1064	
C107	M3			1107	
C022	**M1**	Motor stator resistance	ENGINEERING	1022	Depending on the model. See tables in the SINUS PENTA – Programming Guide.
C065	**M2**			1065	
C108	**M3**			1108	
C022a	**M1**	Phase inductance D-axis	ENGINEERING	754	10.00 mH
C065a	**M2**			765	
C108a	**M3**			1237	
C022z	**M1**	Phase inductance Q-axis	ENGINEERING	1213	10.00 mH
C065z	**M2**			1224	
C108z	**M3**			1233	
C022b	**M1**	Load inertia	ENGINEERING	755	0.000 kgm^2
C065b	**M2**			766	
C108b	**M3**			1238	
C022c	**M1**	Rotor inertia	ENGINEERING	756	1 kgm^2
C065c	**M2**			767	
C108c	**M3**			1239	
C022d	**M1**	Viscous friction coefficient	ENGINEERING	757	0.00 mNm/(rad/s)
C065d	**M2**			768	
C108d	**M3**			1240	
C023	M1	Leakage inductance	ENGINEERING	1023	Depending on the model. See tables in the SINUS PENTA – Programming Guide.
C066	M2			1066	
C109	M3			1109	
C024	M1	Mutual inductance	ADVANCED	1024	250.00mH
C067	M2		ENGINEERING	1067	
C110	M3			1110	
C026	M1	Time constant of bus voltage low-pass filter	ENGINEERING	1026	0 ms
C069	M2			1069	
C112	M3			1112	
C028	M1	Minimum motor speed	BASIC	1028	0 rpm
C071	M2		ENGINEERING	1071	
C114	M3			1114	
C029	M1	Maximum motor speed	BASIC	1029	1500 rpm
C072	M2		ENGINEERING	1072	
C115	M3			1115	
C031	M1	Maximum speed alarm	ADVANCED	1031	0: Disabled
C074	M2		ENGINEERING	1074	
C117	M3			1117	

Parameter		FUNCTION	User Level	Modbus Address	Parameter
C032	M1	Quadratic torque curve decrease	ADVANCED	1032	30%
C075	M2		ENGINEERING	1075	
C118	M3			1118	
C033	M1	Rated revolutions referring to quadratic torque curve decrease	ADVANCED	1033	20%
C076	M2		ENGINEERING	1076	
C119	M3			1119	
C034	M1	Voltage preboost for IFD	BASIC	1034	Depending on the model. See tables in the SINUS PENTA – Programming Guide.
C077	M2		ENGINEERING	1077	
C120	M3			1120	
C035	M1	Voltage Boost 0 at programmable frequency	ADVANCED	1035	Depending on the model. See tables in the SINUS PENTA – Programming Guide.
C078	M2		ENGINEERING	1078	
C121	M3			1121	
C035a	M1	Frequency for application of Boost 0	ADVANCED	1052	5%
C078a	M2		ENGINEERING	1070	
C121a	M3			1113	
C036	M1	Voltage Boost 1 at programmable frequency	ADVANCED	1036	See tables in the SINUS PENTA – Programming Guide Depending on the model.
C079	M2		ENGINEERING	1079	
C122	M3			1122	
C037	M1	Frequency for application of Boost 1	ADVANCED	1037	Depending on the model. See tables in the SINUS PENTA – Programming Guide.
C080	M2		ENGINEERING	1080	
C123	M3			1123	
C038	M1	Autoboost	ADVANCED	1038	Depending on the model. See tables in the SINUS PENTA – Programming Guide.
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	
C042	M1	Vout saturation percentage	ENGINEERING	1042	100%
C085	M2			1085	
C128	M3			1128	

C010 (C053, C096) Type of Control Algorithm

C010 (mot. n.1) **C053 (mot. n.2)** **C096 (mot. n.3)**	**Range**	0 ÷ 1	0: IFD 1: SYN Sensorless 2: SYN
	Default	0	1: SYN Sensorless
	Level	BASIC	
	Address	1010, 1053, 1096	
	Function	This parameter sets the type of control algorithm to be used. Types of control: 0: IFD - V/f control for asynchronous motor 1: SYN Sensorless - Sensorless Synchronous Motor control 2: SYN - Synchronous motor control with a sensor **The V/f control** allows controlling the asynchronous motor by producing voltage depending on frequency. It is possible to configure several types of V/f patterns (see V/f pattern parameters in the SINUS PENTA – Programming Guide). **The synchronous motor controls** (SYN Sensorless and SYN) enable speed control and torque control of a permanent magnet synchronous motor (PMSM).	

C011a (C054a, C097a) Enable Forward Actions over Torque Control

C011a (mot. n.1) **C054a (mot. n.2)** **C097a (mot. n.3)**	**Range**	0 ÷ 1	0: No 1: Yes
	Default	0	0: No
	Level	ADVANCED (**C011a**); ENGINEERING (**C054a**, **C097a**)	
	Address	634, 636, 638	
	Control	SYN	
	Function	If the speed control is active (**C011**=0), this parameter enables forward actions over torque regulation during acceleration/deceleration. The forward action depends on the load set in **C022b** and **C022c**. It is advisable to set parameter **C011a (C054a, C097a)** to 1 only if parameters **C022b** and **C022c** are set to correct values.	

C011b (C054b, C097b) BEMF Compensation

C011b (mot. n.1) **C054b (mot. n.2)** **C097b (mot. n.3)**	**Range**	0 ÷ 1	0: No 1: Yes
	Default	0	0: No
	Level	ADVANCED (**C011b**); ENGINEERING (**C054b**, **C097b1**)	
	Address	635, 637 639	
	Control	SYN	
	Function	If the speed control is active (**C011**=0), this parameter indicates if the back electromotive force (BEMF) is compensated in the current loop starting from the speed reference. This parameter is ignored in torque control mode. If the motor BEMF is known (parameter **C015a**), it is advisable to keep the relevant parameter set to Yes; otherwise, BEMF compensation may be kept disabled, but this will slightly affect the system performance.	

NOTE The BEMF Compensation can be enabled only if **P174d1** (**P174d2** for motor 2 and **P174d3** for motor 3) is disabled.

C015a (C058a, C101a) Back Electromotive Force (BEMF) Constant

C015a (mot. n.1) **C058a (mot. n.2)** **C101a (mot. n.3)**	**Range**	1 ÷ 65000	0.1 ÷ 6500.0 V/kRPM
	Default	1	0.1 V/kRPM
	Level	ENGINEERING	
	Address	753, 764, 1236	
	Control	SYN	
	Function	BEMF of the synchronous motor, expressed in Volt/1000 rpm. This parameter may automatically be updated by the relevant tuning command: **I074** = [3: SYN Autotune] or **I074** = [4: SYN BEMF Tune].	

C022 (C065, C108) Motor Stator Resistance

C022 (mot. n.1) **C065 (mot. n.2)** **C108 (mot. n.3)**	**Range**	0 ÷ 32000	0.000 ÷ 32.000 Ω
	Default	See relevant tables in the SINUS PENTA – Programming Guide.	
	Level	ENGINEERING	
	Address	1022, 1065, 1108	
	Function	This parameter defines stator resistance **Rs**. If a star connection is used, it matches with the phase resistance (half the resistance measured between two terminals); if a delta connection is used, it matches with 1/3 of the phase resistance. This parameter may automatically be updated by the relevant tuning command: SYN Control: **I074** = [3: SYN Autotune] IFD Control: **I074** = [0: IFD Control Auto no Rot].	

C022a (C065a, C108a) Phase Inductance D-axis (Synchronous Motor)

C022a (mot. n.1) **C065a (mot. n.2)** **C108a (mot. n.3)**	**Range**	0 ÷ 65000	0.00 ÷ 650.00 mH
	Default	1000	10.00 mH
	Level	ENGINEERING	
	Address	754, 765, 1237	
	Control	SYN	
	Function	Single-phase inductance D-axis (**Ld**) of the synchronous motor. This parameter may automatically be updated by the relevant tuning command: **I074** = [3: SYN Autotune].	

C022z (C065z, C108z) Phase Inductance Q-axis (Synchronous Motor)

C022z (mot. n.1) **C065z (mot. n.2)** **C108z (mot. n.3)**	**Range**	0 ÷ 65000	0.00 ÷ 650.00 mH
	Default	1000	10.00 mH
	Level	ENGINEERING	
	Address	1213, 1224, 1233	
	Control	SYN	
	Function	Single-phase inductance Q-axis (**Lq**) of the synchronous motor. This parameter may automatically be updated by the relevant tuning command: **I074** = [3: SYN Autotune].	

C022b (C065b, C108b) Load Inertia (Synchronous Motor)

C022b (mot. n.1) **C065b (mot. n.2)** **C108b (mot. n.3)**	**Range**	0 ÷ 65000	0 ÷ 65000 kgm^2
	Default	0	0 kgm^2
	Level	ENGINEERING	
	Address	755, 766, 1238	
	Control	SYN	
	Function	Moment of inertia of the load. If summed to the value in parameter **C022c** (**C065c**, **C108c**), the value in this parameter determines the total moment of inertia of the system. In order for the tuning procedure of the speed loop gains selected by **I074 = 2: SYN update speed loop** to be performed correctly, the total moment of inertia shall be as close as possible to the actual value. The value of this parameter determines the forward action enabled by **C011a**.	

C022c (C065c, C108c) Rotor Inertia (Synchronous Motor)

C022c (mot. n.1) **C065c (mot. n.2)** **C108c (mot. n.3)**	**Range**	1 ÷ 65000	0.001 ÷ 65.000 kgm^2
	Default	1000	1.000 kgm^2
	Level	ENGINEERING	
	Address	756, 767, 1239	
	Control	SYN	
	Function	Moment of inertia of the rotor. If summed to the value in parameter **C022b** (**C065b**, **C108b**), the value in this parameter determines the total moment of inertia of the system. In order for the tuning procedure of the speed loop gains selected by **I074 = 2: SYN update speed loop** to be performed correctly, the total moment of inertia shall be as close as possible to the actual value. The value of this parameter determines the forward action enabled by **C011a**.	

CAUTION **Parameters C022b (C065b, C108b) and C022c (C065c, C108c) are expressed in the same unit of measurement [kgm^2]. The drive will sum up these two values to calculate the total moment of inertia. If the moment of inertia of the rotor exceeds 65 kgm^2, you may enter the resulting value in C022b in addition to the load value.**

C022d (C065d, C108d) Viscous Friction Coefficient (Synchronous Motor)

C022d (mot. n.1) **C065d (mot. n.2)** **C108d (mot. n.3)**	**Range**	0 ÷ 65000	0.00 ÷ 650.00 mNm/(rad/s)
	Default	0	0.00 mNm/(rad/s)
	Level	ENGINEERING	
	Address	757, 768, 1240	
	Control	SYN	
	Function	Sets the viscous friction coefficient. The entered value is helpful for calculating the gain of the speed loop made by tuning procedure **I074** = [2: SYN Update Speed Loop].	

7.9. SPEED SEARCH MENU

This section covers only the missing parameters with respect to the “Speed Search Menu” described in the SINUS PENTA – Programming Guide.

CAUTION This menu is visible only when the SYN Sensorless control is enabled (**C010**=1 for motor n.1, **C053**=1 for motor n.2, **C096**=1 for motor n.3).

7.9.1. MISSING PARAMETERS WITH RESPECT TO THE STANDARD SINUS PENTA CONTROL

Table 9: List of the missing parameters with respect to the Speed Search Menu

Parameter	FUNCTION
C247	Run limit delay for speed search
C248	Speed search time as dec. ramp %
C249	Current used for speed search

7.10. DIGITAL INPUTS MENU

This section covers only the added or missing parameters with respect to the "Digital Inputs Menu" in the SINUS PENTA – Programming Guide.

7.10.1. ADDED PARAMETERS WITH RESPECT TO THE STANDARD SINUS PENTA CONTROL

C188d MDI for SYN Alignment Request

C188d	**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	1149	
	Function	Request for performing the synchronous motor alignment procedure. Do the following: enable the input specified by the parameter, then close the **ENABLE-A**, **ENABLE-B** and **START** inputs.	

CAUTION **The alignment procedure will make the motor run. Make sure that the motor can rotate freely (no mechanical constraints or heavy loads).**

7.10.2. MISSING PARAMETERS WITH RESPECT TO THE STANDARD SINUS PENTA CONTROL

Table 10: List of the missing parameters with respect to the Digital Inputs Menu

Parameter	FUNCTION
C160	MDI for DC braking
C169a	MDI for speed controller parameter selection
C179a	MDI for Commands selection
C179b	MDI for References selection
C183	Maximum fluxing time before disable
C184	Fluxing at start with START closed only
C184a	Disable external torque limit when fluxing
C187a	MDI for multi-torque 0 selection
C187b	MDI for multi-torque 1 selection

7.11. ENCODER/FREQUENCY INPUTS MENU

7.11.1. 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. In addition, if optional board **ES836** or **ES913** is used (see Motor Drives Accessories – User Manual), an additional encoder reading (encoder B) is allowed.
Optional boards **ES860** (3-channel or 5-channel SinCos encoder), **ES861** (resolver), **ES950** (EnDat encoder or BiSS absolute encoders), **ES966** (HIPERFACE absolute encoder) make it possible to interface with that type of transducers for motor control purposes.

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**.

7.11.2. WHEN THE OPTIONAL BOARD IS NOT USED

- **Incremental Encoder reading**:

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 Motor Drives Accessories – User Manual).
No function can be programmed for **MDI6** and **MDI7**; when trying to program **MDI6** and **MDI7,** alarm **A082** Illegal Encoder Configuration will trip when **ENABLE** closes.

- **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 **ENABLE** closes.
If **MDI8** is programmed as a frequency input (**FINB**) with **C189**, no other function can be allocated to MDI8, and **ES836** or **ES913** optional board must not be applied to the power drive, otherwise, alarm **A101** MDI8 Illegal Configuration trips when **ENABLE** closes.

- **Reading a Frequency Input and an 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 optional board **ES836** or **ES913**.

NOTE If an optional board for absolute encoder/resolver is fitted into slot C, digital inputs **MDI6** and **MDI7** may not be used for encoder acquisition.

7.11.3. WHEN USING ES836 OR ES913

• **Reading 1 or 2 Incremental Encoders:**
To read one Encoder, you can use the following:

- optional boards **ES836** or **ES913**; 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).

For 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" in the SINUS PENTA – Programming Guide) to define the minimum speed and the maximum speed read for scaling and saturation of encoder **A** selected as a reference source (in one of parameters **C144** ÷ **C147**, "CONTROL METHOD MENU" in the SINUS PENTA – Programming Guide); 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 **ENABLE** closes.
If encoder B is selected and **ES836** or **ES913** optional board is not detected by the drive, alarm **A082 Illegal Encoder Configuration** will trip when **ENABLE** closes.

• **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 **ENABLE** closes.

• **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** or **ES913** board avoids reading frequency input FINB through MDI8).
If additional functions are programmed for digital input **MDI6**, alarm **A100 MDI**6 **Illegal Configuration** will trip when **ENABLE** closes.
If alarm **A082 Illegal Encoder Configuration** trips, this means that the drive has not detected **ES836** or **ES913** 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 squaring 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).

7.11.4. WITH OPTIONAL BOARDS FOR ABSOLUTE POSITION TRANSDUCERS

7.11.4.1. BOARDS INTO SLOT C

Acquisition boards for absolute encoders may be inserted into slot C. Some of these boards enable interfacing with one incremental line-driver encoder.

Board	Absolute Transducer	Incremental Transducer
ES861	Resolver	Incremental encoder Incr. encoder simulated from resolver
ES950	EnDat Encoder BiSS Encoder	Incremental encoder
ES966	HIPERFACE Encoder 5-channel Sin/Cos Encoder	Incremental encoder 3-channel Sin/Cos encoder

The type of absolute transducer is selected by parameter **R023a** (see EXPANSION BOARD CONFIGURATION MENU). If **R023a** >0, the selected absolute transducer will automatically be used for the motor feedback regardless of the value set in parameter **C189**.

On board ES861, the type of incremental transducer acquired as encoder **A** is selected by parameter **R023b**:

- **R023b**=1: Enc. incr. on Exp. Board – incremental, line-driver encoder
- **R023b**=2: Resolver to Encoder – conversion from resolver to encoder

On the other boards, regardless of **R023b**, the incremental encoder (if any) is encoder **A** and may be programmed by way of parameters **C189** and **C190**. In the event of an encoder simulated from a resolver, the number of pulses will be **1024**, regardless of the value set in **C190**.
If that encoder is set as feedback (**C189=**1, 5, 7, 14):

- If **R023a**=0, encoder A will be used as the motor feedback
- If **R023a**>0, encoder A will be used only as PID feedback (refer to the “PID CONFIGURATION MENU” in the SINUS PENTA – Programming Guide), because the motor feedback is assigned to the absolute transducer selected by **R023a**.

On board ES966, the 3-channel Sin/Cos encoder is acquired as encoder **B** by setting parameter **R023b** to 3: SinCos 3 Ch.
If that encoder is set as feedback (**C189=**3, 6, 8, 13):

- If **R023a**=0, encoder B will be used as the motor feedback
- If **R023a**>0, encoder B will be used only as PID feedback (refer to the “PID CONFIGURATION MENU” in the SINUS PENTA – Programming Guide) because the motor feedback is assigned to the absolute transducer selected by **R023a**.

7.11.4.2. ES860 OPTIONAL BOARD INTO SLOT A

An acquisition board for 3-channel or 5-channel Sin/Cos encoder board (ES860) may be fitted into slot A. The type of encoder is selected:

- by parameter **R023a**=5: SinCos 5 Ch, for 5-channel Sin/Cos encoder (absolute sensor). In that case, the sensor is used as a motor feedback for parameter **C189**
- by parameter **R023b**=3: SinCos 3 Ch, for 3-channel Sin/Cos (incremental sensor). In that case, the sensor is used as the motor feedback only if **R023a**=0 and **C189=3, 6, 8, 13**

7.11.5. LIST OF PARAMETERS C189 TO C203

Table 11: List of Parameters C189 to C203

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C189	Encoder/Frequency input operating mode	BASIC	1189	0 [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 search 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 Squaring channels
C198	Number of channels of Encoder B	ENGINEERING	1198	0:2 Squaring channels
C199	Encoder sign reversal	ENGINEERING	1199	0[Fdbk.NO;Ref.NO]
C201	Resolver excitation frequency	ENGINEERING	1201	1: 10kHz
C202	EXC+ Adjustment	ENGINEERING	1202	75
C203	EXC– Adjustment	ENGINEERING	1203	75

C189 Encoder/Frequency Input Operating Mode

C189			
	Range	0 ÷ 14	See Table 14
	Default	0	0 [Not used; Not used]
	Level	BASIC	
	Address	1189	
	Function	This parameter determines the operating mode of quick acquisition digital inputs or encoders connected to 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 CONTROL MENU or as a reference source of the "PID CONFIGURATION MENU" in the SINUS PENTA – Programming Guide) and the encoder to be used as a speed feedback. Configuration allowed for quick acquisition digital inputs is given in Table 14. The matching between the different physical encoders and logic encoders **A** and **B** is given in Table 12 and Table 13. If the encoder is used as a reference source, the detected speed value will be saturated and scaled based on the 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).**	

NOTE

If parameter **R023a** is >0, the transducer selected by that parameter will be used as the motor feedback, regardless of the value in **C189**.
In that case, encoder A or B selected as the feedback encoder in parameter **C189** will act as the PID feedback only (see the "PID CONFIGURATION MENU" in the SINUS PENTA – Programming Guide).

NOTE

If a board acquiring absolute transducer is fitted, such as **ES861**, **ES950**, **ES966**, inputs **MDI6** and **MDI7** cannot be used as push-pull encoder inputs. Consequently, encoder A will be the incremental encoder connected to the acquisition board.

Table 12: Matching between physical encoders and logic encoder A

R023b	Encoder A
1	Incremental encoder on optional board **ES861**
2	Simulated encoder from resolver on optional board **ES861**
any	• Incremental encoder on optional boards **ES950**, **ES966** • Incremental encoder on optional boards **MDI6/MDI7** if no board is fitted into slot C

Table 13: Matching between physical encoders and logic encoder B

R023b	Encoder B
3	3 Ch Sin/Cos encoder on optional board **ES860** or **ES966**
any	• Incremental encoder on optional board ES836/ES913 • Frequency input **MDI8** if no optional board is fitted into slot A

Table 14: Coding of 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 pulses/rev
	Default	1024	1024 pulses/rev
	Level	BASIC	
	Address	1190	
	Function	Defines the number of pulses per revolution of encoder A (see Table 12).	

C191 Number of Pls/Rev for Encoder B

C191			
	Range	256 ÷ 10000	256 ÷ 10000 pulses/rev
	Default	1024	1024 pulses/rev
	Level	BASIC	
	Address	1191	
	Function	Defines the number of pulses per revolution of encoder B (see Table 13).	

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, the time set in **C192** and the error threshold set in **C193** are used to signal a speed search 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 and the speed error exceeds the speed threshold (**C193**), this parameter determines the error threshold for the speed error timeout. Even if the alarm speed is disabled, the time set in **C192** and the error threshold set in **C193** are used to signal a speed search error to digital outputs set with BRAKE or LIFT mode. Digital outputs are then disabled.	

C194 Speed Error Enable

C194			
	Range	0 ÷ 1	0: Disabled 1: Enabled
	Default	1	1: Enabled
	Level	ENGINEERING	
	Address	1194	
	Function	This parameter enables the speed error alarm.	

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 Squaring Channels 1: Channel only
	Default	0	0: 2 Squaring Channels
	Level	ENGINEERING	
	Address	1197	
	Function	This parameter defines the number of channels used for encoder A reading. Factory-setting is 2 Squaring 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 Squaring channels 1: Channel only
	Default	0	0: 2 Squaring 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

C199	Range	0 ÷ 3	See Table 15
	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.

NOTE If a sign reversal of the encoder feedback is selected (**C199**=1 or 3), this will only affect the encoder set as feedback through **C189**, and will not affect the absolute encoder on optional board defined by **R023a**.

Table 15: Coding of 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

C201 Resolver Excitation Frequency

C201	Range	0 ÷ 4	1: 10kHz 2: 12kHz 3: 15kHz 4: 20kHz
	Default	1	1: 10kHz
	Level	ENGINEERING	
	Address	1201	
	Function	This parameter is active if the resolver is selected as a position sensor (**R023a=1**). Sets the value of the excitation frequency based on the sensor ratings.	

C202 EXC+ Adjustment

C202	Range	0 ÷ 255	0 ÷ 255
	Default	75	75
	Level	ENGINEERING	
	Address	1202	
	Function	Active if the resolver is selected as a sensor (**R023a=1**). Tuning value (+) of the digital potentiometer for the excitation signals of the resolver. Defines the amplitude of excitation signals EXC+ and EXC- according to the table in Figure 2. Parameters **C202** and **C203** shall be set to the same value. Tuning is manually performed. Helpful feedback is represented by measure **M125**.	

C203 EXC– Adjustment

C202	Range	0 ÷ 255	0 ÷ 255
	Default	75	75
	Level	ENGINEERING	
	Address	1203	
	Function	Active if the resolver is selected as a sensor (**R023a=1**). Tuning value (-) of the digital potentiometer for the excitation signals of the resolver. Defines the amplitude of excitation signals EXC+ and EXC- according to the table in Figure 3. Parameters **C202** and **C203** shall be set to the same value. Tuning is manually performed. Helpful feedback is represented by measure **M125**.	

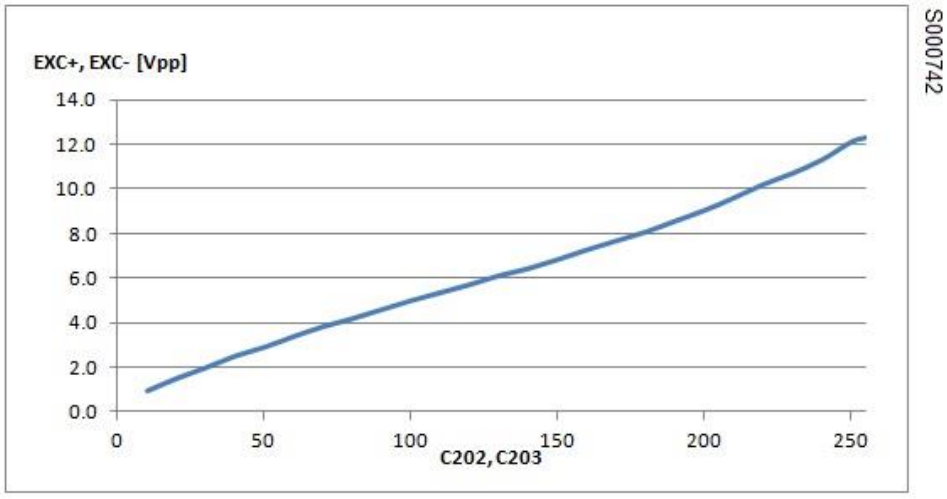


Figure 3: Amplitude of the excitation signals as a function of C202, C203

7.12. EXPANSION BOARD CONFIGURATION MENU

7.12.1. OVERVIEW

The parameters in this menu configure the expansion boards.
In particular, parameters **R023a** and **R023b**, along with **C189** (see ENCODER/FREQUENCY INPUTS MENU), define the function of the position sensors. The encoder configurations are given in the table below. Parameter **C189** is referred to logic encoders **A** and **B**. Encoder **M** is the absolute encoder used for motor control.

Table 16: Possible encoder configurations

Board (slot)	R023a	R023b	Description
ES860 (A)	-	3	**Encoder A**: Inputs MDI6 and MDI7 **Encoder B**: 3-channel Sin/Cos on ES860 **Motor control encoder**: Defined by **C189**
	5	0	**Encoder M**: 5-channel Sin/Cos encoder on ES860 (if ES966 is not fitted into slot C) **Encoder A**: Inputs **MDI6** and **MDI7** **Encoder B**: - **Motor control encoder**: Encoder M (5-channel SinCos encoder)
ES861 (C)	0	1	**Encoder A**: Incremental encoder on ES861 **Encoder B**: Frequency input **MDI8** (if ES836 or ES913 are fitted into slot A: incremental encoders on ES836 and ES913) **Motor control encoder**: Defined by **C189**
		2	**Encoder A**: Incremental encoder simulated from resolver on ES861 **Encoder B**: Frequency input **MDI8** (if ES836 or ES913 are fitted into slot A: incremental encoders on ES836 and ES913) **Motor control encoder**: Defined by **C189**
	1	0	**Encoder M**: Resolver on ES861 **Encoder A**: - **Encoder B**: Frequency input **MDI8** (if ES836 or ES913 are fitted into slot A: incremental encoders on ES836 and ES913) **Motor control encoder**: Encoder M (resolver). Encoders A and B may be used as a PID feedback or reference based on the configuration of **C189**.
		1	**Encoder M**: Resolver on ES861 **Encoder A**: Incremental encoder on ES861 **Encoder B**: Frequency input **MDI8** (if ES836 or ES913 are fitted into slot A: incremental encoders on ES836 and ES913) **Motor control encoder**: Encoder M (resolver). Encoders A and B may be used as a PID feedback or reference based on the configuration of **C189**.
		2	**Encoder M**: Resolver on ES861 **Encoder A**: Incremental encoder simulated from resolver on ES861 **Encoder B**: Frequency input **MDI8** (if ES836 or ES913 are fitted into slot A: incremental encoders on ES836 and ES913) **Motor control encoder**: Encoder M (resolver). Encoders A and B may be used as a PID feedback or reference based on the configuration of **C189**.

ES950 (C)	0	-	**Encoder A**: Incremental encoder on ES950 **Encoder B**: Frequency input **MDI8** (if ES836 or ES913 are fitted into slot A: incremental encoders on ES836 and ES913) **Motor control encoder**: Defined by **C189**
	2/3	-	**Encoder M**: EnDat/BiSS encoder on ES861 **Encoder A**: Incremental encoder on ES950 **Encoder B**: Frequency input **MDI8** (if ES836 or ES913 are fitted into slot A: incremental encoders on ES836 and ES913) **Motor control encoder**: Encoder M (EnDat/BiSS). Encoders A and B may be used as a PID feedback or reference based on the configuration of **C189**.
ES966	0	≠3	**Encoder A**: Incremental encoder on ES966 **Encoder B**: Frequency input **MDI8** (if ES836 or ES913 are fitted into slot A: incremental encoders on ES836 and ES913) **Motor control encoder**: Defined by **C189**
	0	3	**Encoder A**: Incremental encoder on **ES966** **Encoder B**: 3 Ch Sin/Cos encoder on **ES966** **Motor control encoder**: Defined by **C189**
	4	-	**Encoder M**: HIPERFACE encoder on ES966 **Encoder A**: Incremental encoder on ES966 **Encoder B**: Frequency input **MDI8** (if ES836 or ES913 are fitted into slot A: incremental encoders on ES836 and ES913) **Motor control encoder**: Encoder M (HIPERFACE). Encoders A and B may be used as a PID feedback or reference based on the configuration of **C189**.
	5	-	**Encoder M**: 5-channel Sin/Cos encoder on ES966 **Encoder A**: Incremental encoder on ES966 **Encoder B**: Frequency input **MDI8** (if ES836 or ES913 are fitted into slot A: incremental encoders on ES836 and ES913) **Motor control encoder**: Encoder M (5-channel Sin/Cos encoder). Encoders A and B may be used as a PID feedback or reference based on the configuration of **C189**.

NOTE

If **ES966** board is fitted into slot C and **ES860** board is fitted into slot A, the latter may be used only in 3 channel configuration mode by setting **R023b=3**. In that case, the analog part of the SinCos signal will not be considered by **ES860** board.

NOTE

Parameters in this menu are **Rxxx** parameters.
Once changed and saved, **Rxxx** parameters become active only after the drive has been switched off and switched on again, or after resetting its control board by pressing the **RESET** button for more than 5 seconds.

7.12.2. LIST OF PARAMETERS R021 TO R024 AND R092 TO R097

Table 17: List of Parameters R021 to R024 and R092 to R097

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUE
R021	Data Logger setting	ENGINEERING	551	Disable
R023	I/O board setting	ENGINEERING	553	None
R023a	Absolute sensor for motor control	ENGINEERING	594	0: None
R023b	Incremental sensor on expansion board	ENGINEERING	605	0: None
R024	Incremental encoder frequency divider on resolver board	ENGINEERING	221	0: None
R092	EnDat protocol frequency	ENGINEERING	526	2: 2MHz
R093	Number of multiturn bits for absolute digital encoder	ENGINEERING	527	12
R094	Number of single turn bits for absolute digital encoder	ENGINEERING	528	19
R095	BiSS frequency in Sensor Mode	ENGINEERING	529	0: 10MHz
R096	BiSS frequency divider in Register Mode	ENGINEERING	530	5: 64
R097	Sinusoids per turn of 5-Ch HIPERFACE/SinCos Encoder	ENGINEERING	531	1024

R021 Data Logger Setting

R021	**Range**	1 ÷ 2	1: Disable 2: Enable
	Default	1	1: Disable
	Level	ENGINEERING	
	Address	551	
	Function	This parameter enables or disables Data Logger initialization (if the Data Logger board is fitted).	

R023 I/O Board Setting

R023	**Range**	0 ÷ 5	0: None 1: 8I + 6O 2: 8I + 6O + XAIN 3: 8I + 6O + PT100 4: 8I + 6O + XAIN + PT100 5: 3I + 3O
	Default	0	0: None
	Level	ENGINEERING	
	Address	553	
	Function	Based on the settings in the relevant parameter, this parameter enables controlling digital I/Os (XMDI/Os), analog inputs (XAIN) and PT100 probes located on optional control boards. Refer to Table 18.	

Table 18: Optional boards and parameter R023

Board	Description	R023: Allowable values
ES847	I/O Expansion	1: 8I + 6O 2: 8I + 6O + XAIN 3: 8I + 6O + PT100 4: 8I + 6O + XAIN + PT100
ES870	Relay I/O Expansion	1: 8I + 6O
ES861	Resolver	5: 3I + 3O
ES950	BiSS/EnDat Encoder	
ES966	HIPERFACE Encoder	

R023a Absolute Sensor for Motor Control

R023a	**Range**	0 ÷ 5	0: None 1: Resolver 2: EnDat 3: BiSS 4: HIPERFACE 5: 5-channel Sin/Cos
	Default	0	0: None
	Level	ENGINEERING	
	Address	594	
	Function	Defines the type of absolute sensor used for motor control. Refer to Table 19. The sensor set in this parameter is used for motor control regardless of the value set in **C189**.	

Table 19: Optional boards and parameter R023a

Sensor	Board	R023a: allowable values
Resolver	**ES861**	1: Resolver
Encoder BiSS	**ES950 Part Number: ZZ0101880**	2: EnDat
Encoder EnDat	**ES950 Part Number: ZZ0101890**	3: BiSS
Encoder HIPERFACE	**ES966**	4: HIPERFACE
5-channel SinCos encoder	**ES966**	5: 5-channel SinCos encoder
	ES860	5: 5-channel SinCos encoder

NOTE Board **ES950** may be supplied as BiSS or EnDat. The two versions have different purchase codes (see table above). The desired version must be specified when ordering the product.

R023b Incremental Sensor on Expansion Board

R023b	**Range**	0 ÷ 3	0: None 1: Incr. Enc. on Exp. Board 2: Resolver to Encoder 3: SinCos 3 Ch
	Default	0	0: None
	Level	ENGINEERING	
	Address	605	
	Function	The parameter defines the type of incremental sensor acquired by optional board fitted into slot C (ES861, ES950, ES966), or by SinCos board (ES860) fitted into slot A. **0: None**: The incremental sensor on boards ES950, ES966 is acquired as **encoder A**. **1: Enc. Incr. on Exp. Board**: The incremental encoder on optional board ES861 is acquired as **encoder A**. **2: Resolver to Encoder**: The incremental encoder obtained by the resolver signal on optional board ES861 is acquired as **encoder A**. **3: SinCos 3 Ch**: The 3-channel SinCos encoder on optional board ES860 or ES966 is acquired as **encoder B**. Refer to Table 20. The sensor set in this parameter will be used based on the setting in **C189** (see ENCODER/FREQUENCY INPUTS MENU). In order to be used as motor feedback sensor, parameter **R023a** must be set to 0.	

Table 20: Optional boards and parameter R023b

Sensor	Board	R023b: allowable values
Line driver encoder	**ES836**	Any value ≠ 3
	ES913	
	ES950	- (any)
	ES966	
	ES861	1: Enc. Incr. on Exp. Board
Encoder from resolver	**ES861**	2: Resolver to Encoder
3-channel SinCos encoder	**ES860**	3: SinCos 3 Ch
	ES966	

R024 Incremental Encoder Frequency Divider on Resolver Board

R024	**Range**	0 ÷ 3	0: None 1: /2 2: /4 3: /8
	Default	0	0: None
	Level	ENGINEERING	
	Address	221	
	Function	Defines the frequency division factor applied to the encoder fed back as an output on the terminals of the optional board (pins 15 to 20). On **ES861**: applied on the simulated encoder signal fed back on the terminal board. On **ES950** and **ES966**: applied to the signal of the incremental encoder wired on the terminal board and fed back on the terminal board itself.	

R092 EnDat Protocol Frequency

R092	Range	0 ÷ 4	0: 8 MHz 1: 4 MHz 2: 2 MHz 3: 1 MHz 4: 200 kHz
	Default	2	2: 2 MHz
	Level	ENGINEERING	
	Address	526	
	Function	Sets the clock frequency of the EnDat protocol for an EnDat encoder on optional board ES950.	

R093 Number of Multiturn Bits for Absolute Digital Encoder

R093	Range	0 ÷ 31	0 ÷ 31 bit
	Default	12	12 bit
	Level	ENGINEERING	
	Address	527	
	Function	Sets the number of multiturn (MT) bits of absolute digital encoders (EnDat, BiSS, HIPERFACE) on optional boards ES950 and ES966.	

R094 Number of Singleturn Bits for Absolute Digital Encoder

R094	Range	0 ÷ 31	0 ÷ 31 bit
	Default	19	19 bit
	Level	ENGINEERING	
	Address	528	
	Function	Sets the number of singleturn (ST) bits of absolute digital encoders (EnDat, BiSS, HIPERFACE) on optional board ES950 and ES966.	

R095 BiSS Frequency in Sensor Mode

R095	**Range**	0 ÷ 30	0: 10 MHz 1: 5 MHz 2: 3.33 MHz 3: 2.5 MHz 4: 2 MHz 5: 1.67 MHz 6: 1.43 MHz 7: 1.25 MHz 8: 1.11 MHz 9: 1 MHz 10: 0.91 MHz 11: 0.83 MHz 12: 0.77 MHz 13: 0.71 MHz 14: 0.67 MHz 15: 0.63 MHz 16: 0.5 MHz 17: 0.33 MHz 18: 0.25 MHz 19: 0.2 MHz 20: 0.17 MHz 21: 0.14 MHz 22: 0.13 MHz 23: 0.11 MHz 24: 0.1 MHz 25: 0.09 MHz 26: 0.08 MHz 27: 0.08 MHz 28: 0.07 MHz 29: 0.07 MHz 30: 0.06 MHz
	Default	0	0: 10 MHz
	Level	ENGINEERING	
	Address	529	
	Function	Sets the clock frequency of the BiSS protocol in sensor mode for a BiSS encoder on optional board ES950.	

R096 BiSS Frequency Divider in Register Mode

R096	**Range**	0 ÷ 7	0: /2 1: /4 2: /8 3: /16 4: /32 5: /64 6: /128 7: /256
	Default	5	5: /64
	Level	ENGINEERING	
	Address	530	
	Function	Divider of the selected frequency for BiSS in Sensor Mode. The result defines the working frequency for Register Mode transmissions.	

R097 Sinusoids per turn of 5-Ch HIPERFACE/SinCos Encoder

R097	**Range**	0 ÷ 16384	0 ÷ 16384 sinusoids/turn
	Default	1024	1024 sinusoids/turn
	Level	ENGINEERING	
	Address	531	
	Function	Defines the number of sinusoids/turn of the HIPERFACE encoder on optional board ES966, or of 5-channel SinCos encoder on optional board ES966 or ES861.	

NOTE For 3-channel SinCos encoder on optional board ES966 or ES861, the number of sinusoids per turn is defined by parameter **C191** in the ENCODER/FREQUENCY INPUTS MENU.

7.13. ALARMS SPECIFIC TO THE SYNCHRONOUS MOTOR APPLICATION

7.13.1. OVERVIEW

This section covers only the alarms specific to the Synchronous Motor application.

7.13.2. FAULT LIST

For the full list of the Sinus Penta alarms, please refer to the SINUS PENTA – Programming Guide.

Table 21: List of the Alarms specific to the Synchronous Motor application

Alarm	Name	Description
A130	SYN Align KO	Motor alignment procedure failed
A131	ABS Encoder Fault	Absolute encoder malfunction
A132	Motor not Aligned	No alignment between rotor/position sensor

A130 SYN Alignment KO

A130	Description	The motor alignment procedure has failed before being completed
	Event	The motor alignment procedure has failed
	Possible Causes	• Wrong power and/or signal wiring • Wrong parameterization • Electrical failure on inverter board
	Solutions	1. Reset the alarm and the board. 2. Perform the alignment procedure again. 3. If the alarm persists, please contact the CUSTOMER SERVICE of ENERTRONICA SANTERNO.

A131 ABS Encoder Fault

A131	Description	Absolute encoder malfunction
	Event	No position information from the absolute encoder.
	Possible Causes	• Wrong wiring • Wrong parameterization • Electrical failure on optional acquisition board • Sensor failure • Communication channel disturbance
	Solutions	1. Power off the equipment and check wiring. 2. Check the board parameterization. 3. Restart the equipment. 4. If the alarm persists, please contact the CUSTOMER SERVICE of ENERTRONICA SANTERNO.

A132 Motor not Aligned

A132	Description	No alignment between rotor and sensor.
	Event	When the ENABLE closes (except for the autotuning and alignment procedures), the system detects that the rotor is not aligned with the sensor, so the motor cannot be properly controlled. If an incremental sensor is used the alignment procedure shall be performed whenever the drive is powered on.
	Possible Causes	The started motor has not been aligned with the position sensor, or the latest alignment procedure has failed.
	Solutions	1. Remove the ENABLE command and reset the alarm. 2. Performed an alignment procedure as described in this manual. 3. If the alarm persists, please contact the CUSTOMER SERVICE of ENERTRONICA SANTERNO.