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SINUS PENTA

MULTIFUNCTION AC DRIVE

GUIDE TO THE SYNCHRONOUS MOTOR APPLICATION

English

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1. SCOPE OF THIS MANUAL

Elettronica Santerno is committed to update its User Manuals available for download from santerno.com with the latest software version officially released. Please contact Elettronica 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 wiring diagrams and the parameters relating to the Synchronous Motor application.
Accessory boards are covered in the Sinus Penta **Installation Guide**.
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, *not* with Synchronous Motor firmware, needs to be updated.
The procedure above is not required if the drive is factory set with the Synchronous Motor firmware.

2.1. SYNCHRONOUS MOTOR APPLICATION

The Sinus Penta drive featuring Synchronous Motor application enables torque control and speed control of permanent magnet synchronous motors (PMSMs).
Controlling a synchronous motor requires a position transducer (encoder, resolver, etc.). Also, the offset angle between the position 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 position sensors avoids repeating the alignment procedure every time the drive is powered on.
The Sinus Penta application for synchronous motors covers any 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.

3. SOFTWARE DOWNLOAD FOR APPLICATION PROGRAMMING

The Remote Drive software and the PXxxxxF0.mot, PXxxxxF1.mot files of the application are required to download the Synchronous Motor application to a Sinus Penta drive. The download procedure is detailed in the following section.
The PRxxxxF0.mot and PRxxxxF1.mot files are required for the regenerative application.
For different applications, please refer to the relevant manuals and to the updates available on Elettronica Santerno's website:

santerno.com

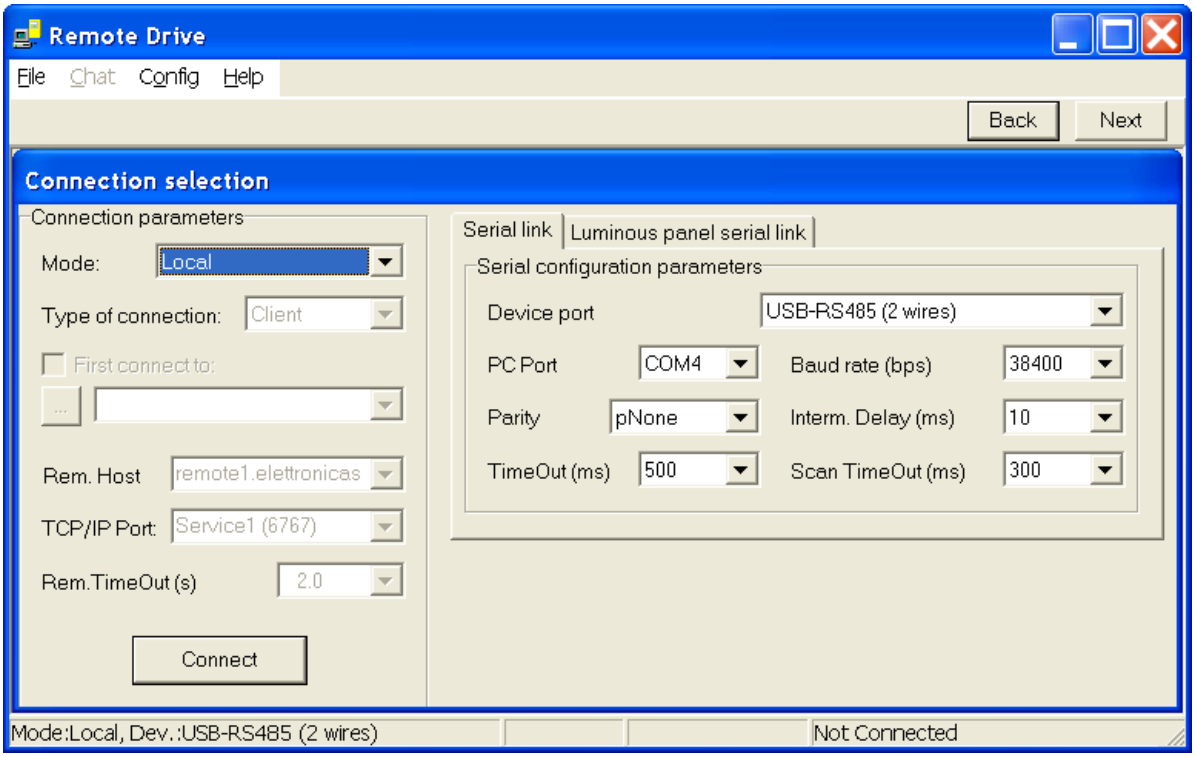
NOTE Please refer to the User Manual of the Remote Drive software for more details.

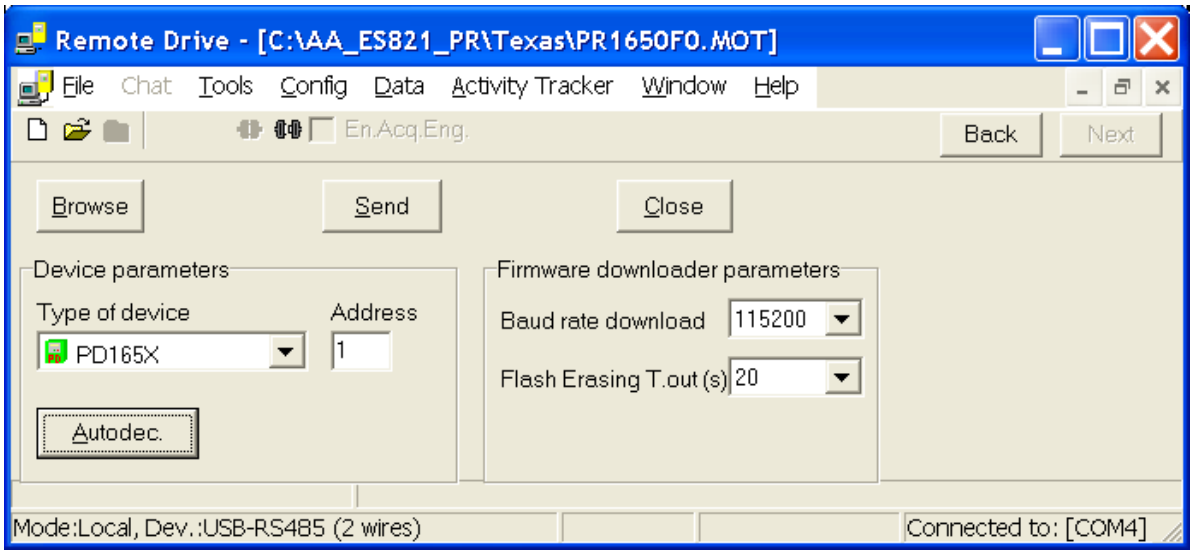
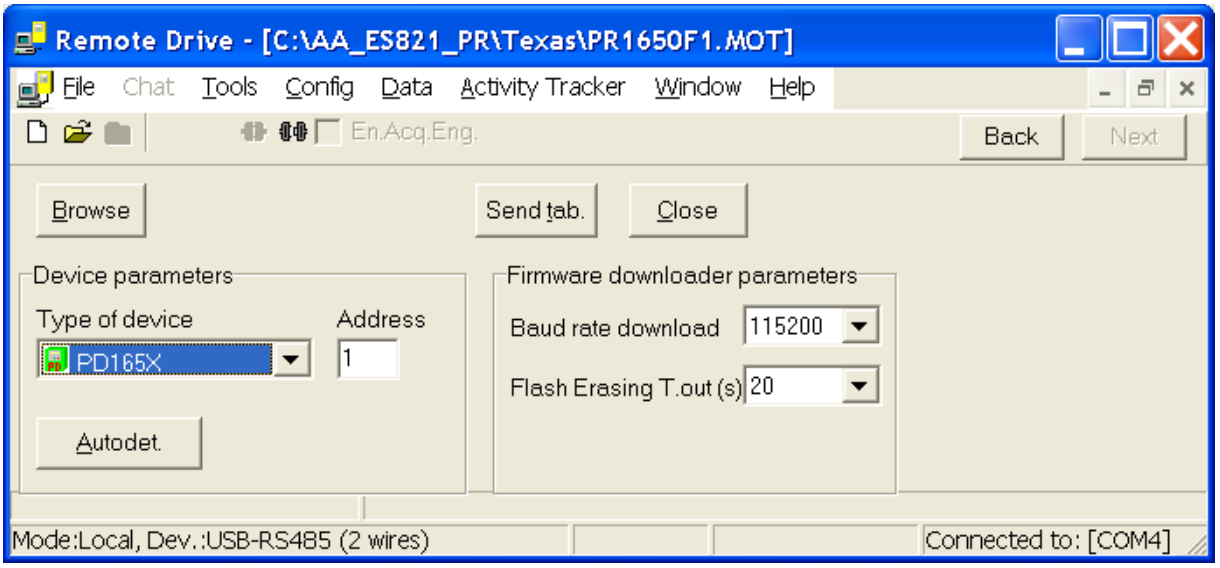
The software of the Sinus Penta drives consists of two files, one containing the firmware and one containing the MMI table for the keypad interface. Both files use hexadecimal files with the MOT format. The filenames ending with "F0" relate to the firmware; the filenames ending with "F1" relate to the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

3.1. FIRMWARE UPGRADE

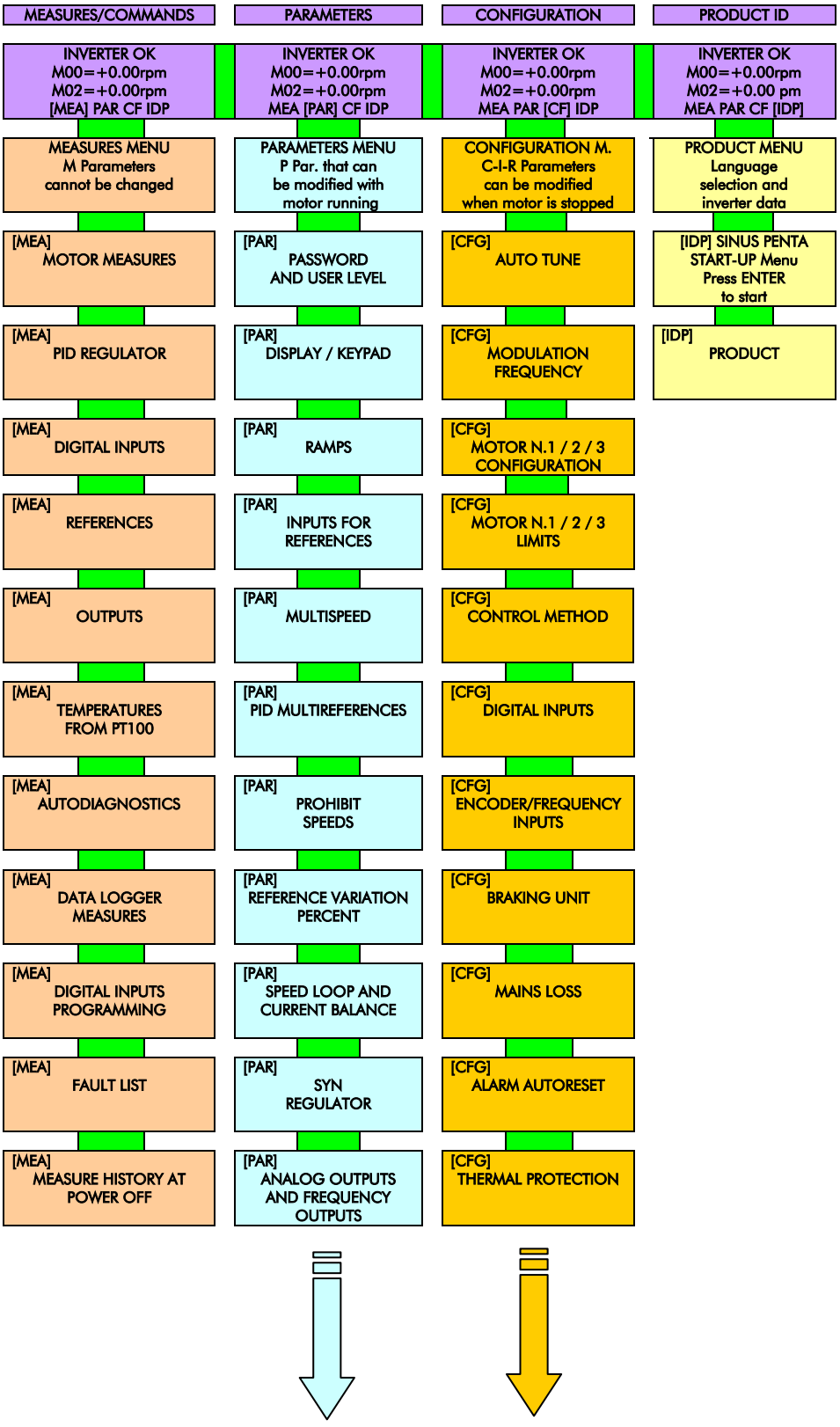
This section covers firmware upgrade and application download.

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


MEASURES/COMMANDS
PARAMETERS
CONFIGURATION
PRODUCT ID
INVERTER OK M00=+0.00rpm M02=+0.00rpm [MEA] PAR CF IDP
INVERTER OK M00=+0.00rpm M02=+0.00rpm MEA [PAR] CF IDP
INVERTER OK M00=+0.00rpm M02=+0.00rpm MEA PAR [CF] IDP
INVERTER OK M00=+0.00rpm M02=+0.00 pm MEA PAR CF [IDP]
MEASURES MENU M Parameters cannot be changed
PARAMETERS MENU P Par. that can be modified with motor running
CONFIGURATION M. C-I-R Parameters can be modified when motor is stopped
PRODUCT MENU Language selection and inverter data
[MEA] MOTOR MEASURES
[PAR] PASSWORD AND USER LEVEL
[CFG] AUTO TUNE
[IDP] SINUS PENTA START-UP Menu Press ENTER to start
[MEA] PID REGULATOR
[PAR] DISPLAY / KEYPAD
[CFG] MODULATION FREQUENCY
[IDP] PRODUCT
[MEA] DIGITAL INPUTS
[PAR] RAMPS
[CFG] MOTOR N.1 / 2 / 3 CONFIGURATION
[MEA] REFERENCES
[PAR] INPUTS FOR REFERENCES
[CFG] MOTOR N.1 / 2 / 3 LIMITS
[MEA] OUTPUTS
[PAR] MULTISPEED
[CFG] CONTROL METHOD
[MEA] TEMPERATURES FROM PT100
[PAR] PID MULTIREFERENCES
[CFG] DIGITAL INPUTS
[MEA] AUTODIAGNOSTICS
[PAR] PROHIBIT SPEEDS
[CFG] ENCODER/FREQUENCY INPUTS
[MEA] DATA LOGGER MEASURES
[PAR] REFERENCE VARIATION PERCENT
[CFG] BRAKING UNIT
[MEA] DIGITAL INPUTS PROGRAMMING
[PAR] SPEED LOOP AND CURRENT BALANCE
[CFG] MAINS LOSS
[MEA] FAULT LIST
[PAR] SYN REGULATOR
[CFG] ALARM AUTORESET
[MEA] MEASURE HISTORY AT POWER OFF
[PAR] ANALOG OUTPUTS AND FREQUENCY OUTPUTS
[CFG] THERMAL PROTECTION

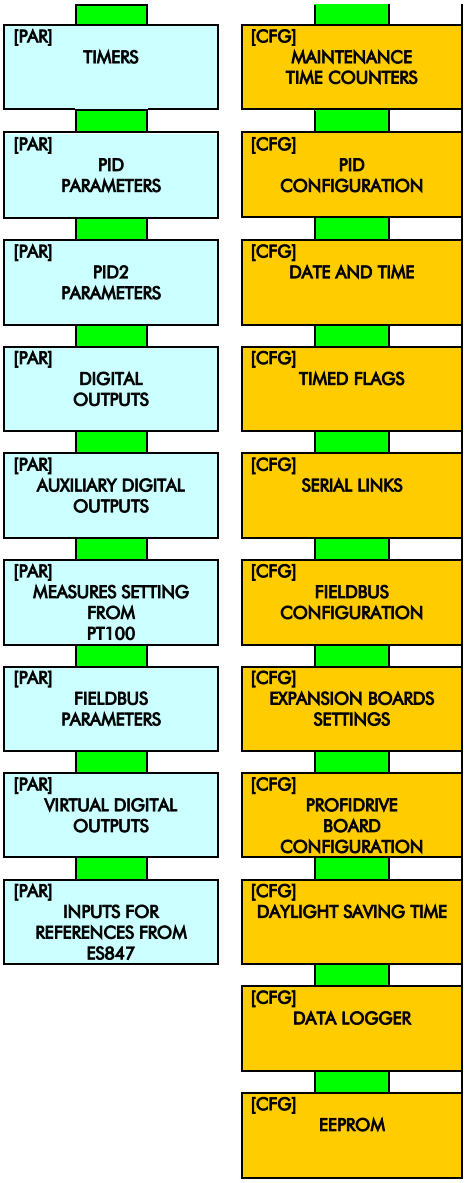


Figure 1: Menu tree of the Synchronous Motor application

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 **Programming Guide**) and power on the Penta drive again.

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

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

Press **ENTER** to enter the wizard.

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

```
P263 Language


→@@@@@@@@@@@@@@@@
```

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

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

Choose one of the following:

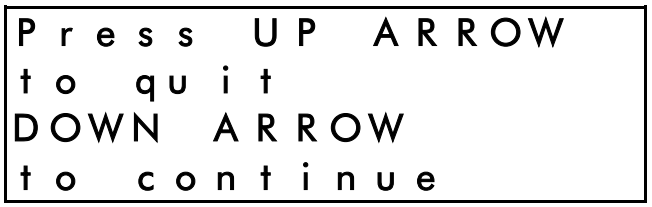
```
1:EVERY START-UP
2:ONLY NOW
3:NEXT START-UP
4:NEVER
```

If you select "EVERY START-UP", the wizard appears whenever the 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	[only if SYN is active]
C189	Encoder operating mode	[only if SYN is active]
C190	Encoder A pls/rev	[only if SYN is active]
C191	Encoder B pls/rev	[only if SYN is active]
I073	Autotuning selection	[only if SYN is active]
I074	Motor tuning 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)

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

2) Power on: Power on the drive and do not close the link to the START input and the ENABLE input 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:

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 **Installation Guide** for more details).

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 **Installation Guide** for more details).

Absolute digital encoders (EnDat, BiSS, HIPERFACE)

In the EXPANSION BOARD CONFIGURATION MENU, set parameter **R023a** to 2, 3, 4 (EnDat, BiSS, HIPERFACE). Set the other parameters relating to the type of encoder being used. Reset the board.

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 **Installation Guide**.

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.

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:

Access the MOTOR CONTROL MENU and set **C010** (Control Algorithm) as SYN (Synchronous Motor).
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 = 3000rpm
  p = 3 pole pairs (6 poles)
  fmot1=3000/60*3=150
- **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 resistor, phase reactor, current loop:

Open the ENABLE input, then access the AUTOTUNE MENU and set **I073**= [1: Motor Tune] and **I074**= [8: SYN Autotune]. Press **ESC** to confirm. Close the ENABLE and START inputs and wait until tune is complete (Warning "**W32** Open Enable" is displayed). The drive has computed and saved the values for: **C022**, **C022a**, **P174a**, **P174b**.
If the values of parameters **C022** and **C022a** are known, they may manually be entered. By setting **I074**= [6: SYN Update Current Loop], only parameters **P174a** and **P174b** 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 terminal **MDI3**, or press the **RESET** key in the display/keypad and perform the autotune procedure again.

8) Alignment procedure:

<u>The alignment procedure must be performed:</u>
- If an absolute position sensor is installed on the motor (encoder type EnDat, BiSS, 5-channel SinCoS encoder, or Resolver):
  - only once at first startup;
  - if alarm **A132** trips;
  - if a mechanical displacement between the motor shafts and the position sensor has occurred.
- If an incremental position sensor is installed on the motor (incremental encoder, 3-channel SinCos encoder):
  - as in the case 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 SYN REGULATORS MENU. Set **I027**=1: Encoder Align.
Close the ENABLE and START inputs.
Wait for **W32** "Open Enable", open the ENABLE and START inputs.

9) Speed loop

This procedure is optional. It enables calculating the speed loop gains; before performing

autotune: the speed loop autotune, set up parameter **C022b** (Load Inertia, MOTOR CONFIGURATION menu) – this parameter is to be expressed in Kgm^2. Parameters **P126** and **P128** may also be entered while performing a manual tune procedure.

Open the ENABLE input, then access the AUTOTUNE MENU and set **I073**= [1: Motor Tune] and **I074**= [7: SYN Update Speed Loop]. Press **ESC** to confirm. Close the ENABLE input 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/(rad/s)).

If the BEMF value is not known, it may be obtained through autotune.

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 input, then access the AUTOTUNE MENU and set **I073**= [1: Motor Tune] and **I074** = [9: SYN BEMF Tune]. Press **ESC** to confirm. Close the ENABLE and START inputs and wait for **W32** "Open Enable". The drive has calculated and saved the values of **C015a**.

11) Startup: Activate the **ENABLE** input (terminal 15) 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 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. PARAMETERS FOR SINUS PENTA DRIVES FEATURING SYNCHRONOUS MOTOR APPLICATION

7.1. MEASURES MENU

7.1.1. OVERVIEW

This section covers the specific measures of the Synchronous Motor application.

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 – Singleturn (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 – Multiturn (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 input closes. 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's **Programming Guide**), except for the following:

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

7.2. SPEED LOOP, POSITION AND CURRENT BALANCING MENU

7.2.1. OVERVIEW

The SPEED LOOP, POSITION AND CURRENT BALANCING MENU allows setting the parameter values of the speed regulators for the three programmable connected motors (SYN control); it also enables manual balancing of the motor currents (any control algorithm – see **P152**).
The speed regulator for each motor has a dual parameter setting capability: two integral terms, two proportional terms and two speed error thresholds (expressed as a percentage of the rated motor speed).
The response of the speed regulator can be dynamically linked with the speed error; in this way, the speed regulator will be more sensitive to remarkable speed errors and less sensitive to negligible speed errors.
Factory setting: because two identical error thresholds are set, only two parameters are used: **P126** (Maximum Integral Time) and **P128** (Minimum Proportional Constant).
The setup of min. integral time and max. proportional constant is enabled provided that two different error thresholds are used.

Example:

P125	100	[ms]	Minimum integral time for maximum error
P126	500	[ms]	Integral time for minimum error
P128	10.00		Proportional constant for minimum error
P129	25.00		Proportional constant for maximum error
P130	2	[%]	Minimum error threshold
P131	20	[%]	Maximum error threshold

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

Error ≥ **P131**
If the speed error exceeds the second error threshold, the speed regulator adopts parameters **P125** and **P129**.

P130<Error<**P131**
When the speed error is included between the two error thresholds, the speed regulator will use coefficients that are dynamically linked with the speed error (see figure below).

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

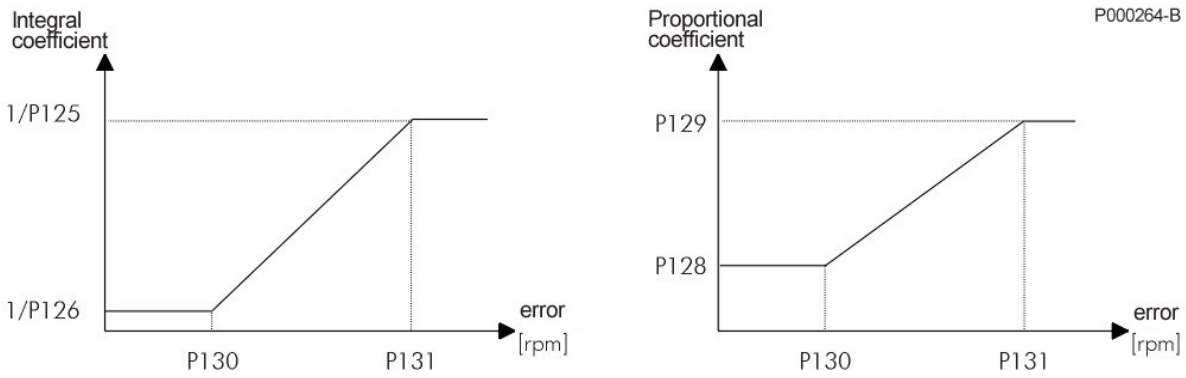


Figure 2: Dual Parameterization function (example)

7.2.2. LIST OF PARAMETERS P125 TO P152

Table 2: List of parameters P125 ÷ P152

Parameter	FUNCTION	User Level	DEFAULT VALUE	MODBUS Address
P125	Mot1 Integral time for maximum error	BASIC	500 ms	725
P126	Mot1 Integral time for minimum error	BASIC	500 ms	726
P127	Mot1 Prop. coefficient of the position regulator for synchronous motors	ENGINEERING	300	727
P128	Mot1 Prop. coefficient for minimum error	BASIC	10.00	728
P129	Mot1 Prop. coefficient for maximum error	BASIC	10.00	729
P130	Mot1 Minimum error threshold	BASIC	1.00%	730
P131	Mot1 Maximum error threshold	BASIC	1.00%	731
P135	Mot2 Integral time for maximum error	BASIC	500 ms	735
P136	Mot2 Integral time for minimum error	BASIC	500 ms	736
P137	Mot2 Prop. coefficient of the position regulator for synchronous motors	ENGINEERING	300	737
P138	Mot2 Prop. coefficient for minimum error	BASIC	10.00	738
P139	Mot2 Prop. coefficient for maximum error	BASIC	10.00	739
P140	Mot2 Minimum error threshold	BASIC	1.00%	740
P141	Mot2 Maximum error threshold	BASIC	1.00%	741
P145	Mot3 Integral time for maximum error	BASIC	500 ms	745
P146	Mot3 Integral time for minimum error	BASIC	500 ms	746
P147	Mot3 Prop. coefficient of the position regulator for synchronous motors	ENGINEERING	300	747
P148	Mot3 Prop. coefficient for minimum error	BASIC	10.00	748
P149	Mot3 Prop. coefficient for maximum error	BASIC	10.00	749
P150	Mot3 Min. error threshold	BASIC	1.00 %	750
P151	Mot3 Max. error threshold	BASIC	1.00 %	751
P152	Symmetry regulation of three-phase current	ENGINEERING	0 %	752

P125 (P135, P145) Integral Time for Maximum Error

P125 (Mot1) P135 (Mot2) P145 (Mot3)	Range	1÷ 32000	1÷ 32000 [Disable] ms
	Default	500	500 ms
	Level	BASIC	
	Address	725,735,745	
	Control	SYN	
	Function	This parameter sets the integral time for the speed regulator when the error is over the maximum threshold. It may be accessed only if the minimum and maximum error thresholds are different (**P130≠P131** for Motor1, **P140≠P141** for Motor2, **P150≠P151** for Motor3).	

P126 (P136, P146) Integral Time for Minimum Error

P126 (Mot1) P136 (Mot2) P146 (Mot3)	Range	1÷ 32000	1÷ 32000 [Disable] ms
	Default	500	500 ms
	Level	BASIC	
	Address	726, 736, 746	
	Control	SYN	
	Function	This parameter sets the integral time for the speed regulator used when the error is under the maximum threshold. If the minimum and maximum error thresholds are the same (**P130=P131** for Mot1, **P140=P141** for Mot2, **P150=P151** for Mot3), this is the integral time of the speed regulator.	

P127 (P137, P147) Proportional Constant of Position Controller

P127 (Mot1) P137 (Mot2) P147 (Mot3)	Range	0÷ 65000	0.00÷ 650.00
	Default	300	3.00
	Level	ENGINEERING	
	Address	727, 737, 747	
	Control	SYN	
	Function	Proportional constant of the position control loop. Applicable to synchronous motors only. It may automatically be updated by means of the relevant adjusting command (see AUTOTUNE MENU - **I074 = 2**: SYN Update Speed Loop).	

P128 (P138, P148) Proportional Coefficient for Minimum Error

P128 (Mot1) P138 (Mot2) P148 (Mot3)	Range	0 ÷ 65000	0.00 ÷ 650.00
	Default	1000	10.00
	Level	BASIC	
	Address	728, 738, 748	
	Control	SYN	
	Function	This parameter sets the minimum proportional coefficient for the speed regulator, used when the error is lower than the minimum threshold. If the minimum and maximum error thresholds are the same (**P130** = **P131** for Mot1, **P140** = **P141** for Mot2, **P150** = **P151** for Mot3), this is the proportional coefficient of the speed regulator. Default value (10): if a speed error of 1% occurs, the regulator will require 10% of the rated motor torque.	

P129 (P139, P149) Proportional Coefficient for Maximum Error

P129 (Mot1) P139 (Mot2) P149 (Mot3)	Range	0 ÷ 65000	0.00 ÷ 650.00
	Default	1000	10.00
	Level	BASIC	
	Address	729,739, 749	
	Control	SYN	
	Function	This parameter sets the proportional coefficient for the speed regulator, used when the error is higher than the maximum threshold. Default value (10): if a speed error of 1% occurs, the regulator will require 10% of the rated motor torque. This parameter may be accessed only if the min. and max. error thresholds are different (**P130** ≠ **P131** for Motor1, **P140** ≠ **P141** for Motor2, **P150** ≠ **P151** for Motor3).	

P130 (P140, P150) Minimum Error Threshold

P130 (Mot1) P140 (Mot2) P150 (Mot3)	Range	0 ÷ 32000	0.00 ÷ 320.00 %
	Default	100	1.00%
	Level	BASIC	
	Address	730, 740, 750	
	Control	SYN	
	Function	This parameter sets the minimum error threshold expressed as a percentage of the rated motor speed. If **P130** = **P131** or in case of speed errors lower than or equal to the min. threshold, parameters **P126** and **P128** will be used.	

P131 (P141, P151) Maximum Error Threshold

P131 (Mot1) P141 (Mot2) P151 (Mot3)	Range	0 ÷ 32000	0.00 ÷ 320.00 %
	Default	100	1.00%
	Level	BASIC	
	Address	731, 741, 751	
	Control	SYN	
	Function	This parameter sets the maximum error threshold expressed as a percentage of the rated motor speed. In case of speed errors greater than or equal to the maximum threshold, the regulator uses parameters **P125** and **P129**.	

P152 Symmetry Regulation of Three-phase Current

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

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 (**C010**=1 for motor n.1, **C053**=1 for motor n.2, **C096**=1 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 position transducer.

7.3.2. LIST OF PARAMETERS P174A1 TO P174C3 AND INPUT I027

Table 3: List of Parameters P174a to P174c3 and input I027

Parameter/ input	FUNCTION	User Level	DEFAULT VALUE	MODBUS Address
I027	SYN Controls	BASIC	–	1414
P174a1	Maximum Time for Encoder Alignment Mot.1	ENGINEERING	10 s	760
P174b1	Proportional Constant of Current Regulator for Mot.1	ENGINEERING	3.00	761
P174c1	Integral Time of Current Regulator for Mot.1	ENGINEERING	2.0 ms	762
P174a2	Maximum Time for Encoder Alignment Mot.2	ENGINEERING	10 s	771
P174b2	Proportional Constant of Current Regulator for Mot.2	ENGINEERING	3.00	772
P174c2	Integral Time of Current Regulator for Mot.2	ENGINEERING	2.0 ms	773
P174a3	Maximum Time for Encoder Alignment Mot.3	ENGINEERING	10 s	1251
P174b3	Proportional Constant of Current Regulator for Mot.3	ENGINEERING	3.00	1252
P174c3	Integral Time of Current Regulator for Mot.3	ENGINEERING	2.0 ms	1253

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. The alignment procedure must be performed: - If an absolute position sensor is installed on the motor (EnDat encoder, BiSS encoder, 5-channel SinCoS encoder, or Resolver): - only once at first startup; - if alarm **A132** trips; - if a mechanical displacement between the motor shafts and the position sensor has occurred. - If an incremental position sensor is installed on the motor (incremental encoder, 3-channel SinCos encoder): - as in the case above; - every time the drive is powered on or reset. After setting **I027** to 1, close the ENABLE and START inputs to start the alignment procedure. Wait for **W32** "Open Enable", then open the ENABLE and START inputs. The offset angle is displayed in measure **M129**.	

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.	

P174b1 (P174b2, P74b3) Proportional Constant of Current Regulator

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 current 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 – measure;* *integral_status = integral_status + error*Ki*Ts;* *output = Kp*error + integral_status;* where **Kp** is the proportional coefficient **Ki** is the integral coefficient = 1/Ti, where Ti is the integral time **Ts** is the 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

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 current 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 – measure;* *integral_status = integral_status + error*Ki*Ts;* *output = Kp*error + integral_status;* where **Kp** is the proportional coefficient **Ki** is the integral coefficient = 1/Ti, where Ti is the integral time **Ts** is the 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. AUTOTUNE MENU

7.4.1. OVERVIEW

NOTE See the FIRST STARTUP PROCEDURE (SYNCHRONOUS MOTOR) section for tuning based on the control algorithm to be used.

NOTA At the end of the Autotune procedure, the system automatically saves the whole parameter set of the drive.

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

7.4.2. 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 4: Programmable "Motor Tune" functions

I074 Setting	Motor Rotation	Type of Tune
0: IFD ctrl no rotation	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 control algorithms.
1: SYN Update current loop	No	**Automatic autotune** of the current loop. Tuning mode required for the correct operation of the SYN algorithm. 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** and **P174c1** (motor 2: **P174b2** and **P174c2**; motor 3: **P174b3** and **P174c3**) will automatically be updated.
2: SYN Update speed loop	No	**Automatic autotune** of the speed loop and position loop (SYN algorithm). 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, the gains for speed loop and position 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	No	**Automatic estimation** of the stator resistance and the phase inductance of the synchronous motor (SYN algorithm) + **automatic tune** of the gains for speed loop and position loop (the position tune is the same as the one obtained with 1: SYN Update current loop). In order to perform the procedure, close the ENABLE signal and the START signal after setting **I074** accordingly. When the procedure is complete, parameters **P174b1**, **P174c1, C22, C22a** (motor 2: **P174b2**, **P174c2, C065, C065a**; motor 3: **P174b3**, **P174c3, C108, C108a**) will automatically be updated.
4: SYN BEMF tune	Yes	**Automatic tune** of the **BEMF**. This procedure causes the motor to rotate at high speed and enables estimating parameter **C015a** (**C058a** and **C097a** respectively for motor 2 and motor 3). In order to perform the procedure, close the ENABLE and the START signal after setting **I074** accordingly.

7.4.3. CHECKING THE ENCODER OPERATION

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** and **START** commands are enabled, 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 the Sinus Penta's **Installation Guide**).
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**.

7.5. MOTOR CONTROL MENU

7.5.1. OVERVIEW

The Sinus Penta allows configuring three different types of motors and two different types of control algorithms at the same time.

The two types of control algorithms are identified with the acronyms:

- ✓ **IFD** (Voltage/Frequency Control);
- ✓ **SYN** (Synchronous Motor)

The **Voltage/Frequency control** allows controlling **asynchronous motors** by producing voltage depending on frequency.
The **Synchronous Motor control** allows controlling torque, speed, position of permanent magnet synchronous motors (PMSMs).

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 **Programming Guide**).
The parameters included in the Motor Control Menus are detailed in Table 5.

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

Table 5: Description of the parameters classified by motor

Parameter Contents	Motor Control 1	Motor Control 2	Motor Control 3
• Rated mains voltage	C008	————————	————————
• Control algorithm being used	C010	C053	C096
• Type of reference being used (speed / torque) (SYN algorithm only)	C011	C054	C097
• SYN control compensations	C011a ÷ C011b	C054a ÷ C054b	C097a ÷ C097b
• Presence of the speed feedback from encoder	C012	C055	C098
• Electric ratings of the connected motor	C015 ÷ C025	C058 ÷ C068	C101 ÷ C111
• Load characteristics (SYN algorithm only)	C022b ÷ C022d	C065b ÷ C065d	C108b ÷ C108d
• Minimum and maximum speed required, speed at the beginning of defluxing, overspeed alarm enable and threshold	C028 ÷ C031	C071 ÷ C074	C114 ÷ C117
• V/f pattern parameters	C013 / C032 ÷ C038	C056 / C075 ÷ C081	C099 / C118 ÷ C124
• Slip compensation activation	C039	C082	C125
• Voltage drop at rated current	C040	C083	C126

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

7.5.2. 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 **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

7.5.3. LIST OF PARAMETERS C008 TO C128

Table 6: 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	Parameter
C010	M1	Type of control algorithm	BASIC	1010	1: SYN
C053	M2			1053	
C096	M3			1096	
C011	M1	Type of reference	ADVANCED	1011	0: Speed (MASTER mode)
C054	M2			1054	
C097	M3			1097	
C011a	M1	Forward Actions over Torque Control	ADVANCED	634	0: No
C054a	M2			636	
C097a	M3			638	
C011b	M1	BEMF Compensation	ADVANCED	635	0: No
C054b	M2			637	
C097b	M3			639	
C012	M1	Encoder/resolver present	BASIC	1012	0: No
C055	M2			1055	
C098	M3			1098	
C013	M1	Type of V/f pattern	BASIC	1013	Depending on the model. See tables in the Programming Guide.
C056	M2			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			1058	
C101	M3			1101	
C015a	M1	BEMF constant	ENGINEERING	753	0.00 V/(rad/s)
C058a	M2			764	
C101a	M3			1236	
C016	M1	Motor rpm	BASIC	1016	1500 rpm
C059	M2			1059	
C102	M3			1102	
C017	M1	Rated motor power	BASIC	1017	Depending on the model. See tables in the Programming Guide.
C060	M2			1060	
C103	M3			1103	
C018	M1	Rated motor current	BASIC	1018	Depending on the model. See tables in the Programming Guide.
C061	M2			1061	
C104	M3			1104	
C019	M1	Rated motor voltage	BASIC	1019	Depends on the inverter voltage class
C062	M2			1062	
C105	M3			1105	
C020	M1	No-load motor power	ADVANCED	1020	0.0%
C063	M2			1063	
C106	M3			1106	

C021	M1	No-load motor power	ADVANCED	1021	0%
C064	M2			1064	
C107	M3			1107	
C022	M1	Motor stator resistance	ENGINEERING	1022	Depending on the model. See tables in the Programming Guide.
C065	M2			1065	
C108	M3			1108	
C022a	M1	Phase inductance	ENGINEERING	754	0.00 mH
C065a	M2			765	
C108a	M3			1237	
C022b	M1	Load inertia	ENGINEERING	755	0.000 kgm^2
C065b	M2			766	
C108b	M3			1238	
C022c	M1	Rotor inertia	ENGINEERING	756	300 kgmm^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 Programming Guide.
C066	M2			1066	
C109	M3			1109	
C024	M1	Mutual inductance	ADVANCED	1024	250.00mH
C067	M2			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			1071	
C114	M3			1114	
C029	M1	Maximum motor speed	BASIC	1029	1500 rpm
C072	M2			1072	
C115	M3			1115	
C031	M1	Maximum speed alarm	ADVANCED	1031	0: Disabled
C074	M2			1074	
C117	M3			1117	
C032	M1	Quadratic torque curve decrease	ADVANCED	1032	30%
C075	M2			1075	
C118	M3			1118	
C033	M1	Rated revolutions referring to quadratic torque curve decrease	ADVANCED	1033	20%
C076	M2			1076	
C119	M3			1119	
C034	M1	Voltage preboost for IFD	BASIC	1034	Depending on the model. See tables in the Programming Guide.
C077	M2			1077	
C120	M3			1120	
C035	M1	Voltage Boost at 5% of the rated motor frequency	ADVANCED	1035	Depending on the model. See tables in the Programming Guide.
C078	M2			1078	
C121	M3			1121	
C036	M1	Voltage Boost at programmable frequency	ADVANCED	1036	Depending on the model. See tables in the Programming Guide.
C079	M2			1079	
C122	M3			1122	
C037	M1	Frequency for application of voltage Boost at programmable frequency	ADVANCED	1037	Depending on the model. See tables in the Programming Guide.
C080	M2			1080	
C123	M3			1123	

C038	M1	Autoboost	ADVANCED	1038	Depending on the model. See tables in the Programming Guide.
C081	M2			1081	
C124	M3			1124	
C039	M1	Slip compensation	ADVANCED	1039	0: Disabled
C082	M2			1082	
C125	M3			1125	
C040	M1	Voltage drop at rated current	ADVANCED	1040	0: Disabled
C083	M2			1083	
C126	M3			1126	
C042	M1	Vout saturation percentage	ENGINEERING	1042	100%
C085	M2			1085	
C128	M3			1128	

C008 Rated Mains Voltage

C008	Range	0 ÷ 8	0: [200 ÷ 240] V 1: 2T Regen. 2: [380 ÷ 480] V 3: [481 ÷ 500] V 4: 4T Regen. 5: [500 ÷ 600] V 6: 5T Regen. 7: [600 ÷ 690] V 8: 6T Regen.
	Default	2	2: [380 ÷ 480] V
	Level	BASIC	
	Address	1008	
	Function	This parameter defines the rated voltage of the mains powering the drive, thus allowing obtaining voltage ranges to be used for the drive operation. The value set in this parameter depends on the **Drive voltage class.** To supply the drive via a non-stabilized DC source, the corresponding AC voltage range must be used (see Table 7); DO NOT USE T Regen settings in this case.	

Table 7: Equivalence between AC mains range and DC range

AC MAINS	DC range
200÷240 Vac	280÷338 Vdc
380÷480 Vac	530÷678 Vdc
481÷500 Vac	680÷705 Vdc
500÷600 Vac	705÷810 Vdc
600÷690 Vac	810÷970 Vdc

NOTE

Select xT Regen (where x relates to the voltage class of the drive) if the drive is DC-supplied through a regenerative Sinus Penta or a different drive used to stabilize the DC bus to a higher level than the stabilization level obtained when rectifying the 3-phase mains.

C009 N. of Configured Motors

C009			
	Range	1÷3	1÷3
	Default	1	1
	Level	ENGINEERING	
	Address	1009	
	Function	This parameter determines the number of motors to be configured. The active motor is selected through digital inputs programmed with **C173** and **C174** (see DIGITAL INPUTS MENU in the **Programming Guide**). The programming parameters of the Motor Control 2 Menu can be accessed only if **C009** = 2 or 3; the programming parameters of the Motor Control 3 Menu can be accessed only if **C009** =3.	

C010 (C053, C096) Type of Control Algorithm

C010 (mot. n.1) C053 (mot. n.2) C096 (mot. n.3)			
	Range	0 ÷ 1	0: IFD 1: SYN
	Default	0	1: SYN
	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 Synchronous motor control **The V/f control** allows controlling the motor by producing voltage depending on frequency. It is possible to configure several types of V/f patterns (see V/f pattern parameters in the **Programming Guide**). **The synchronous motor control** enables speed control and torque control of a permanent magnet synchronous motor (PMSM).	

NOTE The SYN control requires a position transducer, such as en encoder.

C011 (C054, C097) Type of Reference (Master/Slave)

C011 (mot. n.1) C054 (mot. n.2) C097 (mot. n.3)	Range	0 ÷ 2	0: Speed (MASTER mode) 1: Torque (SLAVE mode) 2: Torque with speed limit (SLAVE mode)
	Default	0	0: Speed (MASTER mode)
	Level	ADVANCED	
	Address	1011, 1054, 1097	
	Control	SYN	
	Function	This parameter defines the type of reference to be used. The torque control may be set up (see section Torque Control (VTC and FOC Only) as well in the **Programming Guide**). When the Torque control with speed limit mode is used, the drive will limit the motor rotation to the rpm set in parameter **C029 (C072, C115).** This function can be used to automatically toggle from the torque control mode to the speed control mode: when the torque control mode is implemented, the motor speed can reach any value included in the "AB" zone (see Figure 3). If the limit speed is attained due to particular load conditions, the drive will automatically switch to the speed control ("BC" zone). The controlled torque is no longer maintained. If the torque returns to its setpoint value, the drive will automatically switch to the torque control again ("AB" zone).	

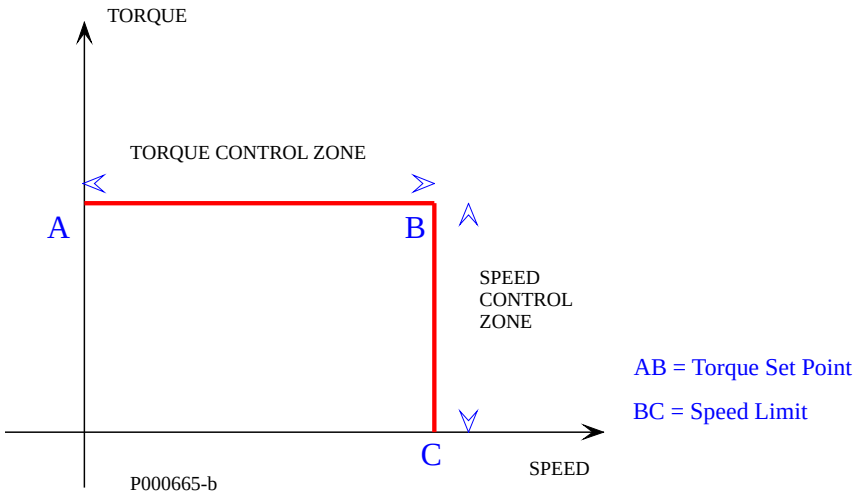


Figure 3: Torque control with speed limit

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	
	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	
	Address	635, 637 639	
	Control	SYN	
	Function	When in speed control mode or position control mode, 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.	

C012 (C055, C098) Feedback from Encoder/Resolver

C012 (mot. n.1) C055 (mot. n.2) C098 (mot. n.3)	Range	0 ÷ 1	0: No 1: Yes
	Default	0	0: No
	Level	BASIC	
	Address	1012, 1055, 1098	
	Control	SYN	
	Function	Enables using the position transducer. See the ENCODER/FREQUENCY INPUTS MENU in order to define the characteristics of the position transducer and to define whether encoder A (terminal board MDI6 and MDI7), encoder B (optional board) or the absolute encoder/resolver is used for the speed feedback. If **C010=1: SYN**, this parameter is automatically set to [1: Yes] and cannot be changed, because the SYN control requires a position transducer.	

C013 (C056, C099) Type of V/F Pattern

C013 (mot. n.1) C056 (mot. n.2) C099 (mot. n.3)	Range	0 ÷ 2	0: Constant Torque 1: Quadratic 2: Free Setting
	Default	See relevant Tables in the **Programming Guide**.	
	Level	BASIC	
	Address	1013, 1056, 1099	
	Control	IFD	
	Function	Enables selecting different types of V/f patterns: If **C013 (C056, C099) = Constant torque**, voltage at zero frequency can be selected (Preboost **C034** (**C077, C120**). If **C013 (C056, C099) = Quadratic** you can select: voltage at zero frequency (preboost, **C034** (**C077,C120**)), maximum voltage drop with respect to the theoretical V/f pattern, **C032** (**C075 C118**), and the frequency allowing implementing max. voltage drop, **C033** (**C076, C119**). If **C013 (C056, C099) = Free setting** you can select: voltage at zero frequency (preboost **C034** (**C077, C120**)); voltage increase to 20% of the rated frequency (Boost0 **C035** (**C078, C121**)); voltage increase to a programmed frequency (Boost1 **C036** (**C079, C122**); frequency for Boost1 **C037** (**C080, C123**)).	

C014 (C057, C100) Phase rotation

C014 (mot. n.1) C057 (mot. n.2) C100 (mot. n.3)	Range	0÷1	0: [No]; 1: [Yes]
	Default	0	0: [No]
	Level	ENGINEERING	
	Address	1014, 1057,1100	
	Function	Allows reversing the mechanical rotation of the connected motor.	

DANGER!!! The activation of **C014 (C057, C100)** causes the mechanical rotation of the motor and the connected load to reverse accordingly.

C015 (C058, C101) Rated Motor Frequency

C015 (mot. n.1) C058 (mot. n.2) C101 (mot. n.3)	Range	10 ÷ 10000	1.0 Hz ÷ 1000.0 Hz
		See upper limits according to the relevant Table in the **Programming Guide**.	
	Default	500	50.0 Hz
	Level	BASIC	
	Address	1015, 1058, 1101	
	Function	This parameter defines the rated motor frequency (nameplate rating). For SYN control, it is to be calculated as follows: **fmot** = **rpmnom**/60 * **p**, where: **rpmnom** is the rated motor speed in rpm **p** is the number of pole pairs of the connected motor. Example: rpmnom=3000rpm p=3 pole pairs (6 poles) fmot=3000/60*3=150	

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

C015a (mot. n.1) C058a (mot. n.2) C101a (mot. n.3)	Range	0 ÷ 65000	0.00 ÷ 650.00 V/(rad/s)
	Default	0	0.00 V/(rad/s)
	Level	BASIC	
	Address	753, 764, 1236	
	Control	SYN	
	Function	BEMF of the synchronous motor. This parameter may automatically be updated by the relevant tuning command (**I074 = 4: SYN BEMF tune**).	

C016 (C059, C102) Rated motor RPM

C016 (mot. n.1) C059 (mot. n.2) C102 (mot. n.3)	Range	1 ÷ 32000	1 ÷ 32000 rpm
	Default	1500	1500 rpm
	Level	BASIC	
	Address	1016, 1059, 1102	
	Function	This parameter defines the rated motor rpm (nameplate rating).	

C017 (C060, C103) Rated Motor Power

C017 (mot. n.1) C060 (mot. n.2) C103 (mot. n.3)	Range	1 ÷ 32000	0.1 ÷ 3200.0 kW
		Upper limited to twice the default value	
	Default	See relevant tables in the **Programming Guide**.	
	Level	BASIC	
	Address	1017, 1060, 1103	
	Function	This parameter defines the rated motor power (nameplate rating).	

C018 (C061, C104) Rated Motor Current

C018 (mot. n.1) C061 (mot. n.2) C104 (mot. n.3)	Range	1 ÷ 32000	0.1 ÷ 3200.0 A
		See twice the upper values in **Inom** column in Table 73 and Table 77 in the **Programming Guide R07**.	
	Default	See relevant tables in the **Programming Guide**.	
	Level	BASIC	
	Address	1018, 1061, 1104	
	Function	This parameter defines the rated motor current (nameplate rating).	

C019 (C062, C105) Rated Motor Voltage

C019 (mot. n.1) C062 (mot. n.2) C105 (mot. n.3)	Range	50 ÷ 12000	5.0 ÷ 1200.0 V
	Default	2300 for class 2T drives 4000 for class 4T drives 5750 for class 5T drives 6900 for class 6T drives	230.0V for class 2T drives 400.0V for class 4T drives 575.0V for class 5T drives 690.0V for class 6T drives
	Level	BASIC	
	Address	1019, 1062, 1105	
	Function	This parameter defines the rated motor voltage (nameplate rating).	

C020 (C063, C106) No-load Motor Power

C020 (mot. n.1) C063 (mot. n.2) C106 (mot. n.3)	Range	0 ÷ 1000	0.0 ÷ 100.0%
	Default	0	0.0%
	Level	ADVANCED	
	Address	1020, 1063, 1106	
	Control	IFD	
	Function	This parameter defines the power absorbed by the motor at rated voltage and rated rpm when no load is connected to the motor. It is expressed as a percentage of the value in parameter **C017**.	

C021 (C064, C107) No-load Motor Current

C021 (mot. n.1) C064 (mot. n.2) C107 (mot. n.3)	Range	1 ÷ 100	1 ÷ 100%
	Default	0	0%
	Level	ADVANCED	
	Address	1021, 1064, 1107	
	Control	IFD	
	Function	This parameter defines the current absorbed by the motor at rated voltage and rated rpm when no load is connected to the motor. It is expressed as a percentage of the rated motor current **C018** (**C061**, **C104**).	

C022 (C065, C108) Motor Stator Resistance

C022 (mot. n.1) C065 (mot. n.2) C108 (mot. n.3)	Range	0 ÷ 32000	0.000 ÷ 32.000Ω
	Default	See relevant tables in the **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 value of the resistance of one phase (half the resistance measured between two terminals); if a delta connection is used, it matches with 1/3 of the resistance of one phase. Autotune is always recommended. This parameter may automatically be updated by the relevant tuning command: SYN Control: **I074 = 4: SYN BEMF tune** IFD Control: **I074 = 0: IFD Control Auto no Rot.**	

C022a (C065a, C108a) Phase Inductance (Synchronous Motor)

C022a (mot. n.1) C065a (mot. n.2) C108a (mot. n.3)	Range	0 ÷ 65000	0.00 ÷ 65.000 mH
	Default	0	0.00 mH
	Level	ENGINEERING	
	Address	754, 765, 1237	
	Control	SYN	
	Function	Single-phase inductance of the synchronous motor. This parameter may automatically be updated by the relevant tuning command (**I074 = 4: SYN BEMF tune**)	

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

C022b (mot. n.1) C065b (mot. n.2) C108b (mot. n.3)	Range	0 ÷ 65000	0.000 ÷ 65.000 kgm^2
	Default	0	0.000 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	0 ÷ 65000	0 ÷ 65000 kgmm^2
	Default	300	300 kgmm^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 two different units of measure: C022b is in kgm^2, C022c is in kgmm^2. The relation between the two units of measure is:
1 kgm^2 = 1000000 kgmm^2

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.	

C023 (C066, C109) Motor Leakage Inductance

C023 (mot. n.1) C066 (mot. n.2) C109 (mot. n.3)	Range	0 ÷ 32000	0.00 ÷ 320.00mH
	Default	See relevant tables in the **Programming Guide**.	
	Level	ENGINEERING	
	Address	1023, 1066, 1109	
	Control	IFD	
	Function	Sets the total leakage inductance of the connected motor. If a star connection is used, it matches with the value of the inductance of one phase; if a delta connection is used, it matches with 1/3 of the inductance of one phase. Autotune is always recommended.	

NOTE

By means of the Autotuning function, calculate the value of the leakage inductance (**C023**). From the resulting value, manually subtract the value in mH of the output inductance (if any).

C024 (C067, C110) Mutual Inductance

C024 (mot. n.1) C067 (mot. n.2) C110 (mot. n.3)	Range	0 ÷ 65000	0.00 ÷ 650.00mH
	Default	25000	250.00mH
	Level	ADVANCED	
	Address	1024, 1067, 1110	
	Control	IFD	
	Function	This parameter defines the mutual inductance of the connected motor. The approximate value of the mutual inductance results from no-load current according to the formula below: $M \cong (Vmot - Rstat*Io) / (2\pi fmot* Io)$	

NOTE

Parameter **C024** (mutual inductance) is **automatically calculated** based on the preset no-load current value (**C021**) whenever parameters **I073** and **I074** are set as follows:
I073 = [1: Motor Tune]
I074 = [0: All no rotation]
whether current loop tuning is performed or not.

C026 (C069, C112) Time Constant of Bus Voltage Low-pass Filter

C026 (mot. n.1) C069 (mot. n.2) C112 (mot. n.3)	Range	0 ÷ 32000	0.0 ÷ 3200.0 ms
	Default	0	0.0 ms
	Level	ENGINEERING	
	Address	1026, 1069, 1112	
	Function	This parameter defines the time constant of the low-pass filter of the bus voltage readout. Changing this value can avoid motor oscillations, especially when no load is connected to the motor.	

C028 (C071, C114) Minimum Motor Speed

C028 (mot. n.1) **C071 (mot. n.2)** **C114 (mot. n.3)**	**Range**	–32000 ÷ 32000 (*)	–32000 ÷ 32000 rpm (*)
	Default	0	0 rpm
	Level	BASIC	
	Address	1028, 1071, 1114	
	Function	This parameter defines the minimum speed of the connected motor. When references forming the total reference are at their min. relative value, the total reference equals the min. speed of the connected motor. *Example:* CONTROL METHOD MENU **C143** → [1: REF] Selection of reference 1 source **C144** → [2: AIN1] Selection of reference 2 source **C145** → [0: Disable] Selection of reference 3 source **C146** → [0: Disable] Selection of reference 4 source INPUTS FOR REFERENCES MENU **P050** → [0: ±10 Type of reference for REF input **P051** → [– 10V] Value of the min. reference for REF input **P052** → [+10V] Value of the max. reference for REF input **P055** → [0: ±10 Type of reference for AIN1 input **P056** → [– 5 V] Value of min. reference for AIN1 input **P057** → [+5 V] Value of max. reference for AIN1 input The speed reference is the min. speed set in **C028** (motor 1) when both REF input and AIN1 input values are lower than or equal to the minimum values set in **P051** and **P056** respectively.	

(*) NOTE The maximum allowable value (as an absolute value) for **C028** and **C029** (minimum and maximum motor speed) also depends on the preset **maximum carrier frequency** (see Table 63 in the **Programming Guide R.07**). It can be max. 4 times the rated speed of the connected motor.

NOTE The value set as the min. speed is used as the saturation of the total reference; the speed reference will never be lower than the value set as minimum speed.

NOTE The minimum speed is not respected only when the REV command or the CW/CCW command is sent after setting a value for max. speed exceeding the minimum value (**C029**>**C028** for motor 1) and with the maximum reference to the drive. The motor rpm will be –**C029** <**C028**.

C029 (C072, C115) Maximum Motor Speed

C029 (mot. n.1) C072 (mot. n.2) C115 (mot. n.3)	**Range**	0 ÷ 32000 (*see note in parameter **C028**)	0 ÷ 32000 rpm (*see note in parameter **C028**)
	Default	1500	1500 rpm
	Level	BASIC	
	Address	1029, 1072, 1115	
	Function	This parameter defines the maximum speed of the connected motor. When references forming the global reference are at their maximum relative value, the global reference equals the max. speed of the connected motor. If **C011** (**C054**, **C097**) = **2: Torque with speed limit**, this parameter is used to limit the motor rotation.	

NOTE

In the CONTROL METHOD MENU, if an external speed/torque limit source (**C147**) is selected, the speed limit value set with this parameter is the upper limit, that can be reduced by adjusting the external source. Also, the ramp times set in the RAMPS MENU (**P009–P025**) are applied to this limit.

C031 (C074, C117) Maximum Speed Alarm

C031 (mot. n.1) C074 (mot. n.2) C117 (mot. n.3)	**Range**	0 ÷ 32000	0: [Disabled] ÷ 32000 rpm
	Default	0	0: Disabled
	Level	ADVANCED	
	Address	1031, 1074, 1117	
	Function	If it is not set to zero, this parameter determines the speed value to be entered for the maximum speed alarm (**A076**).	

C032 (C075, C118) Reduction in Quadratic Torque Curve

C032 (mot. n.1) C075 (mot. n.2) C118 (mot. n.3)	**Range**	0 ÷ 1000	0 ÷ 100.0%
	Default	300	30.0%
	Level	ADVANCED	
	Address	1032, 1075, 1118	
	Control	IFD	
	Function	If the V/f curve pattern **C013 (C056, C099) = Quadratic**, this parameter defines the maximum voltage reduction in terms of theoretical V/f pattern, which is implemented at the frequency programmed in **C033 (C076, C119)**.	

C033 (C076, C119) Frequency for Maximum Reduction in Quadratic Torque Curve

C033 (mot. n.1) C076 (mot. n.2) C119 (mot. n.3)	Range	1 ÷ 100	1 ÷ 100%
	Default	20	20%
	Level	ADVANCED	
	Address	1033, 1076, 1119	
	Control	IFD	
	Function	If the V/f pattern **C013 (C056, C099) = Quadratic**, this parameter defines the frequency implementing the maximum torque reduction in terms of theoretical V/f pattern set in **C032 (C075, C120)** (see section V/F Pattern Parameters in the **Programming Guide**.	

C034 (C077, C120) Torque Curve Increment Preboost

C034 (mot. n.1) C077 (mot. n.2) C120 (mot. n.3)	Range	0 ÷ 50	0.0 ÷ 5.0 %
	Default	See relevant tables in the **Programming Guide**.	
	Level	BASIC	
	Address	1034, 1077, 1120	
	Control	IFD	
	Function	Torque compensation at minimum frequency produced by the drive. Determines the increase of the output voltage at 0Hz.	

C035 (C078, C121) Torque Curve Increment Boost 0

C035 (mot. n.1) C078 (mot. n.2) C121 (mot. n.3)	Range	–100 ÷ +100	–100 ÷ +100 %
	Default	See relevant tables in the **Programming Guide**.	
	Level	ADVANCED	
	Address	1035, 1078, 1121	
	Control	IFD	
	Function	Torque compensation at low rpm. Determines how output voltage varies at 5% of the rated motor frequency with respect to the voltage obtained with a constant V/f pattern (constant voltage frequency).	

C036 (C079, C122) Torque Curve Increment Boost 1

C036 (mot. n.1) C079 (mot. n.2) C122 (mot. n.3)	Range	–100 ÷ +400	–100 ÷ +400 %
	Default	See relevant tables in the **Programming Guide**.	
	Level	ADVANCED	
	Address	1036, 1079, 1122	
	Control	IFD	
	Function	Torque compensation at preset frequency (parameter **C037** for motor 1, **C080** for motor 2 and **C123** for motor 3). Determines how output voltage varies at preset frequency with respect to voltage obtained with a constant V/f pattern (constant voltage frequency).	

C037 (C080, C123) RPM Relating to C36 (C079,C122) (Frequency for Application of Boost 1)

C037 (mot. N.1) C080 (mot. n.2) C123 (mot. n.3)	Range	6 ÷ 99	6 ÷ 99 %
	Default	See relevant tables in the **Programming Guide**.	
	Level	ADVANCED	
	Address	1037, 1080, 1123	
	Control	IFD	
	Function	Frequency for application of voltage Boost with parameter **C036** for motor 1, parameter **C079** for motor 2 and parameter **C122** for motor 3. This is expressed as a percentage of the rated motor frequency.	

C038 (C081, C124) Torque Curve Automatic Increment

C038 (mot. n.1) C081 (mot. n.2) C124 (mot. n.3)	Range	0 ÷ 10	0 ÷ 10 %
	Default	See relevant tables in the **Programming Guide**.	
	Level	ADVANCED	
	Address	1038, 1081, 1124	
	Control	IFD	
	Function	Variable torque compensation expressed as a percentage of the rated motor voltage. The preset value expresses the voltage increase when the motor is running at its rated torque.	

C039 (C082, C125) Slip Compensation

C039 (mot. n.1) C082 (mot. n.2) C125 (mot. n.3)	Range	0 ÷ 200	[0: Disabled] ÷ 200 %
	Default	0	[0: Disabled]
	Level	ADVANCED	
	Address	1039, 1082, 1125	
	Control	IFD	
	Function	This parameter represents the rated motor slip expressed as a value percent. If set to 0, this function is disabled.	

C040 (C083, C126) Voltage Drop at Rated Current

C040 (mot. n.1) C083 (mot. n.2) C126 (mot. n.3)	Range	0÷500	0÷50.0%
	Default	0	0: Disabled
	Level	ADVANCED	
	Address	1040, 1083, 1126	
	Control	IFD	
	Function	Defines the increase in voltage (in terms of the corresponding produced frequency) when the current produced by the motor is greater than or equal to the rated current. For example: **C040 = 10%** Voltage drop at rated current **C013 = Constant Torque** Type of V/f pattern **C015 = 50 Hz** Rated frequency **C019 = 380 V** Rated voltage If the drive output frequency is 25 Hz, it must deliver 190V. When the output current is equal to the rated current of the motor (**C018**), the voltage actually produced is Vout = 190 * (1+ **C040**/100) = 209V.	

C042 (C085, C0128) Vout Saturation Percentage

C042 (mot. n.1) C085 (mot. n.2) C128 (mot. n.3)	Range	10 ÷ 120	10 ÷ 120 %
	Default	100	100%
	Level	ENGINEERING	
	Address	1042, 1085, 1128	
	Function	This parameter sets the bus voltage value percent used to generate the output voltage of the drive. Changes made to this parameter affect the motor performance in terms of defluxing.	

7.6. DIGITAL INPUTS MENU

The following parameter has been added to the Digital Inputs menu for the Synchronous Motor application:

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** and **START** input.	

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

7.7. ENCODER/FREQUENCY INPUTS MENU

7.7.1. 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 the Sinus Penta's **Installation Guide**), 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**.

7.7.2. 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 the Sinus Penta's **Installation Guide**).
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** option 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.

7.7.3. WHEN USING ES836 OR ES913

• **Reading 1 or 2 Incremental Encoders:**
To read one Encoder, use the optional board or digital inputs **MDI6** and **MDI7** (if a push–pull encoder is used).
Both the optional board and digital inputs **MDI6** and **MDI7** can be used to read two encoders at a time. Use parameter **C189** to set the readout of the speed measure of the controlled motor or to read reference values.
You can use encoder **A** or encoder **B** as a speed feedback or a reference source (speed reference, torque reference or PID reference).

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) 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); 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** option 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 option 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 MDI6 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).

7.7.4. WITH OPTIONAL BOARDS FOR ABSOLUTE POSITION TRANSDUCERS

7.7.4.1. 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 **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 **Programming Guide**) because the motor feedback is assigned to the absolute transducer selected by **R023a**.

7.7.4.2. 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**

7.7.5. LIST OF PARAMETERS C189 TO C199

Table 8: List of Parameters C189 ÷ C199

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 searching error timeout	ENGINEERING	1192	5.00 sec
C193	Error between reference and speed	ENGINEERING	1193	300 rpm
C194	Tracking error alarm enable	ENGINEERING	1194	1: Active
C195	Filter time constant over value of feedback from encoder	ENGINEERING	1195	5.0 ms
C196	Filter time constant over value of reference from encoder	ENGINEERING	1196	5.0 ms
C197	Number of channels of Encoder A	ENGINEERING	1197	0:2 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 11
	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 option 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 **Programming Guide**) and the encoder to be used as a speed feedback. Configuration allowed for quick acquisition digital inputs is given in Table 11. The matching between the different physical encoders and logic encoders **A** and **B** is given in Table 9 and Table 10. 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 **Programming Guide**).

NOTE

If a board acquiring absolute position 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 9: 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 10: Matching between physical encoders and logic encoder B

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

Table 11: 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 9).	

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 10).	

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 searching error to digital outputs set with BRAKE or LIFT mode. Digital outputs are then disabled.	

C193 Speed Error Threshold

C193			
	Range	0 ÷ 32000	0 ÷ 32000 rpm
	Default	300	300 rpm
	Level	ENGINEERING	
	Address	1193	
	Function	If the speed alarm (**C194**) is enabled 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 searching 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 12
	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 12: 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	This parameter is active if the resolver is selected as a position sensor (**R023a=1**). Adjustment value (+) of the potentiometer for the resolver excitation signal. Adjustment is manual. Measure **M125** is a useful feedback.	

C203 EXC– Adjustment

C202	Range	0 ÷ 255	0 ÷ 255
	Default	75	75
	Level	ENGINEERING	
	Address	1203	
	Function	This parameter is active if the resolver is selected as a position sensor (**R023a=1**). Adjustment value (–) of the potentiometer for the resolver excitation signal. Adjustment is manual. Measure **M125** is a useful feedback.	

7.8. EXPANSION BOARD CONFIGURATION MENU

7.8.1. 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/encoders. 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 13: 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	-	**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**
	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

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.

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

Table 14: 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 singleturn 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 15.	

Table 15: 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 position sensor used for motor control. Refer to Table 16. The sensor set in this parameter is used for motor control regardless of the value set in C189.	

Table 16: 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 position 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 17. 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 17: 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	12	12 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.

7.9. ALARMS SPECIFIC TO SYN APPLICATION

7.9.1. OVERVIEW

This section covers only the alarms specific to the SYN application.
Refer to the **Programming Guide** for the whole list of the Sinus Penta alarms.

7.9.2. LIST OF THE ALARM CODES

Table 18: List of the Alarms specific to the SYN 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, contact the CUSTOMER SERVICE of ELETTRONICA 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, contact the CUSTOMER SERVICE of ELETTRONICA SANTERNO.

A132 Motor not Aligned

A132	Description	No alignment between rotor/position sensor.
	Event	When the ENABLE closes (except for the autotuning and alignment procedures), the system detects that the rotor is not aligned with the position sensor, so the motor cannot be properly controlled. If a relative position sensor is used (incremental encoder or 3-channel Sin/Cos encoder), 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, contact the CUSTOMER SERVICE of ELETTRONICA SANTERNO.