• 15R0102B1 •

SINUS PENTA

MULTIFUNCTION AC DRIVE

USER MANUAL

-Programming Instructions-

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SW VER. 1.67x

English

• This manual is integrant and essential to the product. Carefully read the instructions contained herein as they provide important hints for use and maintenance safety.
• This device is to be used only for the purposes it has been designed to. Other uses should be considered improper and dangerous. The manufacturer is not responsible for possible damages caused by improper, erroneous and irrational uses.
• **Elettronica Santerno is responsible for the device in its original setting.**
• Any changes to the structure or operating cycle of the device must be performed or authorized by the Engineering Department of Elettronica Santerno.
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0.4. How to Use this Manual

0.4.1. Overview

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

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

- Display/keypad unit;
- Serial link through RS485 standard port or ES822 (isolated optional serial board) RS485/RS32;
- ES851 (optional Data Logger and communications board).

For the instructions on how to use and remote the display/keypad unit, please refer to the Sinus Penta's Installation Manual.

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

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

0.4.2. Special Applications Dedicated to Sinus Penta Drives

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

NOTE	In order to install your application SW and update the firmware packets of your SINUS PENTA drive, you can use the Remote Drive software provided by Elettronica Santerno. Please refer to the RemoteDrive's User Manual for detailed instructions.

Any detail concerning optional functionality is given in separate manuals covering PENTA's optional applications.

0.4.3. MENUS AND SUBMENUS

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

Programming parameters and Measure parameters are divided into:

Mxxx Measures (always Read Only):

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

Pxxx Parameters (always R/W):

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

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

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

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

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

NOTE

Unlike **Cxxx** parameters, **Rxxx** parameters become active only after the drive has been switched off and switched on again, or after resetting its control board by pressing the **RESET** button for more than 5 seconds.

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

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

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

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

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

0.4.4. Alarms and Warnings

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

Axxx	Description	
	Event	
	Possible cause	
	Solution	

1. USING THE DISPLAY/KEYPAD UNIT

1.1. Overview

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

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

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

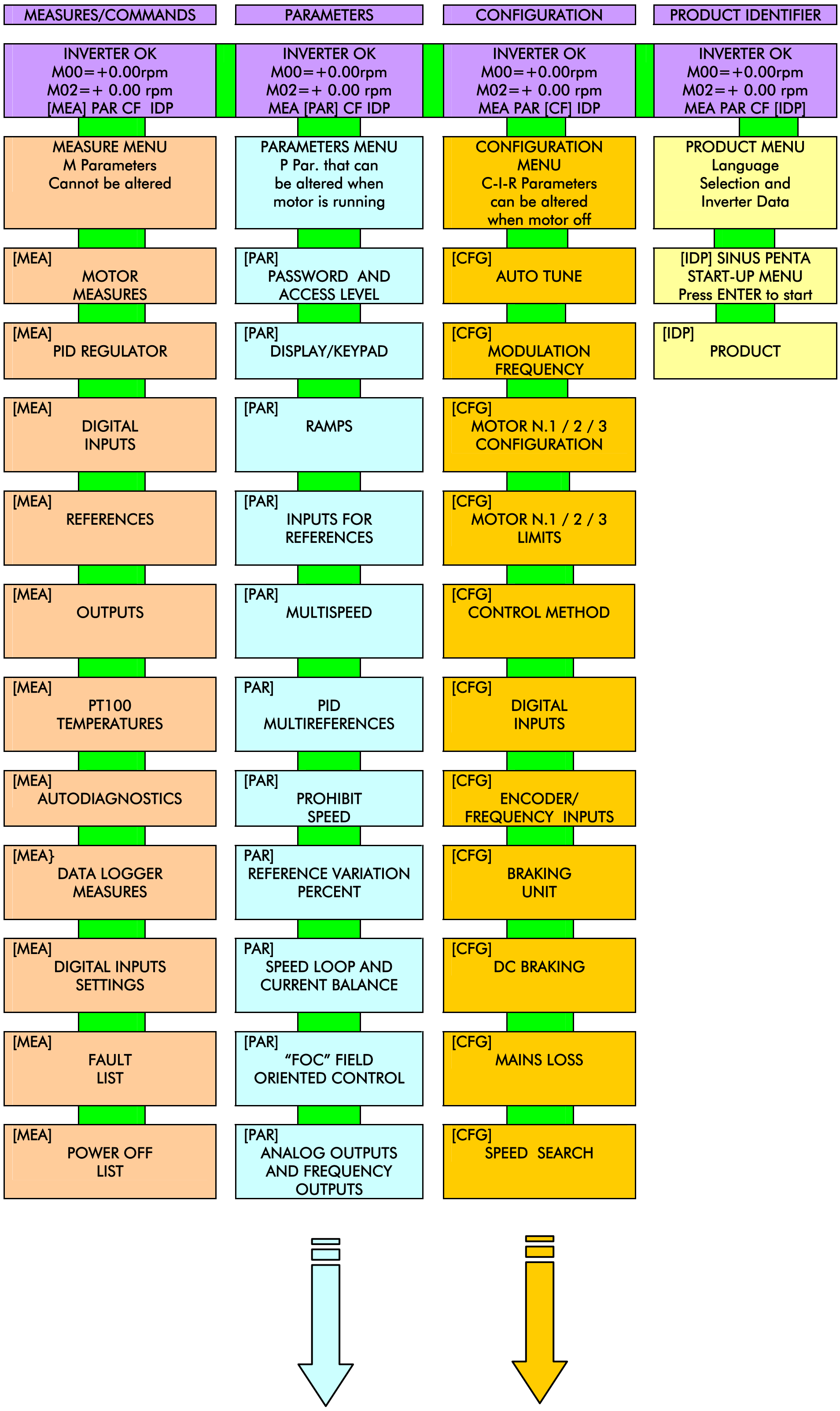
The complete tree structure is displayed, but the actual structure depends on the user level set in P001 and on the implemented programming. For example, if only motor 1 is programmed (C009=1), the menus relating to motors 2 and 3 will not be displayed (Motor 2/3 Configuration and Motor 2/3 Limit). Also,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

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

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

The function keys and their functionality are described below.

1.2. Menu Tree


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

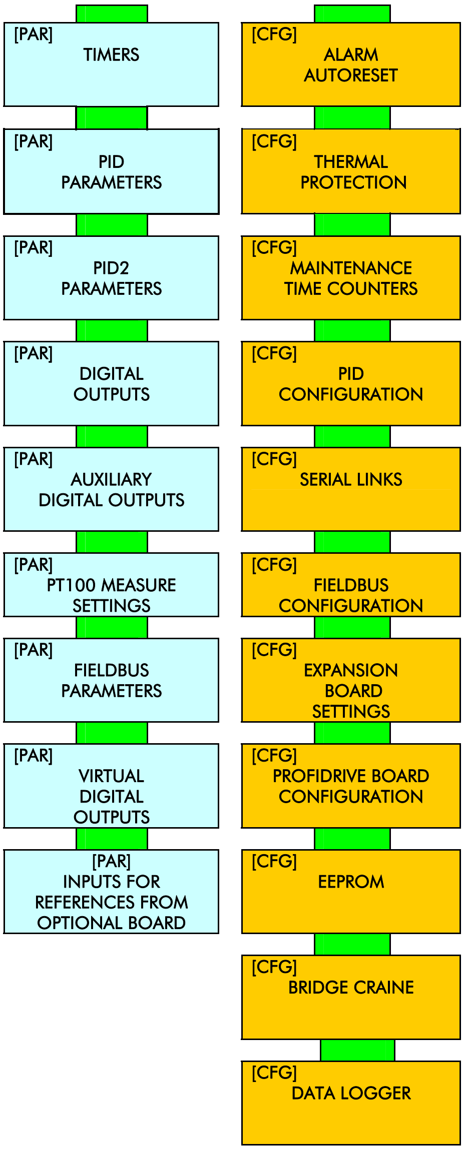


Figure 1: Menu Tree.

1.3 Navigation

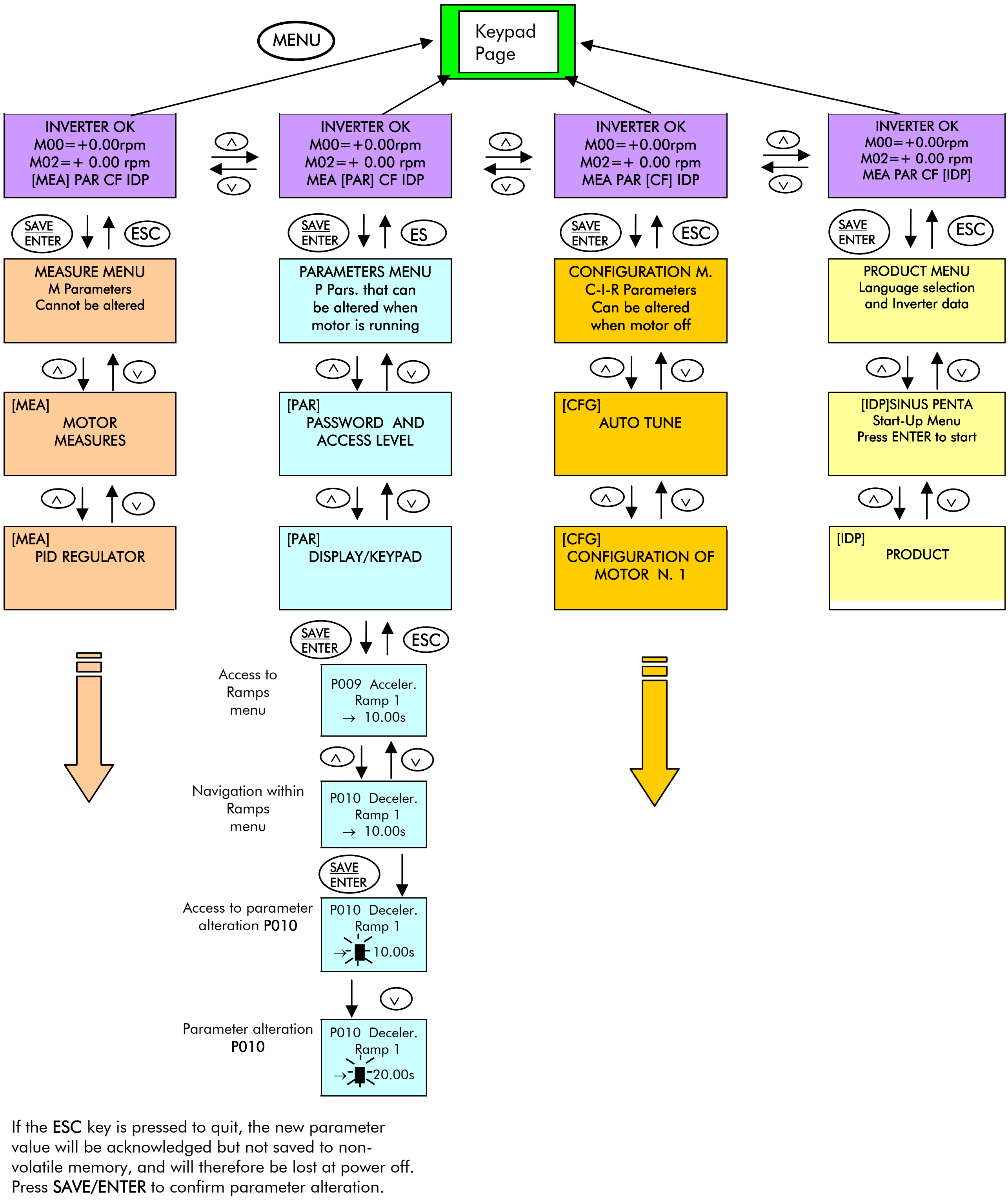


Figure 2: Navigation example.

1.4. Parameter Alteration

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

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

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

Press the SAVE/ENTER key for parameter alteration; when a flashing cursor appears, press ▲ and ▼ to change the parameter value. Do one of the following to quit the editing mode:
Press ESC → the parameter value used by the drive is altered and is maintained until the drive is shut down.
Press SAVE/ENTER → the parameter value is stored to non-volatile memory and is not deleted when the drive is shut down.
Inputs (Ixxx) cannot be saved to non-volatile memory and are automatically set to their default values.
Rxxx parameters become active only when the drive control board has been reset by pressing the RESET key for a few seconds or by switching off the drive.

1.5. Programming the Root Page

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

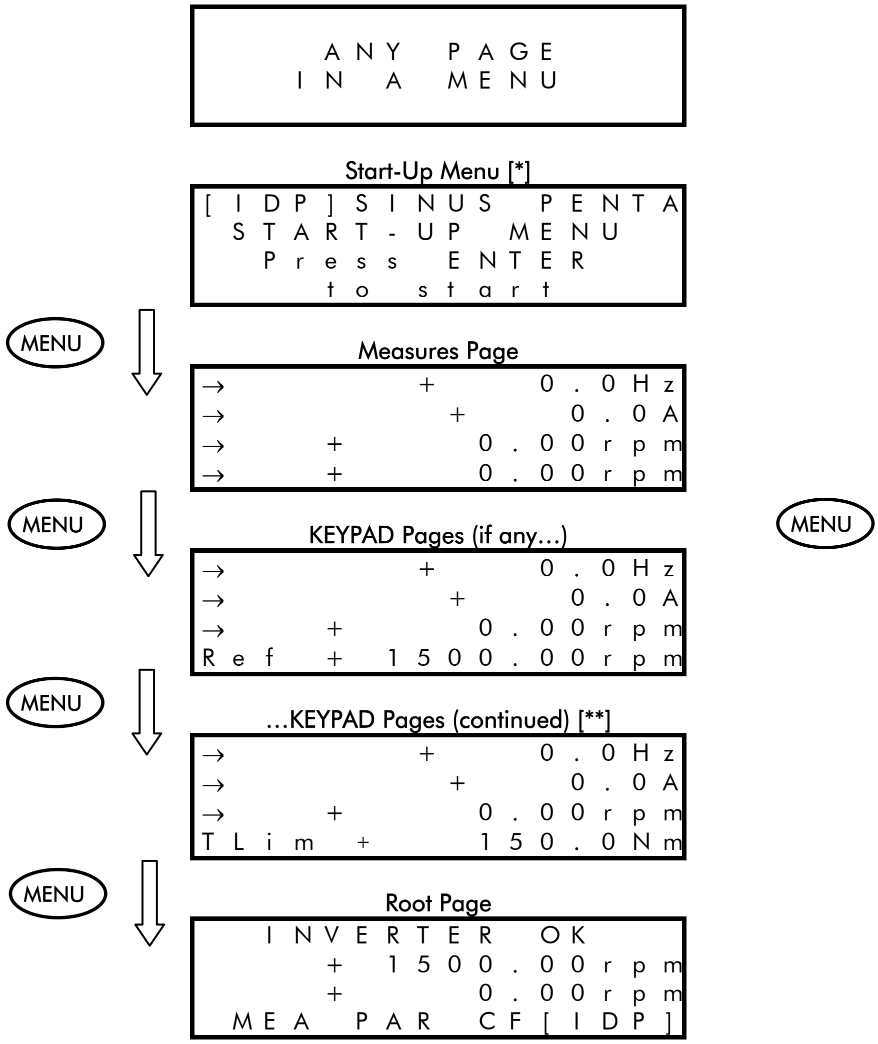
Root page

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

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

1.6. Using the MENU Key

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

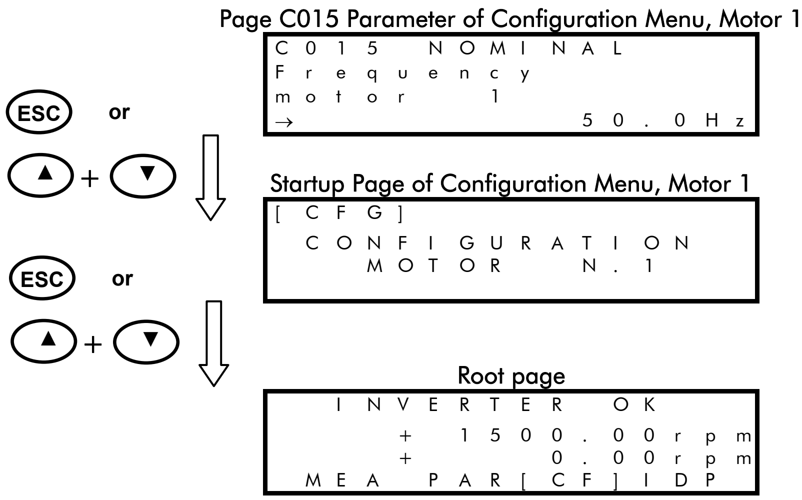


NOTE [*] The Start-Up menu is available only if **P265**=3:Start-Up (see the DISPLAY/KEYPAD MENU).

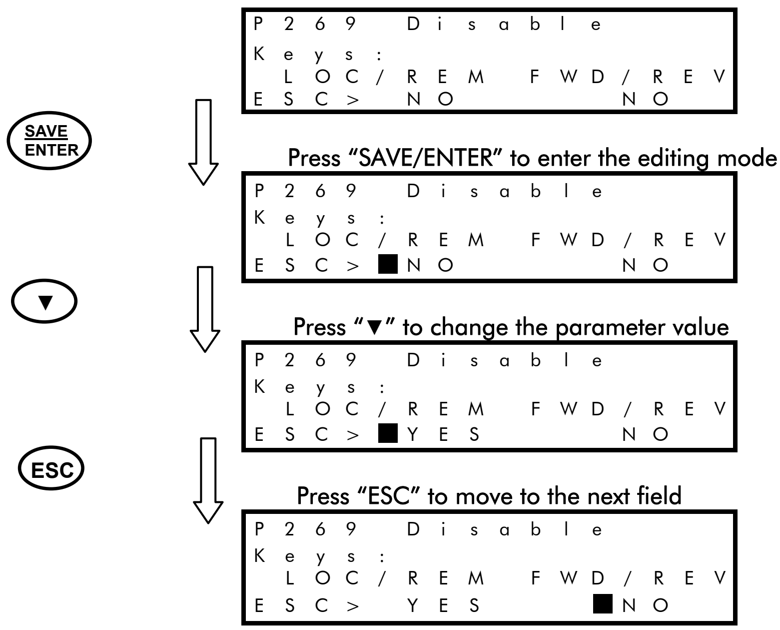
NOTE [**] The Keypad pages are available only if the relevant references / feedback / limits are activated (see the CONTROL METHOD MENU and the PID CONFIGURATION MENU).

1.7. ESC Key (Pressing ▲ and ▼ at a time)

Simultaneously press the ▲ and ▼ keys to perform the same function as the **ESC** key and to move up one level in the menu tree.
In the example below, starting from parameter **C015** in the MOTOR CONTROL MENU inside the Configuration Menu, you can move up to the Root page by pressing the **ESC** key or the ▲ and ▼ keys at a time.



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



Press the following keys to quit the last page displayed:

- **ESC** (new values are not saved to Eeprom)
- **SAVE/ENTER** (new values are saved to Eeprom).

1.8. RESET Key (Alarm and Control Board Reset)

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

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

Use the keypad to perform the UPLOAD (parameters stored in the drive are copied to the keypad) and DOWNLOAD (parameters stored in the keypad are copied to the drive) functions.
Press the **TX/RX** key to go to the UPLOAD page; press the **TX/RX** key again to toggle between the UPLOAD and DOWNLOAD pages.

NOTE

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

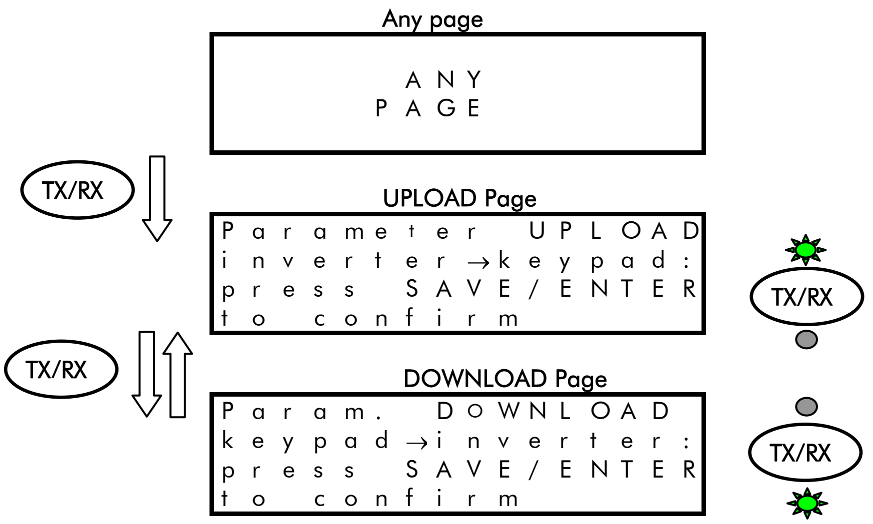
NOTE

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

The **TX/RX** key is disabled under the following conditions:

- no password is entered in **P000**
- the OPERATOR mode is activated with the **MENU** Key (**P264b** = OPERATOR)
- the drive is running.

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



Press **SAVE/ENTER** from the UPLOAD (/DOWNLOAD) page to confirm UPLOADING (/DOWNLOADING). The relevant LED will come on (fixed light).
If the **SAVE/ENTER** key is not pressed for confirmation within 10 seconds from the selection of the UPLOAD (/DOWNLOAD) page, the starting page is automatically displayed.

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

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

1.10. LOC/REM Key (Keypad Pages)

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

NOTE

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

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

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

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

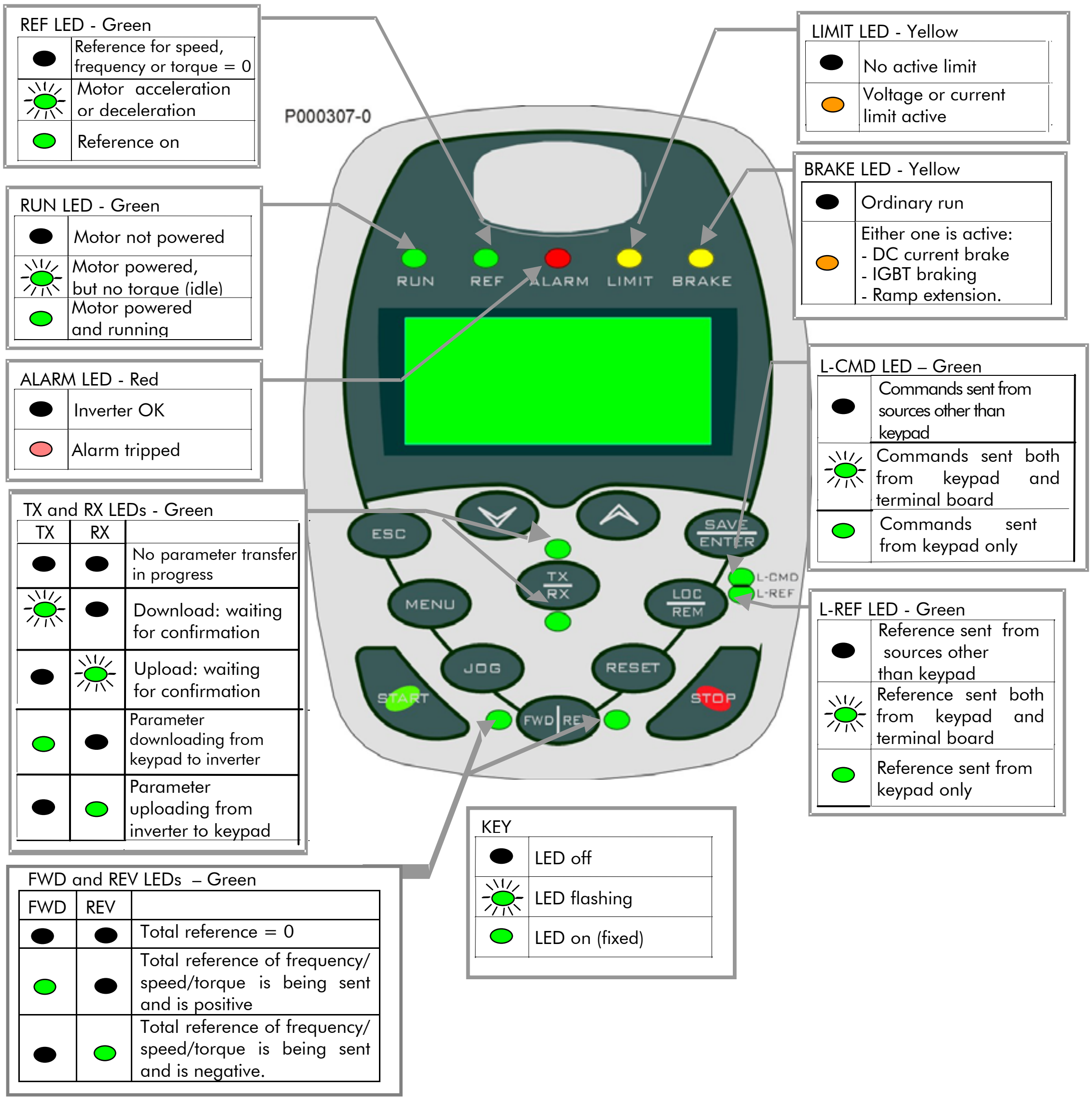
1.11. SAVE/ENTER Key

The SAVE/ENTER key allows selecting a lower level when navigating within the programming menus. It also allows changing a parameter value (to change a parameter value, press the SAVE/ENTER key from the page of the parameter you want to alter). An example is given in
.
From the Keypad pages, the SAVE/ENTER key allows accessing the Keypad Help page containing any details about the measures displayed in the Keypad page.

1.12. Indicator LEDs on the Display/Keypad

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

Figure 3: Display/keypad.



NOTE See also the OPERATING AND REMOTING THE KEYPAD section in the Sinus Penta's **Installation Instructions** manual.

2. DESCRIPTION OF INPUT AND OUTPUT SIGNALS

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

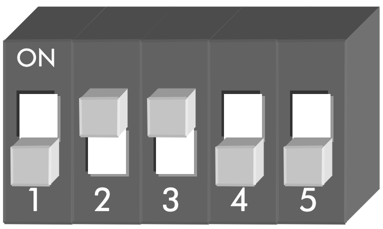
- 3 Analog Inputs (single-ended REF input, differential AIN1 & AIN2 inputs) that can be programmed as voltage/current inputs via SW1 DIP-switch (see Configuration DIP-switches in the Sinus Penta's Installation Instructions Manual).
- 3 Analog Outputs that can be programmed as voltage/current inputs via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

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

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

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

SW1



3. REFERENCES AND FEEDBACKS

The drive references are the following:

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

3.1. Main Speed/Torque Reference

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

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

3.2. Speed/Torque Limit Reference

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

3.3. PID Reference

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

3.4. PID Feedback Reference

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

4. PROGRAMMABLE FUNCTIONS

4.1. Multimotor

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

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

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

4.2. Voltage/Frequency Pattern

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

4.3. Slip Compensation

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

4.4. Speed Searching

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

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

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

4.6. DC Braking

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

4.7. Motor Thermal Protection

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

4.8. Prohibit Speeds

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

4.9. Digital PID Regulator

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

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

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

4.10. Bridge Crane Application

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

4.11. Setting Two Alternative Command Sources and Reference Sources

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

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

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

CAUTION

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

See also parameter **C179** in the DIGITAL INPUTS MENU.

4.12. Fire Mode

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

CAUTION

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

NOTE

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

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

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

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

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

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

CAUTION

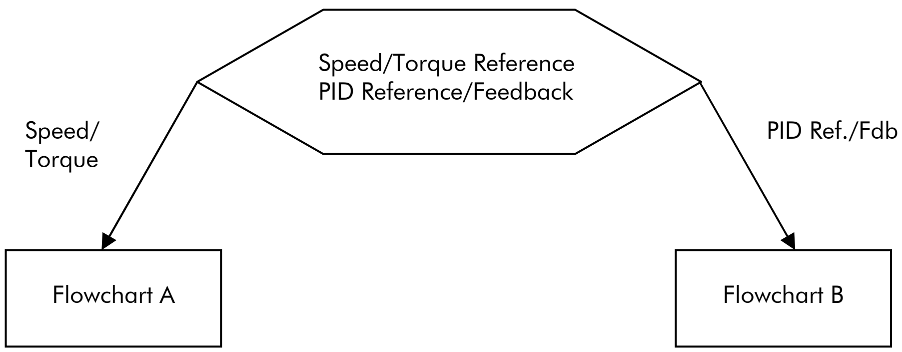
If an asterisk (*) appears next to INVERTER OK on the display, the product guarantee is no longer valid.
The asterisk appears if at least one condition requiring the activation of a protection feature occurs when the inverter is running in Fire Mode.

5. PROGRAMMING EXAMPLES

5.1. Overview

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

5.2. Programming a Reference



FLOWCHART A

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

Selecting the Reference Sources

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

Forcing the Reference Sources

Sources:

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

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

Sources :

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

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

FLOWCHART B

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

Selecting the
Reference/Feedback Sources

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

Forcing the
Reference/Feedback Sources

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

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

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

Sources :	
Serial Link	Reference from serial link
Fieldbus	Reference from fieldbus
Keypad	Ref. from display/keypad
Feedback reference only :	
Iout	Output current
Vout	Output voltage
Vdc	DC bus voltage
Pout	Output power

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

EXAMPLE

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

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

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

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

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

Setting the reference from digital inputs:

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

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

In the **Multispeed** menu, set the speed steps as follows:

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

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

5.3. Configuring the External Torque Limit

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

Selecting the Reference Source

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

Forcing the Reference Sources

Sources:

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

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

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

Sources:

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

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

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

5.4. Configuring the Feedback from Encoder

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

Setting the Speed Feedback

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

Selecting the Encoder

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

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

ENCODER B
Encoder acquired via option board **ES836** (see the Installation Instructions manual for the Configuration of the jumper and the dip-switches for the encoder type and supply).

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

Checking the Encoder

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

When performing the Autotune function, the encoder signal used as feedback is automatically corrected (see **C199**).

5.5. Configuring a Reference from Encoder

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

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

Selecting the Encoder

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

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

ENCODER B
Encoder acquired with option board **ES836** (see the Installation Instructions manual for the configuration of the jumper and the dip-switches for the encoder type and supply).

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

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

Checking the Reference Sign

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

6. START-UP MENU

6.1. Overview

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

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

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

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

Press Enter to enter the wizard.

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

```
P263 Language


→@@@@@@@@@@@@@@@
```

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

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

Choose one of the following:

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

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

Parameters included in the Start-Up menu:

Parameter	Description	Visibility
C008	Rated mains voltage	
C010	Type of control algorithm	
C012	Speed feedback from encoder	[only if FOC is active]
C013	Type of V/f pattern	[only if IFD is active]
C015	Rated motor power	
C016	Rated motor rpm	
C017	Rated motor power	
C018	Rated motor current	
C019	Rated motor voltage	
C021	No-load current of the motor	[only if FOC is active]
C028	Min. motor speed	
C029	Max. motor speed	
C034	Voltage preboost	[only if IFD is active]
P009	Acceleration ramp time	
P010	Deceleration ramp time	
C043	Current limit while accelerating	[only if IFD is active]
C044	Current limit at constant rpm	[only if IFD is active]
C045	Current limit while decelerating	[only if IFD is active]
C048	Torque limit	[only if VTC/FOC are active]
C189	Encoder operating mode	[only if FOC is active]
C190	Encoder A pls/rev	[only if FOC is active]
C191	Encoder B pls/rev	[only if FOC is active]
I073	Autotuning selection	[only if VTC/FOC are active]
I074	Motor tuning selection	[only if VTC/FOC are active]
C265	Motor thermal protection	
C267	Motor thermal time constant	[only if protection is active]
C291	PID operating mode	
C285	PID reference selection	[only if PID is active]
C288	PID feedback selection	[only if PID is active]
P267	Preset PID units of measure	[only if PID is active]
P257	PID measure scale factor	[only if PID is active]
P236	Max. value of PID output	[only if PID is active]
P237	Min. value of PID output	[only if PID is active]
P237a	PID wake up enable	[only if PID is active]
P237b	PID wake up level	[only if PID is active]
P255	START disable delay if PID Out=P237	[only if PID is active]

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

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

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

7. FIRST STARTUP

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

7.1. "IFD" Control Algorithm

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

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

2) Power on: Power on the drive and do not close the link to the START input to prevent the motor from running.

3) Parameter alteration: Access parameter P000 (Key parameter) and set its code (default value: 00001). 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 mains voltage range or the DC supply stabilized by a Regenerative Penta drive. To set the type of power supply for the drive, access the MOTOR CONTROL MENU and set configuration parameter C008 to the value corresponding to the installation concerned.

5) Motor parameters: Set C010 (Control Algorithm) as IFD Voltage/Frequency; set the motor ratings as follows:

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

For loads with square torque with respect to the rpm (centrifugal pumps, fans, etc.), set C034 (preboost1) to 0%. Press SAVE/ENTER each time a new parameter value is set.

6) Autotune: For the IFD control algorithm, the Autotune function is not necessary but is always recommended.

First remove the ENABLE command, then access the AUTOTUNE MENU and set I073 [1: Motor Tune] and I074 = [0: All Ctrl no rotation]. Use the ESC key to accept changes. Close the ENABLE command and wait until tune is complete (Warning "W32 Open Enable" is displayed). The drive has computed and saved the values for C022 (stator resistance) and C023 (leakage inductance).

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.

7) Overload: Set parameters in the LIMITS MENU depending on the max. desired current.

8) 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. Make sure that the motor is rotating in the correct direction. If not, select the Engineering Level (P001) and 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 5 minutes, reverse two of the motor phases.

9) Possible failures:

If no failure occurred, go to step 10. Otherwise, check the drive connections paying particular attention to supply voltages, DC link and input reference. Also check if alarm messages are displayed. In the MEASURES MENU, check the reference speed (M001), the supply voltage to the control section (M030), the DC link voltage (M029), and the condition of control terminals (M033). Check to see if these readouts match with the measured values.

10) Additional parameter alterations:

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

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

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

11) Reset:

If an alarm trips, find the cause responsible for the alarm and reset the drive. Enable input MDI3 (terminal 16) for some time, or press the RESET key on the display/keypad.

NOTE

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

7.2. "VTC" Control Algorithm

1) Wiring: Follow the instructions stated in the "Caution Statements" and "Installation" sections in the Sinus Penta's Installation Instructions Manual.

2) Power on: Power on the drive and do not close the link to the START input to prevent the motor from running.

3) Parameter alteration: Access parameter P000 (Key parameter) and set its code (default value: 00001). Select the Engineering access level setting 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 mains voltage range or the DC supply stabilized by a Regenerative Penta drive. To set the type of power supply for the drive, access the MOTOR CONTROL MENU and set configuration parameter C008 to the value corresponding to the installation concerned.

5) Motor parameters: Set C010 (Control Algorithm) as VTC Vector Torque Control. Set the motor ratings as follows:

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

Also set C022 (resistance of one stator phase for a star connection or one third of one phase resistance for a delta connection) and C023 (stator leakage inductance of one phase for a star connection or one third of the leakage of one phase for a delta connection). The value for C022 corresponds to half the resistance value measured with an ohm-meter between two phases of the motor. If values to be set for C022 and C023 are not known, motor autotune is required (see step 6), otherwise, go to step 7. Press SAVE/ENTER each time a new parameter is set.

6) Autotune: First remove the ENABLE command, then access the AUTOTUNE MENU and set I073 [1: Motor Tune] and I074 = [0: All Ctrl no rotation]. Use the ESC key to accept changes. Close the ENABLE command and wait until tune is complete (Warning "W32 Open Enable" is displayed). The drive has computed and saved the values for C022 (stator resistance) and C023 (leakage inductance).

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.

NOTE: With 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 installed between the drive and the motor.

7) Overload: Set parameter C048 in the LIMITS MENU based on the maximum torque that can be generated expressed as a percentage of the motor rated torque.

8) 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. 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 5 minutes, reverse two of the motor phases.

9) Speed regulator adjustment:	If overshoot occurs when the speed setpoint is attained or if a system instability is detected (uneven motor operation), adjust the parameters relating to the speed loop (SPEED LOOP AND CURRENT BALANCING MENU). Set the two parameters relating to integral time (**P125, P126**) as [Disabled] and set low values for the parameters relating to proportional gain (**P127, P128**). Set equal values for **P127** and **P128** and increase them until overshoot takes place when the setpoint is attained. Decrease **P127** and **P128** by approx. 30%, then decrease the high values set for integral time in **P125** and **P126** (keep both values equal) until an acceptable setpoint response is obtained. Check to see if the motor runs smoothly at constant speed.
10) Possible failures:	If no failure occurred, go to step 11. Otherwise, check the drive connections paying particular attention to supply voltages, DC link and input reference. Also check if alarm messages are displayed. In the MEASURES MENU, check the speed reference (**M000**), the reference speed processed by the ramps (**M002**), the supply voltage of the control section (**M030**), the DC-link voltage (**M029**), the condition of the control terminals (**M033**). Check to see if these readouts match with the measured values.
11) Additional parameter alterations:	When parameter **P003** = Standby Only (condition required for altering C parameters), you can alter **Cxxx** parameters in the CONFIGURATION menu only when the drive is DISABLED or STOPPED, whereas if **P003** = Standby + Fluxing, you can alter Cxxx parameters when the motor is stopped but the drive is enabled. Before altering any parameters, remember that the correct code for parameter **P000** must be previously set up. You can write down any custom parameters in the table provided on the last pages of this Programming Manual.
12) Reset:	If an alarm trips, find the cause responsible for the alarm and reset the drive. Enable input MDI3 (terminal 16) for some time, or press the **RESET** key on the display/keypad.

7.3. "FOC" Motor Control

1) Wiring: Follow the instructions stated in the "Caution Statements" and "Installation" sections in the Sinus Penta's Installation Instructions Manual.

2) Power on: Power on the drive and do not close the link to the START input to prevent the motor from running.

3) Parameter alteration: Access parameter P000 (Key parameter) and set its code (default value: 00001). Use the ESC, ▲,▼ and SAVE/ENTER keys to access the programming parameters. Select the Engineering access level setting P001= Eng. Also refer to the Menu Tree.

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

5) Motor parameters: Set C010 (Control Algorithm) as FOC Field Oriented Control. Set the motor ratings as follows:

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

If the no-load current of the motor is known, in C021 (Io) set the value of Io expressed as a percentage of the motor rated current.
If the no-load current of the motor is not known, but the motor can run with no connected load, start the motor at its rated speed, read the current value detected by the drive (parameter M026) in the Motor Measures Menu and use it as the first attempt value for Io.

NOTE — If the connected motor must run at a higher speed than its rated speed (flux weakening), measure the no-load current value of the motor at its rated speed, not at its max. speed.

If the no-load current of the motor is not known and the motor cannot run in no-load conditions, use a first attempt value for Io that is automatically computed by the drive, as described in step 7.

NOTE — When parameter C021 (Io)=0, the drive will automatically set a value depending on the motor ratings whenever the motor autotune (step 7) is performed.

Once a no-load current value is entered in C021, the value of the parameter relating to mutual inductance (C024) will be automatically computed when parameters I073= [1: Motor Tune] and I074= [1: FOC Auto no rotation] are set up as for current autotune (C024 is computed even if no autotune procedure occurs).

Also set C022 (resistance of one stator phase for a star connection or one third of one phase resistance for a delta connection) and C023 (stator leakage inductance of one phase for a star connection or one third of the leakage of one phase for a delta connection). The value for C022 corresponds to half the resistance value measured with an ohm-meter between two phases of the motor. If values to be set for C022 and C023 are not known, motor autotune is required (see step 6), otherwise, go to step 7. Press SAVE/ENTER each time a new parameter is set.

6) Encoder TEST:	**The motor must run when testing the encoder.** Access the ENCODER/FREQUENCY INPUTS MENU; set the source of the encoder signal used as a speed feedback (Encoder A in terminal board, Encoder B from ES836 option board); enter the number of pulse/rev and the number of the encoder channels (more details are given in the relevant section in the **Installation Instructions Manual**). In MOTOR CONTROL MENU, set the parameter relating to the speed feedback from encoder: **C012** = Yes. Access the AUTOTUNE MENU and set parameter **I073** (Select Autotune Type) as "Encoder Tune". Use the **ESC** key to confirm changes. Close the **ENABLE** command and wait until encoder tune is complete ("W32 Open Enable" is displayed). Once encoder tune is complete, the display will show one of the following messages: "**W31** Encoder Ok"; the speed feedback is correct. If the speed detected by the encoder is opposite to the desired speed, the drive will automatically reverse the feedback sign (parameter **C199**). "**A059** Encoder Fault"; the speed detected from the encoder is not consistent with the control speed. Possible causes: - Wrong number of pls/rev of the encoder - Wrong power supply of the Encoder (e.g. +5V instead of +24V): check the encoder ratings and the position of jumpers and dip-switches for the encoder supply in the optional encoder board - Wrong configuration of the dip-switches for the encoder selection (push-pull or line-driver encoder) in the optional encoder board - No connection to the encoder channel (check wiring) - At least one Encoder channel is faulty (replace the encoder).
7) Autotune of the stator resistance and leakage inductance:	First remove the **ENABLE** command, then access the MOTOR CONTROL MENU and set **I073** (1: Motor Tune) and **I074** = (0: All Ctrl no rotation) . Use the **ESC** key to accept changes. Close the **ENABLE** command and wait until autotune is complete (warning "**W32** Open Enable" is displayed). The drive has computed and saved the values for **C022** and **C023**. 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 completed. 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) Autotune of the current loop:	First remove the **ENABLE** command, , then access the AUTOTUNE MENU and set **I073** (1: Motor Tune) and **I074** = (1: FOC Auto no rotation). Use the **ESC** key to accept changes. Close the **ENABLE** command and wait until autotune is complete (warning "**W32** Open Enable" is displayed). The drive has computed and saved the values for **P155** and **P156**. If alarm "**A065** Autotune KO" trips, this means that the **ENABLE** command has opened before autotune was completed or that the autotune algorithm failed. 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.

NOTE

If the **ENABLE** command was not opened before autotune was over, decrease by 5% the no-load current value set in **C021** and perform autotune again.

9) Tuning the rotor time constant: The rotor time constant (C025) is estimated with a special autotune procedure allowing the motor to run even in no-load conditions. First remove the **ENABLE** command, then access the AUTOTUNE MENU and set **I073** (1: Motor Tune) and **I074** = (2: FOC Auto + rot) . Use the **ESC** key to accept changes. Close the **ENABLE** command and wait until autotune is over (warning "**W32** Open Enable" is displayed). When autotune is complete, the value obtained for the rotor time constant is automatically saved in parameter **C025**.

If the motor cannot run in no-load conditions, use a first attempt value for **Io** that is automatically computed by the drive, as described in step 7.

10) Startup: Now that all the parameters have been set for the FOC motor control algorithm, 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. 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 5 minutes, reverse two of the motor phases.

11) Speed regulator adjustment: If overshoot occurs when the speed setpoint is attained or if a system instability is detected (uneven motor operation), adjust the parameters relating to the speed loop (SPEED LOOP AND CURRENT BALANCING MENU). Set the two parameters relating to integral time (**P125, P126**) as [Disabled] and set low values for the parameters relating to proportional gain (**P127, P128**). Set equal values for **P127** and **P128** and increase them until overshoot takes place when the setpoint is attained. Decrease **P127** and **P128** by approx. 30%, then decrease the high values set for integral time in **P125** and **P126** (keep both values equal) until an acceptable setpoint response is obtained. Check to see if the motor runs smoothly at constant speed.

12) Possible failures: If alarm "**A060** Fault No Curr." trips, this means that the current loop is not properly tuned. Follow the instructions given in step 8 and decrease the value of I_0 (parameter **C021** in the MOTOR CONTROL MENU).
If the motor is noisy when starting, this means that the rotor time constant is not correct. Follow the instructions given in step 9 again, or manually change the value of the rotor time constant (parameter **C025**) for a smooth motor startup.
If no failure occurred, go to step 13. Otherwise, check the drive connections paying particular attention to supply voltages, DC link and input reference. Also check if alarm messages are displayed. In the Motor Measure submenu, check the speed reference (**M000**), the reference speed processed by the ramps (**M002**), the supply voltage of the control section (**M030**), the DC link voltage (**M029**), the condition of the control terminals (**M033**). Check to see if these readouts match with the measured values.

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

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

When parameter **P003** = Standby Only (condition required for altering C parameters), you can alter **Cxxx** parameters in the CONFIGURATION menu only when the drive is DISABLED or STOPPED, whereas if **P003** = Standby + Fluxing, you can alter Cxxx parameters when the motor is stopped but the drive is enabled.
Before altering any parameters, remember that the correct code for parameter **P000** must be previously set up.
You can write down any custom parameters in the table provided on the last pages of this Programming Manual.

14) Reset: If an alarm trips, find the cause responsible for the alarm and reset the drive. Enable input MDI3 (terminal 16) for some time, or press the **RESET** on the display/keypad.

8. MEASURES MENU

8.1. Overview

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

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

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

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

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

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

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

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

Data Logger Measures Menu
This menu contains the status of the type of connections (serial links, Ethernet and modem) supported by ES851 Data Logger board (this menu is available only if ES847 is fitted).

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

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

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

8.2. Motor Measures Menu

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

M000 Speed Reference at Constant RPM

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

M002 Speed Ramp Output

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

M004 Motor Speed

M004-5	Range	± 32000 (integer part) ± 99 (decimal part)	± 32000.99 rpm
	Active	Always active.	
	Address	1654 (integer part) 1655 (decimal part)	
	Function	Motor speed value.	

M006 Drive Output Frequency

M006	Range	± 10000	± 1000.0 Hz (see Table 61)
	Active	Always active.	
	Address	1656	
	Function	This is the measure of the voltage frequency output of the drive.	

M007 Torque Reference at Constant Speed (Nm)

M007	Range	± 3200	± 3200 Nm Note: The actual range depends on the torque limit values set for the selected motor. C047–C048 Motor 1 C090–C091 Motor 2 C133–C134 Motor 3
	Active	Active only when a torque reference is used for the selected motor.	
	Address	1657	
	Function	This is the measure of the torque reference required at constant speed and expressed in Nm.	

M008 Torque Demand (Nm)

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

M009 Torque Generated by the Motor (Nm)

M009	Range	± 32000	± 32000 Nm
	Active	Active for VTC and FOC controls only.	
	Address	1659	
	Function	Approximate value of the torque produced by the connected motor.	

M010 Torque Reference at Constant RPM (%)

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

M011 Torque Demand (%)

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

M012 Torque Generated by the Motor (%)

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

M013 Torque Limit Demand before Ramps (Nm)

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

M014 Torque Limit Demand after Ramps (Nm)

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

M013a Speed Limit before the Ramps

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

M014a Speed Limits after the Ramps

M014a	Range	± 32000	± 2000 rpm
	Active	Active for FOC only.	
	Address	1727	
	Function	Current limit value of the motor speed of rotation in "torque control with speed limit" mode (C011=2 for Motor 1; C054, C097 for Motors 2 and 3).	

M015 Torque Limit Reference before Ramps (%)

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

M016 Torque Limit Reference after Ramps (%)

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

M017 Flux Reference

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

M026 Output Current

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

M026a Motor Thermal Capacity

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

M027 Output Voltage

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

M028 Output Power

M028	Range	0 ÷65535	0 ÷6553.5 kW Note: The actual range depends on the drive size.
	Active	Always active.	
	Address	1678	
	Function	Measure of the active power produced by the drive.	

M028a Energy Consumption

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

M029 DC-Bus Voltage

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

M030 Supply Voltage

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

8.3. PID Regulator Menu

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

M018 PID Reference at Constant RPM (%)

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

M018a PID2 Reference at Constant RPM (%)

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

M019 PID Reference after Ramps (%)

M019	Range	±10000	±100.00 % Note: The actual range depends on the max. value and the min. value of the PID reference set in parameters **P245–P246**.
	Active	Always active.	
	Address	1669	
	Function	This is the measure of the PID reference after the ramps expressed as a percentage. Scaling is detailed in the PID2 PARAMETERS MENU and the PID CONFIGURATION MENU.	

M019a PID2 Reference after Ramps (%)

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

M020 PID Feedback (%)

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

M020a PID2 Feedback (%)

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

M021 PID Error (%)

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

M021a PID2 Error (%)

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

M022 PID Output (%)

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

M022a PID2 Output (%)

M022a	Range	±10000	±100.00 % Note: The actual range depends on the min. and max. saturation values of the PID output set in parameters **P436–P437**.
	Active	This measure is active if enabled from **C291a**	
	Address	1718	
	Function	This is the measure percent of the PID2 feedback selected with **C286** for the PID2 or the 2-zone mode. Scaling is detailed in the PID2 PARAMETERS MENU and the PID CONFIGURATION MENU.	

M023 PID Reference after Ramps

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

M023a PID2 Reference after Ramps

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

M024 PID Feedback

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

M024a PID2 Feedback

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

8.4. Digital Inputs Menu

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

M031 Delayed Digital Inputs

M031	Range	Bit-controlled measure	See Table 1
	Active	Always active.	
	Address	1681	
	Function	State of the virtual control terminal board used by the drive. This is the terminal board resulting from the combination of the preset command sources (local terminal board, serial link and fieldbus), where the **ENABLE** command is given by the AND logic of all the **ENABLE** commands. For the other inputs, the OR command between the different command sources is used. See also the CONTROL METHOD MENU and the TIMERS MENU.	

M032 Instant Digital Inputs

M032	Range	Bit-controlled measure	See Table 1
	Active	Always active.	
	Address	1682	
	Function	State of the virtual control terminal board before applying the timers to the digital inputs (if no timer is applied, it matches with M031). This is the terminal board resulting from the combination of the preset command sources (local terminal board, serial link and fieldbus), where the **ENABLE** command is given by the AND logic of all the **ENABLE** commands. For the other inputs, the OR command between the different command sources is used. See also the CONTROL METHOD MENU and the TIMERS MENU.	

Table 1: Codification of Measures M031, M032.

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

M033 Local Control Terminal Board

M033	Range	Bit-controlled measure	See Table 2
	Active	Always active.	
	Address	1683	
	Function	State of the digital inputs in the drive terminal board.	

M034 Control Terminals from Serial Link

M034	Range	Bit-controlled measure	See Table 2
	Active	Always active.	
	Address	1684	
	Function	State of the digital inputs in the terminal board controlled via serial link.	

M035 Control Terminal Board from Fieldbus

M035	Range	Bit-controlled measure	See Table 2
	Active	Always active.	
	Address	1685	
	Function	State of the digital inputs in the terminal board controlled from fieldbus.	

Table 2: Codification of Measures M033, M034, M035.

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

M036 Auxiliary Digital Inputs in the Terminal Board

M036	Range	Bit-controlled measure	See Table 3
	Active	Always active.	
	Address	1686	
	Function	State of the 8 auxiliary digital inputs in ES847 or ES870 terminal board.	

M036a Auxiliary Digital Inputs via Serial Link

M36a	Range	Bit-controlled measure	See Table 3
	Active	Always active.	
	Address	1713	
	Function	State of the 8 auxiliary digital inputs via serial link.	

M036b Auxiliary Digital Inputs via PROFIdrive

M036b	Range	Bit-controlled measure	See Table 3
	Active	Always active.	
	Address	1717	
	Function	State of the 8 auxiliary digital inputs via PROFIdrive.	

Table 3: Codification of Measures M036, M036a, M036b.

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

8.5. References Menu

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

M037 REF External Analog Reference

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

M038 AIN1 External Analog Reference

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

M039 AIN2 External Analog Reference

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

M039a XAIN4 External Analog Reference

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

M039b XAIN5 External Analog Reference

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

M040 Speed Reference from Serial Link

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

M042 Speed Reference from Fieldbus

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

M044 Torque Reference from Serial Link

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

M045 Torque Reference from Fieldbus

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

M046 PID Reference from Serial Link

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

M047 PID Reference from Fieldbus

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

M048 PID Feedback from Serial Link

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

M049 PID Feedback from Fieldbus

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

M050 Encoder Reference

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

M051 Frequency Input Reference

M051	Range	1000 ÷ 10000	10000 ÷ 100000 Hz. Note: The actual range depends on the frequency min. value and max. value set in **P071-P072**.
	Active	Always active.	
	Address	1701	
	Function	Frequency readout in the digital input set as a reference source (see the ENCODER/FREQUENCY INPUTS MENU and the CONTROL METHOD MENU).	

8.6. Outputs Menu

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

M056 Digital Outputs

M056	Range	Bit-controlled measure.	See Table 4
	Active	Always active.	
	Address	1706	
	Function	State of digital inputs MDO1÷4 and state of the precharge contactor.	

Table 4: Codification of Measure M056.

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

M056a Virtual Digital Outputs

M056a	Range	Bit-controlled measure.	See Table 5
	Active	Always active.	
	Address	1675	
	Function	State of virtual digital outputs MPL1÷4.	

Table 5: Codification of Measure M056a.

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

M057 Frequency Output

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

M058 AO1 Analog Output

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

M059 AO2 Analog Output

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

M060 Analog Output AO3

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

M061 Auxiliary Digital Outputs

M061	Range	Bit-controlled measure.	See Table 6
	Active	Always active.	
	Address	1711	
	Function	State of the auxiliary digital outputs located on the expansion board.	

Table 6: Codification of Measure M061.

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

8.7. Temperature Measures from PT100 Menu

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

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

M069 PT100 Measure in Channel 1

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

M070 PT100 Measure in Channel 2

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

M071 PT100 Measure in Channel 3

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

M072 PT100 Measure in Channel 4

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

8.8. Autodiagnostics Menu

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

M052 / M054 Functioning Times

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

Functioning Times:

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

M062 Ambient temperature Measure

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

M064 IGBT Temperature Measure

M064	Range	± 32000	± 320.0 °C
	Active	Always active.	
	Address	1714	
	Function	Measure of the temperature in IGBTs. Note: Not all drive sizes are provided with this sensor (see Table 12 in the PRODUCT MENU).	

M065 Operation Time Counter

M065	Range	0÷65000	0÷650000h
	Active	Always active.	
	Address	1715	
	Function	Time elapsed after resetting the operation time counter. The Operation Time is the activation time of the drive IGBTs.	

M066 Supply Time Counter

M066	Range	0÷65000	0÷650000h
	Active	Always active.	
	Address	1716	
	Function	Time elapsed after resetting the supply time counter.	

M089 Drive State

M089	Range	See Table 116.
	Active	Always active.
	Address	1739
	Function	Describes the current condition of the Penta drive.

M090 Active Alarm

M090	Range	See Table 113.
	Active	Always active.
	Address	1740
	Function	Alarm tripped at the moment.

8.9. Data Logger Measures Menu

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

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

M100 Data Logger Status (Line 3)

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

M100 ES851 Fault (Line 4)

M100 Line 4	Range	0 ÷ 6, 99 ÷ 104	0: No alarm 1: Parameter save fault 2: Log write error 3: FBS configuration failure 4: RS232 Modbus configuration failure 5: RS485 Modbus configuration failure 6: TCP/IP stack configuration failure 99: Flash card lacking or inaccessible 100: Invalid stream access 101: TCP/IP socket fault 102: Dial out connection failure 103: ES821 Clock fault 104: Modem initialization failure
	Active	This measure is active only if programmed from parameter **R021**.	
	Address	1340	
	Function	This indicates a general alarm tripped for ES851. In case an alarm trips, please contact ELETTRONICA SANTERNO's CUSTOMER SERVICE and mention the alarm code and name.	

M101 Connection Status

M101	Range	Bit-controlled measure	See Table 7
	Active	This measure is active only if programmed from parameter **R021**.	
	Address	1338	
	Function	Status of the connections supported by ES851. Note that the COM1 serial link is RS232 by default, whereas COM 2 is RS485 by default. For more details, please refer to the Programming Instructions manual for ES851 Data Logger.	

Table 7: Data Logger connection status.

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

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

8.10. Digital Input Settings Menu

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

Table 8: Codification of the functions assigned to the digital inputs.

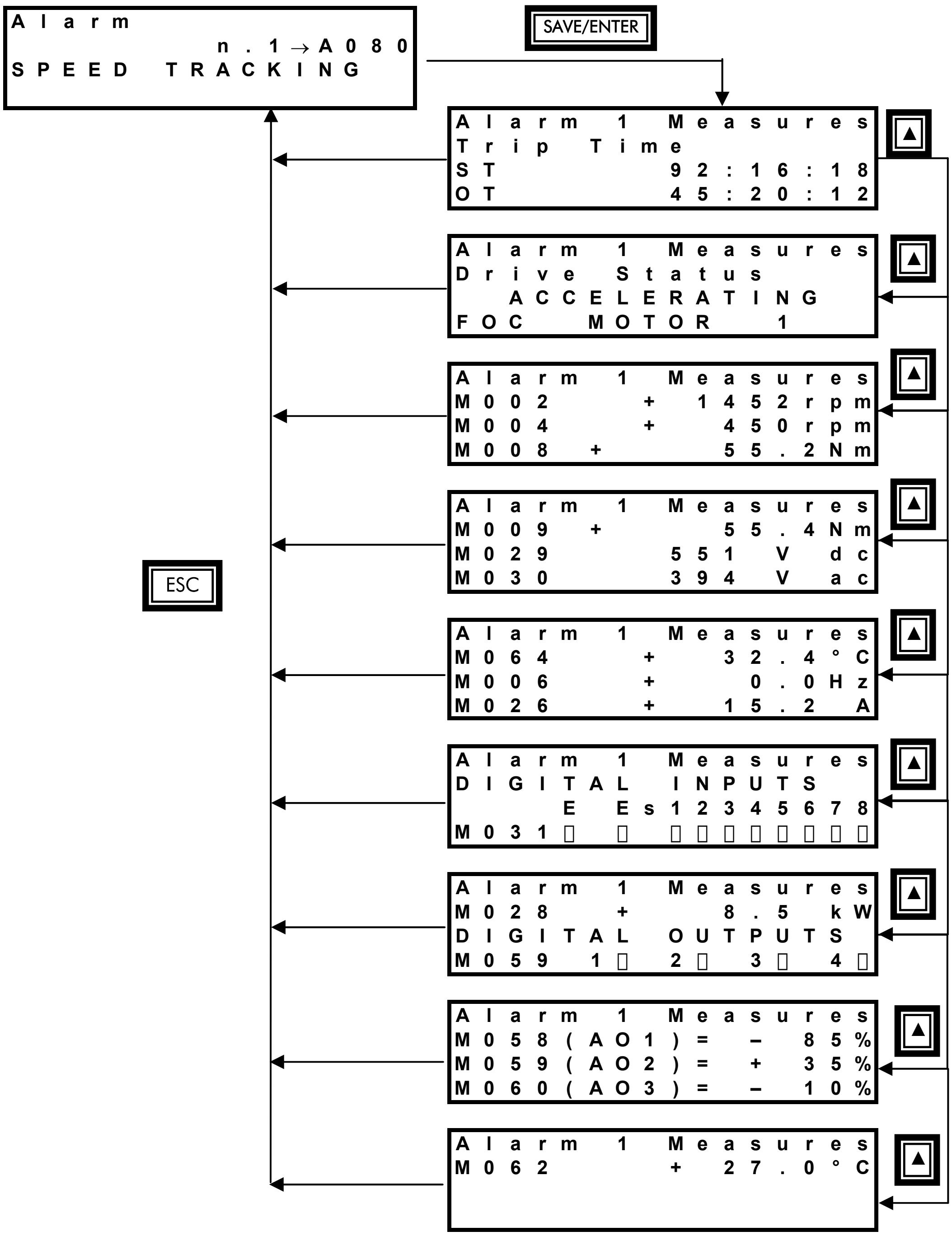
Display Items	Function Assigned to the Digital Inputs
STOP	Stop function
REVERSE	Startup with negative speed
EN–S	ENABLE in safety condition
DISABLE	Drive disable
MVel0	Multispeed 0
MVel1	Multispeed 1
MVel2	Multispeed 2
MVel3	Multispeed 3
Cw/CCw	Reversal of the direction of rotation
DCB	DC braking
UP	Reference increase
DOWN	Reference decrease
UDReset	Reset of speed setpoint due to UP/DOWN command
Alarm 1	Auxiliary trip 1
Alarm 2	Auxiliary trip 2
Alarm 3	Auxiliary trip 3
MRmp0	Multiramp 0
MRmp1	Multiramp 1
JOG	Jog mode
SLAVE	Selection of Slave Mode
PID Dis	PID Disable
KpdLock	Display/keypad unit
Mot 2	Selection of Motor 2
Mot 3	Selection of Motor 3
Var 0	Reference Variation 0
Var 1	Reference Variation 1
Var 2	Reference Variation 2
PID UDR	PID Reference Reset due to UP/DOWN commands
LOCAL	Selection of Local mode
Brk Lock	Mechanical brake locking
FireM	Fire Mode enabled
Src. Sel	Reference/command source switch
nTlim	External torque limit disable
START_B	START function, terminals B
STOP_B	STOP function, terminals B
REVERSE_B	Startup with negative speed, terminals B
MRef0	PID Multireference 1
MRef1	PID Multireference 2
MRef2	PID Multireference 3
PID Csl	PID Control Selection
START	START function
ENABLE	ENABLE function
RESET	Alarm RESET
EncA	Encoder A Input
EncB	Encoder B Input
FinA	FINA Frequency input
FinB	FINB Frequency input
Multi	More than one function allocated to the same input

8.11. Fault List Menu

Scroll the Fault List Menu to display the codes of the last eight alarms tripped.

Press the SAVE/ENTER key to access the alarm submenu and navigate to each value measured by the drive when the alarm tripped.
The diagram below shows a navigation example for the Fault List Menu (relating to alarm n.1 in particular). Note that n.1 is the last alarm tripped and n.8 is the first alarm tripped.
The measures marked with Mxxx are the same measures explained in this section.

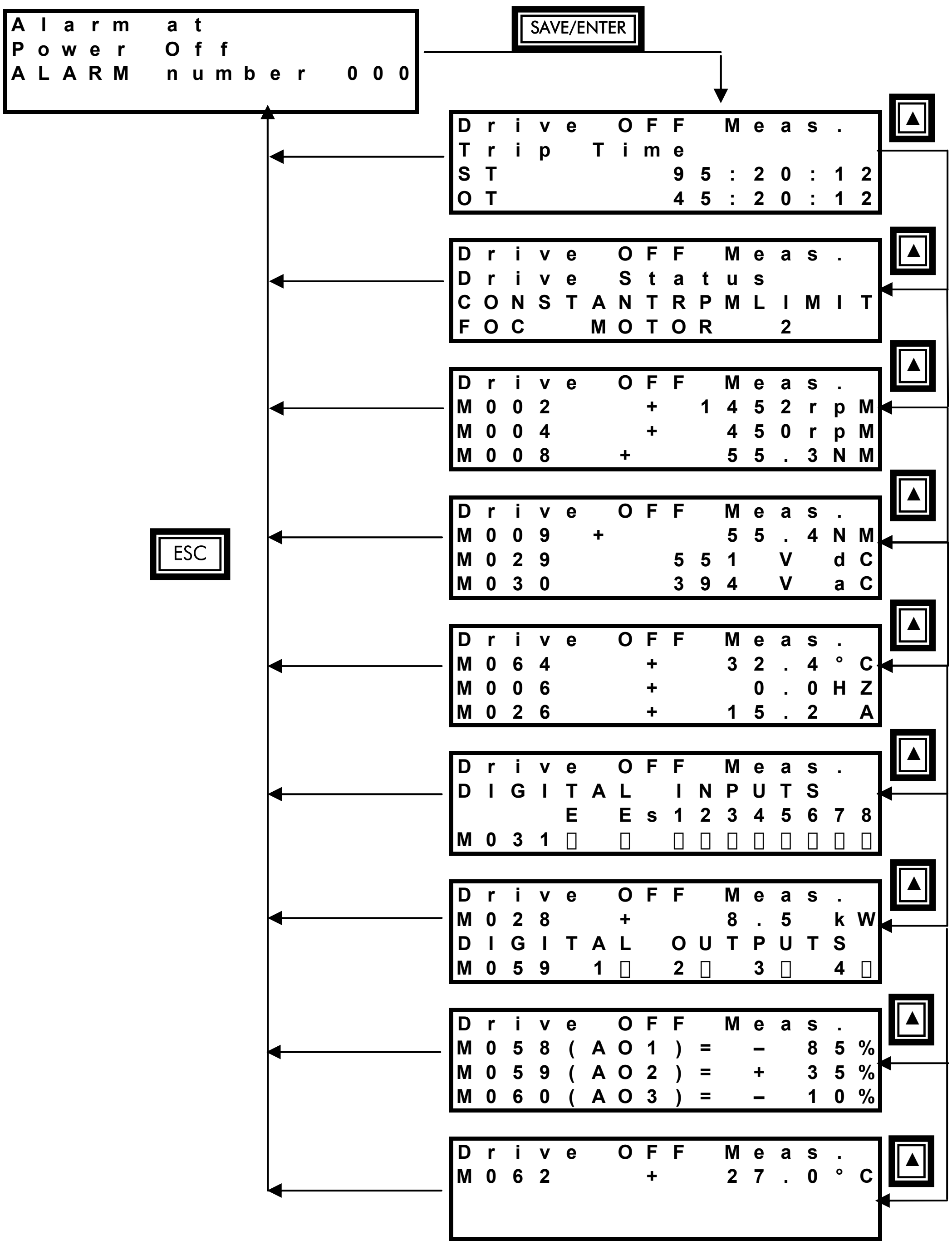
Navigation Example - Fault List Menu.



8.12. Power Off List Menu

This menu contains the measures of some characteristic variables detected at the drive power off, in conjunction with the alarm (if any) tripped at that moment.
Press the SAVE/ENTER key to access the submenu and navigate to the measures detected by the drive when the alarm tripped. Measures and codes are the same as the ones shown in the Fault List Menu.
The diagram below shows a navigation example for the Power Off List.

Navigation Example – PowerOff List Menu



9. PRODUCT MENU

9.1. Overview

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

Product Name and Type
Implemented Software
SW Versions
Serial Number
Manufacturer

9.2. List of Parameter P263 and Fire Mode Enable Password

Table 9: List of parameter P263 and Fire Mode Enable Password.

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

P263 Language

P263	Range	0 ÷ 4	0: ITALIANO 1: ENGLISH 2: ESPANOL 3: PORTUGUES 4: DEUTSCH
	Default	1	1: ENGLISH
	Level	BASIC	
	Address	863	
	Function	The dialog language is factory set to English. Use parameter **P263** to choose a different language. The software implemented in the display/keypad is called MMI (man/machine interface); its version is displayed in the SW screen of the Product Menu.	

CAUTION

By request, Elettronica Santerno can provide the extended version of the MMI software containing languages different from the ones mentioned above.

Product Name and Type

Product Name and Type	Range	Fan control: bits 0 to 3 Voltage class: bits 4 to 7 Drive size: bits 8 to 15	0 ÷ 3 – see Table 12 0 ÷ 3 – see Table 11 0 ÷ 81 – see Table 10
	Address	Product type: 1736	
	Function	This screen displays the name of the product (PENTA) and the type of product (see example below) .	

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

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

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

Table 10: Indexes corresponding to the different models (sizes) of the Penta Drive.

Index	Model	Index	Model	Index	Model	Index	Model	Index	Model
0	0005	17	0035	34	0150	51	0313	68	0749
1	0007	18	0036	35	0162	52	0314	69	0750
2	0008	19	0037	36	0164	53	0366	70	0800
3	0009	20	0038	37	0179	54	0367	71	0828
4	0010	21	0040	38	0180	55	0368	72	0831
5	0011	22	0049	39	0181	56	0399	73	0832
6	0013	23	0060	40	0200	57	0401	74	0850
7	0014	24	0062	41	0201	58	0402	75	0960
8	0015	25	0067	42	0202	59	0457	76	0964
9	0016	26	0069	43	0216	60	0459	77	0965
10	0017	27	0074	44	0217	61	0523	78	1128
11	0020	28	0076	45	0218	62	0524	79	1129
12	0023	29	0086	46	0250	63	0526	80	1130
13	0025	30	0088	47	0259	64	0598	81	1296
14	0030	31	0113	48	0260	65	0599	82	1800
15	0033	32	0129	49	0290	66	0600	83	2076
16	0034	33	0131	50	0312	67	0748		

Table 11: Voltage classes of the PD.

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

Table 12: Control modes of the cooling fans.

Index	Character	Description
0	_	The cooling fans are not controlled by the Penta drive.
1	S	The Penta drive acquires information about the correct operation of the cooling fans and it logs the temperature measures. If a fan fault is detected, the relevant alarm trips. On the other hand, temperature measures do not cause any alarm.
2	P	The fan start is controlled by the state of the thermoswitch inside the Penta drive.
3	N	An NTC temperature sensor controls the operation of the cooling fans; temperature is measured by the Penta drive and the threshold for the startup of the cooling fan is set in parameter **C264**.

SW Application

SW Application		
	Function	This screen displays the type of software application which is implemented in the drive (e.g. Multipump, Regenerative, etc...). See Elettronica Santerno's Catalogue about Software Accessories. For the application software downloading instructions see the Applications Manual.

SW Versions

SW Versions	Range	0 ÷ 65535	0 ÷ 65.535
	Address	Texas: 233 MMI: 1489 Motorola: 1487	
	Function	This screen displays the SW versions implemented on the Penta drive: Texas → SW version of the DSP Texas MMI → SW version of the display/keypad Motorola → SW version of Motorola microprocessor	

Serial Number

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

Fire Mode Enable Password

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

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

Manufacturer

Manufacturer		
	Function	The name of Elettronica Santerno is displayed followed by Elettronica Santerno's website (www.elettronicasanterno.com).

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

Product ID

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

10. PASSWORD AND USER LEVEL MENU

10.1. Overview

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

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

10.2. List of Parameters P000 to P003

Table 13: List of parameters P000 to P003.

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

<u>P000: Write Enable</u>

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

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

P001: User Level

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

P002 Password for Write Enable

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

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

P003 Conditions for C Parameter Alterations

P003	Range	0 ÷ 1	0:[Stand-by only] ÷ 1:[StandBy+Fluxing]
	Default	1	1:[StandBy+Fluxing]
	Level	ADVANCED	
	Address	509	
	Function	Factory setting allows **C parameters** to be programmed even when the inverter is enabled. However, the motor must be stopped. If **P003=0: [Stand-by only]**, C parameters can be changed only when the inverter is disabled.	

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

11. DISPLAY/KEYPAD MENU

11.1. Overview

NOTE It is recommended that the “Operating and Remoting the Keypad” section in the Sinus Penta’s Installation Instructions Manual be read as well.

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

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

11.2. Root Page

```
 I N V E R T E R   O K
→     +   1 5 0 0 . 0 0 r p m
→     +         0 . 0 0 r p m
 M E A   P A R   C F [ I D P ]
```

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

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

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

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

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

11.3. Keypad Page and Local Mode

Keypad

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

SAVE/ENTER

Keypad Help

```
→M006  Mot.Freq.
→M026  I(RMS) Out
→M004  Motor Spd
Ref  +  1500.00rpm
```

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

NOTE

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

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

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

LOCAL MODE

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

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

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

11.4. List of Parameters P264 to P269

Table 14: List of parameters P264 to P269.

Parameter	FUNCTION	User Level	DEFAULT SETTING	MODBUS Address
P264	Navigation mode	ADVANCED	0 :[BY MENU]	864
P264a	Circular navigation	ADVANCED	1: [YES]	865
P264b	Navigation mode with the **MENU** key	ADVANCED	0:[STANDARD]	512
P265	Root page	ADVANCED	3: [Start Up]	866
P266	Type of Keypad page in Local Mode	ADVANCED	1:[Ref.Activated]	511
P267	Preset PID units of measure	ENGINEERING	0:[Disable]	867
P267a	Custom PID units of measure	ENGINEERING	[%]	1867
P267b	Preset PID2 units of measure	ENGINEERING	0:[Disable]	861
P267c	Custom PID2 units of measure	ENGINEERING	[%]	1869
P268	Measure n.1 on Root page	ADVANCED	M004 Motor Spd	cannot be accessed
P268y	Scaling of Measure n.1 on Root page	ADVANCED	100.00%	515
P268a	Measure n.2 on Root page	ADVANCED	M000 Speed Ref.	cannot be accessed
P268z	Scaling of Measure n.2 on Root page	ADVANCED	100.00%	516
P268b	Measure n.1 on Keypad page	ADVANCED	M006 Mot.Freq.	cannot be accessed
P268c	Measure n.2 on Keypad page	ADVANCED	M026 Motor Current	cannot be accessed
P268d	Measure n.3 on Keypad page	ADVANCED	M004 Motor Spd	cannot be accessed
P268e	Measure n.4 on Keypad page	ADVANCED	M000 Speed Ref.	cannot be accessed
P269	Disable **Loc/Rem Fwd/Rev** keys	ENGINEERING	[NO NO]	869

P264 Navigation Mode

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

NOTE

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

P264a Circular Navigation

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

P264b Navigation Mode with the MENU Key

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

P265 Startup Page

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

P266 Type of Keypad Page in Local Mode

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

P267 Preset PID/PID2 Units of Measure

P267	Range	0 ÷ 34	See Table 15.
	Default	0	0: [Disable]
	Level	ENGINEERING	
	Address	867/861	
	Function	The PID/PID2 reference and PID/PID2 feedback are expressed as a percentage in measures **M020, M021, M020a, M021a.** Parameters **P257/P457** allow setting a gain value to "scale" the PID reference and PID feedback and to obtain the following measures: **M023 = P257 * M020;** **M024 = P257 * M021** which are properly scaled. Parameters **P267/P267b** (see codification of **P267/P267b**) sets the unit of measure for the measures above; the unit of measure can also be entered in parameter **P267a/P267c** (only if **P267/P267b** = 0: [Disable]). Example: the PID reference is 100%; **M020** = 100%; if **P257** = 0.04 and **P267** = 1: [bars], the scaled measure for the PID reference is → **M023** = 4.00 bars.	

Table 15: Preset PID units of measure.

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

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

P267a	Range	0x20 ÷ 0x8A (every byte)	ASCII 0x20 = blank ASCII 0x8A = □
	Default	0x015D255B	ASCII 0x5D = [ASCII 0x25 = % ASCII 0x5B =] ⇒ [%]
	Level	ENGINEERING	
	Address	1867/1869	(This is a 32-bit data item) Characters are 8-bit ASCII encoded; there are three 8-bit characters starting from the less significant bit. Bit 24 must always be set to 1.
	Function	Parameter **P267a/P267c** is active only if **P267/P267b** = 0: [Disable] and it relates to the unit of measure actually displayed in **M023, M024, M023a, M024a**. This parameter allows setting a 3-character string to display the units of measures for the PID Measures: **M023, M024, M023a, M024a**. Press the **SAVE/ENTER** key to edit each character: when a flashing cursor appears on the left of each character, press ▲ and ▼ to scroll all the characters displayed. Press the **ESC** key to go to the next character. Press **SAVE/ENTER** to store the new parameter value.	

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

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

P268 / P268a		
	Range	M000 ÷ M064
	Default	P268 → **M004** Motor Spd P268a → **M000** Speed Ref.
	Level	ADVANCED
	Address	Cannot be accessed via serial link.
	Function	These two parameters allow selecting two measures to be displayed on the Root Page.

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

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

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

P268b, P268c, P268d, P268e		
	Range	M000 ÷ M064
	Default	P268b → **M006** Mot.Freq. P268c → **M026** Motor Current P268d → **M004** Motor Spd P268e → **M000** Speed Ref.
	Level	ADVANCED
	Address	Cannot be accessed via serial link.
	Function	These four parameters allow selecting four measures to be displayed on the Keypad Page. NOTE: Measure n. 4 is displayed on the Measure Keypad page only, and is replaced by the reference value on the remaining Keypad pages.

NOTE Measure n. 4 is available in the measure Keypad page only. The reference to measure n. 4 is available for the remaining Keypad pages.

P269 Disable Loc/Rem Fwd/Rev Keys

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

12. RAMPS MENU

12.1. Overview

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

12.1.1. DESCRIPTION OF THE SPEED RAMPS

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

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

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

The set ramp time corresponds to the time the speed reference takes to reach the max. speed (from 0 rpm) as an absolute value between min. speed and max. speed of the selected motor (**C028** and **C029** for motor 1, and so on). The time unit of measure may have the following values:

0 → 0.01 s
1 → 0.1 s
2 → 1 s
3 → 10 s

The programmable range may be 0s – 327000s.
Example of a speed ramp:

Table 16: Example of a Speed Ramp.

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

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

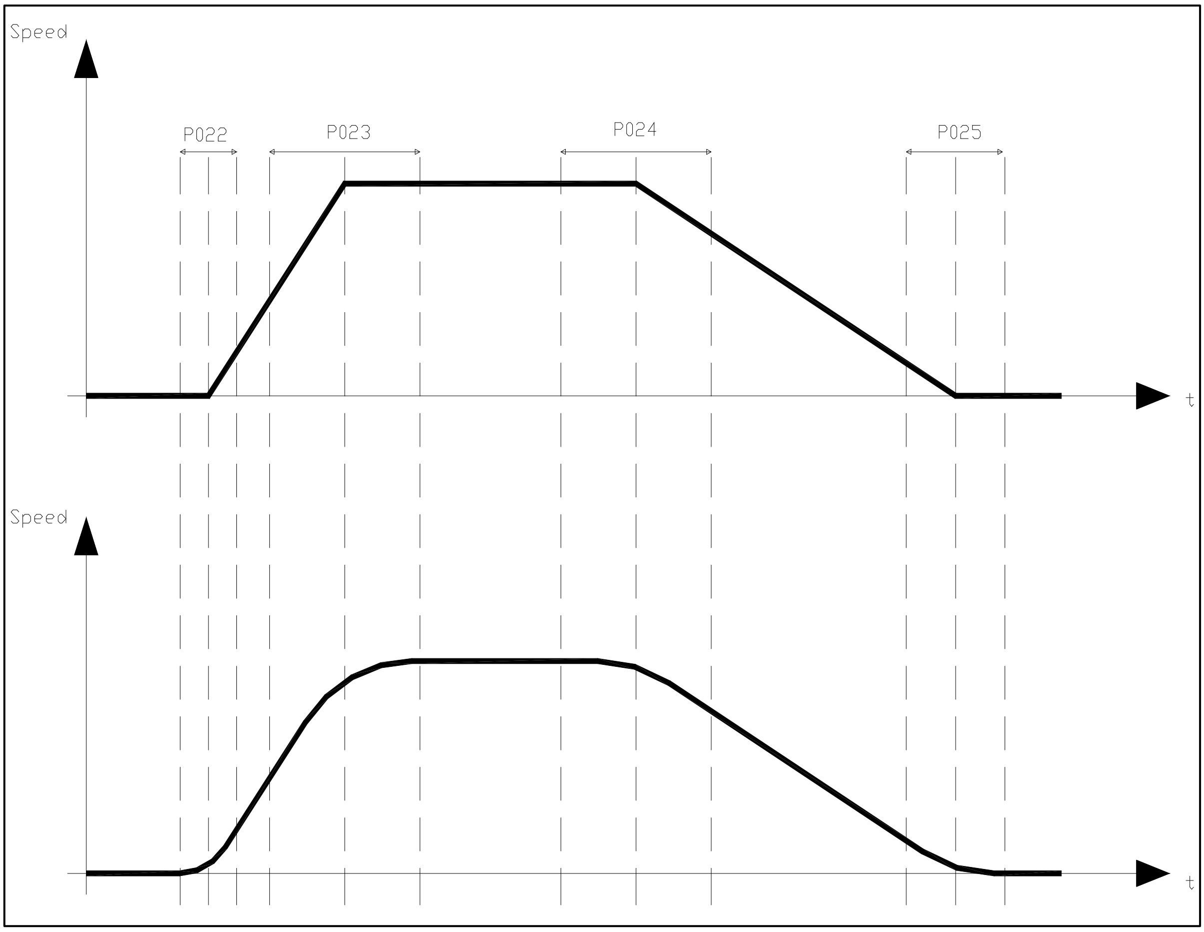


Figure 4: Example of S ramps.

You can also select the rounding off and the rounding off percentage for the 4 stages of starting ramp up and the starting ramp down, and for the end ramp up and the end ramp down (S ramps). The ramp rounding off allows reaching the reference end value with a zero tangent, both while accelerating and while decelerating, thus suppressing torque peaks that could damage mechanical couplings.
The rounding off is expressed as a percentage of the ramp time it relates to; if used, it allows increasing the preset ramp time by half the sum value of the two rounding off values. Its effect is shown in the figures below.

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

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

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

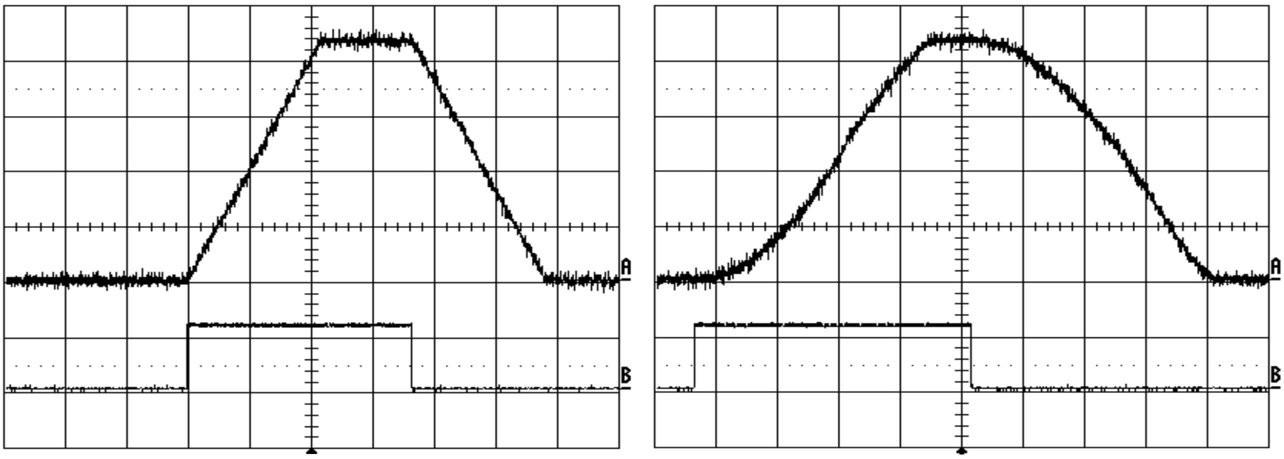


Figure 5: Speed profile without Rounding Off and with Rounding Off 2 (example).

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

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

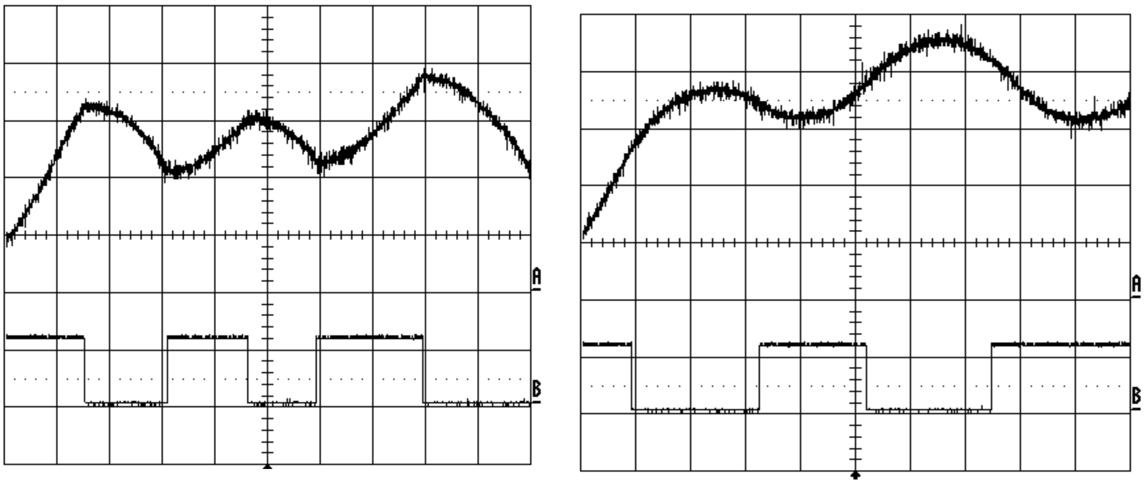


Figure 6: Speed profile with Acceleration Reset - Yes to No (Example).

12.1.2. DESCRIPTION OF THE TORQUE RAMPS

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

12.2. List of Parameters P009 to P033

Table 17: List of parameters P009 to P033.

Parameter	FUNCTION	User Level	Default Values	MODBUS Address
P009	Speed ramp 1: acceleration time	BASIC	See Table 72	609
P010	Speed ramp 1: deceleration time	BASIC	See Table 72	610
P012	Speed ramp 2: acceleration time	ADVANCED	See Table 72	612
P013	Speed ramp 2: deceleration time	ADVANCED	See Table 72	613
P014	Speed ramps 1and 2: time unit of measure	ADVANCED	See Table 72	614
P015	Speed ramp 3: acceleration time	ADVANCED	See Table 72	615
P016	Speed ramp 3: deceleration time	ADVANCED	See Table 72	616
P018	Speed ramp 4: acceleration time	ADVANCED	See Table 72	618
P019	Speed ramp 4: deceleration time	ADVANCED	See Table 72	619
P020	Speed ramps 3 and 4: time unit of measure	ADVANCED	See Table 72	620
P021	Selection for S ramp rounding off	ADVANCED	See Table 72	621
P022	Acceleration S ramp: start rounding off time	ADVANCED	50%	622
P023	Acceleration S ramp: end rounding off time	ADVANCED	50%	623
P024	Deceleration S ramp: start rounding off time	ADVANCED	50%	624
P025	Deceleration S ramp: end rounding off time	ADVANCED	50%	625
P026	Torque ramp time: up	ADVANCED	5 s	626
P027	Torque ramp time: down	ADVANCED	5 s	627
P028	Unit of measure for torque ramp time	ADVANCED	0.1 s	628
P029	Jog ramp acceleration time	ADVANCED	1 s	629
P030	Jog ramp deceleration time	ADVANCED	1 s	629
P031	Gradient variation acceleration reset	ADVANCED	1 : [YES]	630
P032	Fire Mode Ramp: acceleration time	ENGINEERING	See Table 72	632
P033	Fire Mode Ramp: deceleration time	ENGINEERING	See Table 72	633

P009 Speed Ramp 1: Acceleration Time

P009	Range	0 ÷ 32700	0 ÷327.00 s if **P014**=0 → 0.01 s 0 ÷3270.0 s if **P014**=0 → 0.1 s 0 ÷32700 s if **P014**=0 → 1 s 0 ÷327000 s if **P014**=0 → 10 s
	Default	See Table 72.	
	Level	BASIC	
	Address	609	
	Function	Determines the time the reference takes to go from 0 rpm to the max. preset speed (considering the max. value between absolute values for max. speed and min. speed set for the selected motor). If S ramps are used, the actual time the reference takes to reach constant rpm exceeds the time set in **P009** for a percentage equal to (**P022**+**P023**)/2.	

P010 Speed Ramp 1: Deceleration Time

P010	Range	0 ÷ 32700	0 ÷327.00 s if **P014**=0 → 0.01 s 0 ÷3270.0 s if **P014**=0 → 0.1 s 0 ÷32700 s if **P014**=0 → 1 s 0 ÷327000 s if **P014**=0 → 10 s
	Default	See Table 72.	
	Level	BASIC	
	Address	610	
	Function	Determines the time the reference takes to go from the max. preset speed (considering the max. value between absolute values for max. speed and min. speed set for the selected motor) to zero rpm. If S ramps are used, the actual time the reference takes to reach 0 speed exceeds the time set in **P010** for a percentage equal to (**P024**+**P025**)/2.	

P012 Speed Ramp 2: Acceleration Time

P012	Range	0 ÷ 32700	0 ÷327.00 s if **P014**=0 → 0.01 s 0 ÷3270.0 s if **P014**=0 → 0.1 s 0 ÷32700 s if **P014**=0 → 1 s 0 ÷327000 s if **P014**=0 → 10 s
	Default	See Table 72.	
	Level	ADVANCED	
	Address	612	
	Function	Same as ramp 1 (see **P009**).	

NOTE

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

P013 Speed Ramp 2: Deceleration Time

P013	Range	0 ÷ 32700	0 ÷327.00 s if **P014**=0 → 0.01 s 0 ÷3270.0 s if **P014**=0 → 0.1 s 0 ÷32700 s if **P014**=0 → 1 s 0 ÷327000 s if **P014**=0 → 10 s
	Default	See Table 72.	
	Level	ADVANCED	
	Address	613	
	Function	Same as ramp 1 (see **P010**).	

NOTE

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

P014 Speed Ramps 1 and 2: Time Unit of Measure

P014	Range	0 ÷ 3	0 → 0.01 s 1→ 0.1 s 2→ 1 s 3→ 10 s
	Default	See Table 72.	
	Level	ADVANCED	
	Address	614	
	Function	Defines the unit of measure for the time periods for speed ramp 1 (**P009** and **P010**), for speed ramp 2 (**P012** and **P013**), and for ramps in Fire Mode (**P032** and **P033**). The allowable programmable range may be extended from 0 s to 327000s. E.g. **P014**=1 then **P009**=100; this means **P009** = 100 x 0.1 s = 10 s **P014**=0 then **P009**=100; this means **P009** = 100 x 0.01 s = 1 s **P014**=3 then **P009**=100; this means **P009** = 100 x 10 s = 1000 s	

P015 Speed Ramp 3: Acceleration Time

P015	Range	0 ÷ 32700	0 ÷327.00 s if **P020**=0 → 0.01 s 0 ÷3270.0 s if **P020**=0 → 0.1 s 0 ÷32700 s if **P020**=0 → 1 s 0 ÷327000 s if **P020**=0 → 10 s
	Default	See Table 72.	
	Level	ADVANCED	
	Address	615	
	Function	Same as ramp 1 (see **P009**).	

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

P016 Speed Ramp 3: Deceleration Time

P016	Range	0 ÷ 32700	0 ÷327.00 s if **P020**=0 → 0.01 s 0 ÷3270.0 s if **P020**=0 → 0.1 s 0 ÷32700 s if **P020**=0 → 1 s 0 ÷327000 s if **P020**=0 → 10 s
	Default	See Table 72.	
	Level	ADVANCED	
	Address	616	
	Function	Same as ramp 1 (see **P010**).	

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

P018 Speed Ramp 4: Acceleration Time

P018	Range	0 ÷ 32700	0 ÷327.00 s if **P020**=0 → 0.01 s 0 ÷3270.0 s if **P020**=0 → 0.1 s 0 ÷32700 s if **P020**=0 → 1 s 0 ÷327000 s if **P020**=0 → 10 s
	Default	See Table 72.	
	Level	ADVANCED	
	Address	618	
	Function	Same as ramp 1 (see **P009**).	

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

P019 Speed Ramp 4: Deceleration Time

P019	Range	0 ÷ 32700	0 ÷327.00 s if **P020**=0 → 0.01 s 0 ÷3270.0 s if **P020**=0 → 0.1 s 0 ÷32700 s if **P020**=0 → 1 s 0 ÷327000 s if **P020**=0 → 10 s
	Default	See Table 72.	
	Level	ADVANCED	
	Address	619	
	Function	Same as ramp 1 (see **P010**).	

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

P020 Speed Ramps 3 and 4: Time Unit of Measure

P020	Range	0 ÷ 3	0 → 0.01 s 1→ 0.1 s 2→ 1 s 3→ 10 s
	Default	See Table 72.	
	Level	ADVANCED	
	Address	620	
	Function	Defines the unit of measure for the times for speed ramp 3, **P015** and **P016**, and speed ramp 4, **P020** and **P018**. The allowable programmable range may be extended from 0 s to 327000s.	

P021 Selection for Ramp Rounding Off

P021	Range	0000b ÷ 1111b binary 0x0000 ÷ 0x000F hexadecimal 0 ÷ 15	0000b (no S ramps) 1111b (all S ramps)
	Default	See Table 72	
	Level	ADVANCED	
	Address	621	
	Function	In this parameter, you can select the bit corresponding to the ramp to be rounded off. Example: **P021** = 0011b = 3 decimal → ramps 1 and 2 are rounded off. The ramp rounding off allows reaching the reference end value with a zero tangent, both while accelerating and while decelerating, thus suppressing torque peaks that could damage mechanical couplings.	

P022 Acceleration Ramp: Start Rounding Off Time

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

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

P023 Acceleration Ramp: End Rounding Off Time

P023	Range	0 ÷ 100	0 ÷ 100 %
	Default	50	50%
	Level	ADVANCED	
	Address	623	
	Function	Sets the rounding off time period for the end stage of the acceleration ramp. This parameter is expressed as a percentage of the acceleration ramp time of the active ramp.	

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

P024 Deceleration Ramp: Start Rounding Off Time

P024	Range	0 ÷ 100	0 ÷ 100 %
	Default	50	50%
	Level	ADVANCED	
	Address	624	
	Function	See the function for **P022**. The only difference is that this rounding off function is applied to the first stage of a deceleration ramp.	

NOTE

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

P025 Deceleration Ramp: End Rounding Off Time

P025	Range	0 ÷ 100	0 ÷ 100 %
	Default	50	50%
	Level	ADVANCED	
	Address	625	
	Function	See the function for **P023**. The only difference is that this rounding off function is applied to the last stage of a deceleration ramp.	

NOTE

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

P026 Torque Ramp Time: Up

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

P027 Torque Ramp Time: Down

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

P028 Unit of Measure for Torque Ramp Time

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

P029 Jog Ramp Acceleration Time

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

P030 Jog Ramp Deceleration Time

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

P031 Gradient Variation Acceleration Reset

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

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

P032 Fire Mode Acceleration Ramp

P032	Range	0 ÷ 32700	0 ÷ 327.00 s if **P014**=0 → 0.01 s 0 ÷ 3270.0 s if **P014**=1 → 0.1 s 0 ÷ 32700 s if **P014**=2 → 1 s 0 ÷ 327000 s if **P014**=3 → 10 s
	Default	See Table 72.	
	Level	ENGINEERING	
	Address	632	
	Function	This ramp is used to accelerate the motor when in Fire Mode.	

P033 Fire Mode Deceleration Ramp

P033	Range	0 ÷ 32700	0 ÷ 327.00 s if **P014**=0 → 0.01 s 0 ÷ 3270.0 s if **P014**=1 → 0.1 s 0 ÷ 32700 s if **P014**=2 → 1 s 0 ÷ 327000 s if **P014**=3 → 10 s
	Default	See Table 72.	
	Level	ENGINEERING	
	Address	633	
	Function	This ramp is used to decelerate the motor when in Fire Mode.	

13. INPUTS FOR REFERENCES MENU

13.1. Processing Speed/Torque References

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

Table 18: Parameters used for the Inputs for References Menu.

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

The following pages contain block diagrams illustrating speed reference processing (Figure 6) and torque reference processing (Figure 7). Menus and parameters used are also stated.

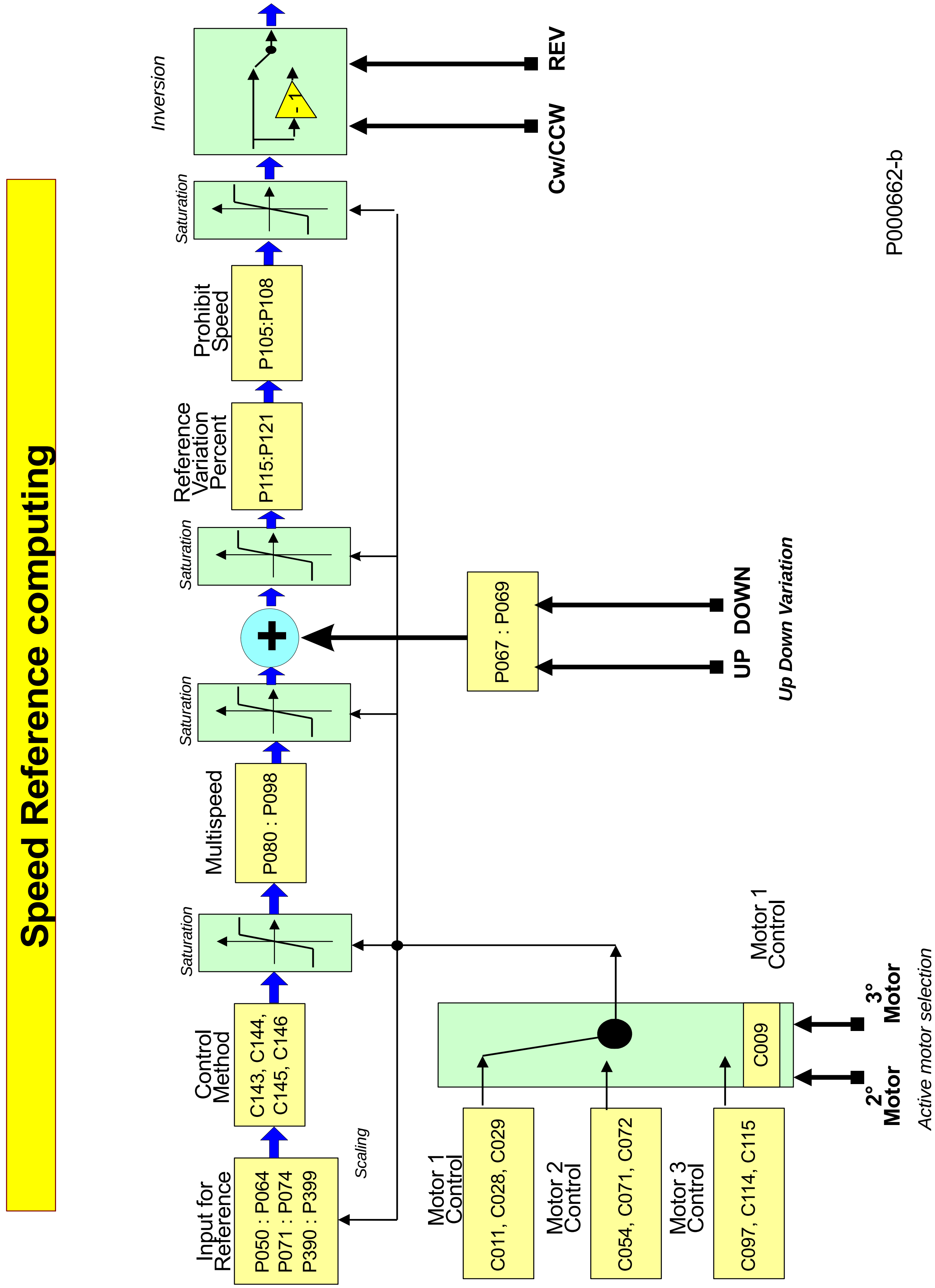


Figure 7: Speed Reference computing.

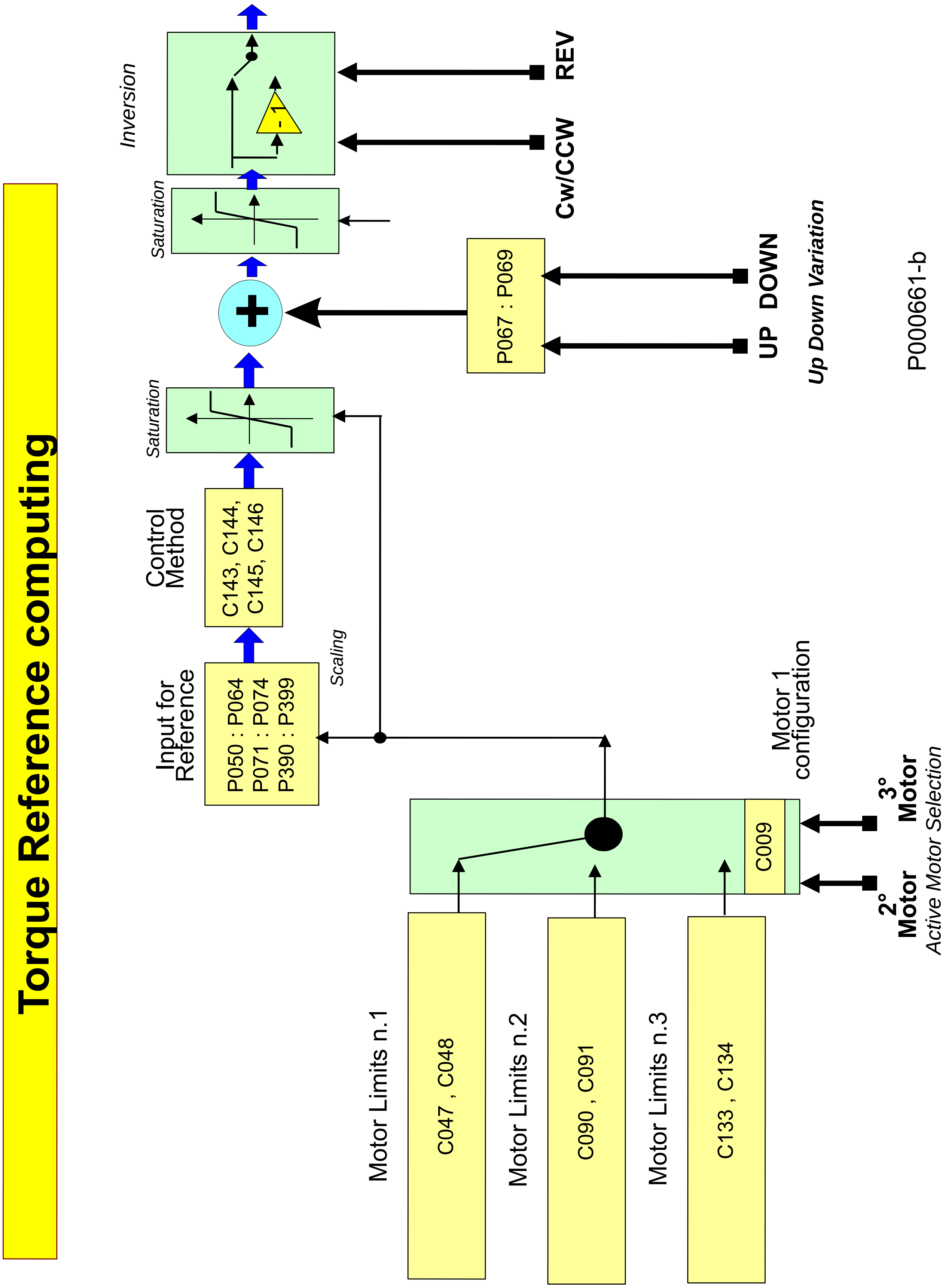


Figure 8: Torque Reference computing.

13.2. Scaling Analog Inputs REF, AIN1, AIN2

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

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

Table 19: Analog Input Hardware Mode.

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

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

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

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

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

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

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

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

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

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

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

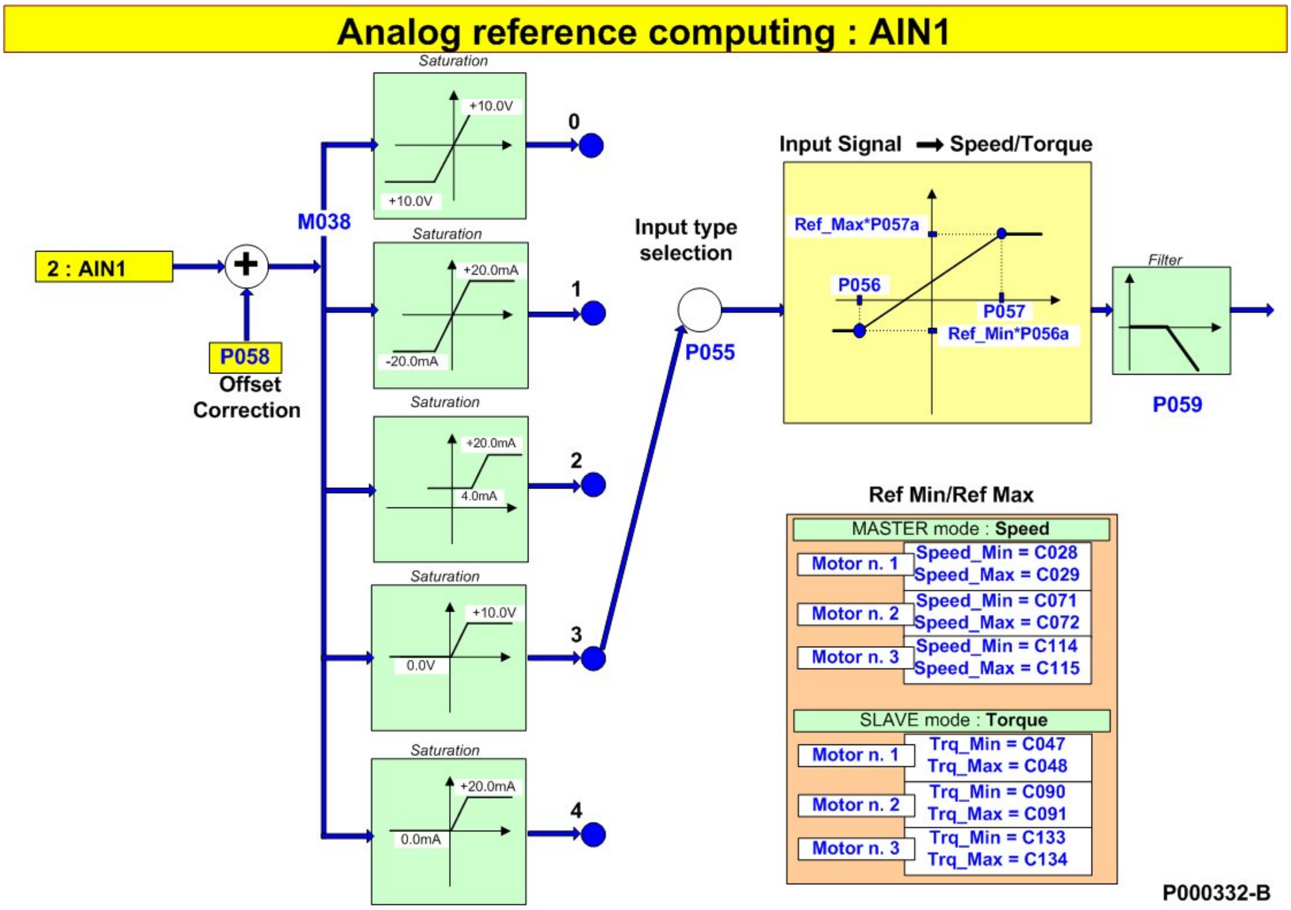


Figure 9: Computing Speed Analog Reference from terminal board: AIN1.

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

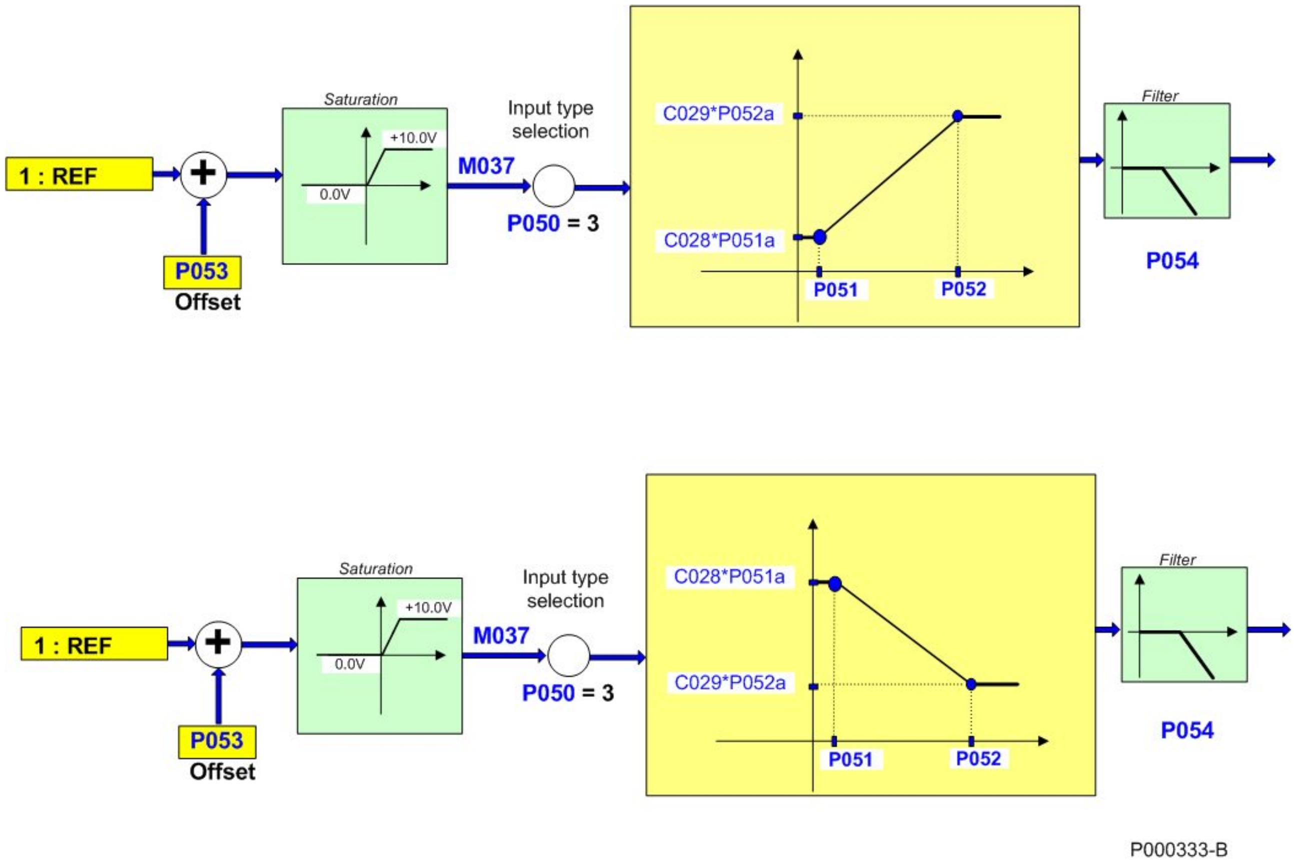


Figure 10: Computing Inputs REF (1) and (2) (examples).

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

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

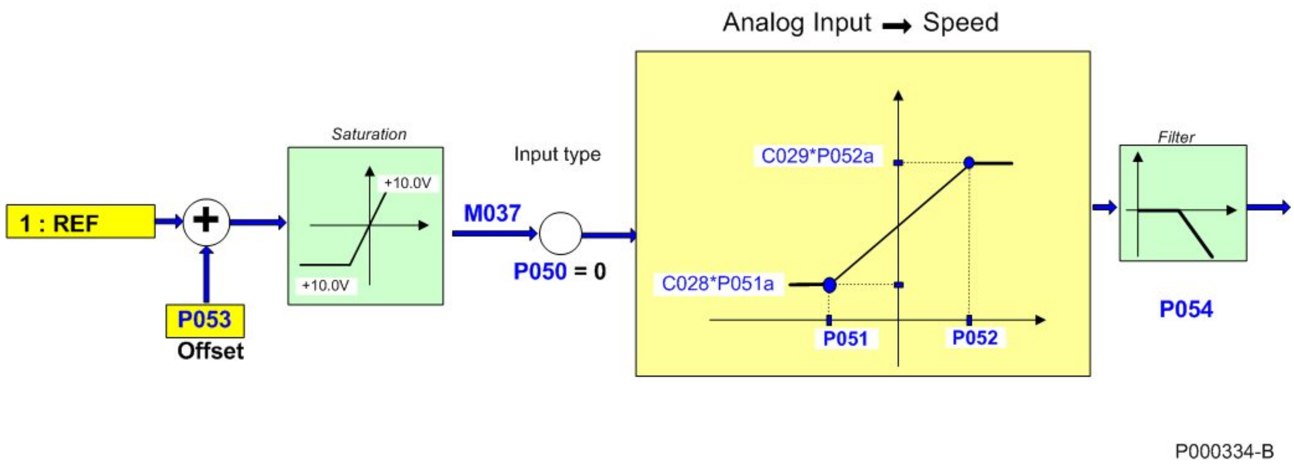


Figure 11: Computing REF Input (Example 3).

The Setup in Figure 11 is as follows:
P050 = 0
P051 = –5V; P051a = 100%; P052 = +8V; P052a = 100%
Speed_Min = C028 = 300 rpm; Speed_Max = C029 =1450 rpm

13.3. List of Parameters P050 to P074a

Table 20: List of parameters P050 to P074a.

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

P050 Type of Signal over REF Input

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

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

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

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

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

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

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

P052	Range	−100 ÷ 100, if **P050** = 0 −200 ÷ 200, if **P050** = 1 +40 ÷ 200, if **P050** = 2 0 ÷ 100, if **P050** = 3 0 ÷ 200, if **P050** = 4	−10.0 V ÷ 10.0 V, if **P050** = 0: ± 10 V −20.0 mA ÷ 20.0 mA, if **P050** = 1: ± 20 mA +4.0mA ÷ 20.0 mA, if **P050** = 2: 4 ÷ 20 mA 0.0 V ÷ 10.0V, if **P050** = 3: 0 ÷ 10 V 0.0 mA ÷ 20.0 mA, if **P050** = 4: 0 ÷ 20 mA
	Default	100	10.0 V
	Level	ADVANCED	
	Address	652	
	Function	This parameter selects the value for REF input signal for minimum reference, or better the reference set in **C029xP052a** (Master mode) or in **C048xP052a** (Slave mode). If motor 2 is active, **C072** and C091 will be used instead of **C029** and **C048**; if motor 3 is active, the values set in **C115** and C134 will be used.	

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

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

P053 Offset over REF Input

P053	Range	−2000 ÷ 2000	−10.00 V ÷ +10.00 V, if **P050** = 0 or 3 − 20.00 mA ÷ +20.00 mA, if **P050** = 1,2,4
	Default	0	0 V
	Level	ADVANCED	
	Address	653	
	Function	This parameter selects the offset correction value of the REF analog signal that has been measured. The value set is added to the signal measured before saturation or conversion; its unit of measure is the same as the one of the signal selected for REF analog input.	

P054 Filtering Time over REF Input

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

P055 Type of Signal over AIN1 Input

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

NOTE

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

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

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

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

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

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

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

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

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

P058 Offset over AIN1 Input

P058	Range	–2000 ÷ 2000	–10.00 V ÷ +10.00 V, if **P055** = 0 or 3 – 20.00 mA ÷ +20.00 mA, if **P055** = 1,2,4
	Default	0	0 V
	Level	ADVANCED	
	Address	658	
	Function	This parameter selects the offset correction value of AIN1 analog signal that has been measured. The value set is added to the signal measured before saturation or conversion; its unit of measure is the same as the one of the signal selected for AIN1 analog input.	

P059 Filtering Time over AIN1 Input

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

P060 Type of Signal over AIN2 Input

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

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

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

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

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

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

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

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

P062	Range	–100 ÷ 100, if **P060** = 0 –200 ÷ 200, if **P060** = 1 +40 ÷ 200, if **P060** = 2 0 ÷ 100, if **P060** = 3 0 ÷ 200, if **P060**= 4	–10.0 V ÷ 10.0 V, if **P060**= 0: ± 10 V –20.0 mA ÷ 20.0 mA, if **P060** = 1: ± 20 mA +4.0mA ÷ 20.0 mA, if **P060** = 2: 4 ÷ 20 mA 0.0 V ÷ 10.0V, if **P060** = 3: 0 ÷ 10 V 0.0 mA ÷ 20.0 mA, if **P060** = 4: 0 ÷ 20 mA
	Default	200	+20.0 mA
	Level	ADVANCED	
	Address	662	
	Function	This parameter selects the value for AIN2 input signal for maximum reference, or better the reference set in **C029xP062a** (Master mode) or in **C048** (Slave mode). If motor 2 is active, **C072xP062a** and **C091** will be used instead of **C029** and **C048**; if motor 3 is active, the values set in **C115** and **C134** will be used.	

P062a Percentage of Speed_Min/Trq_Min Producing Max. Reference (Y-axis related to P062)

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

P063 Offset over AIN2 Input

P063	Range	–2000 ÷ 2000	–10.00 V ÷ +10.00 V, if **P060** = 0 o 3 – 20.00 mA ÷ +20,00 mA , if **P060** = 1,2,4
	Default	0	0 V
	Level	ADVANCED	
	Address	663	
	Function	This parameter selects the offset correction value of AIN2 analog signal that has been measured. The value set is added to the signal measured before saturation or conversion; its unit of measure is the same as the one of the signal selected for AIN2 analog input.	

P064 Filtering Time over AIN2 Input

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

P065 Minimum Reference and START Disabling Threshold

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

NOTE Parameter **P065** is active in Master mode only, i.e. when the reference is a speed reference.

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

P066 START Disable delay at P065 Threshold

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

P067 Keypad and Terminal Board UP/DOWN Ramp

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

P068 Storage of UP/DOWN Values at Power Off

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

P068a Reset UP/DOWN Speed/Torque at Stop

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

P068b Reset UP/DOWN PID at Stop

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

P068c Reset UP/DOWN Speed/Torque at Source Changeover

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

P068d Reset UP/DOWN PID at Source Changeover

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

P069 Range of UP/DOWN Reference

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

P070 JOG reference (Speed/Torque)

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

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

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

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

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

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

P072			
	Range	1000 ÷ 10000	10 kHz ÷ 100 kHz
	Default	10000	100 kHz
	Level	ADVANCED	
	Address	672	
	Function	This parameter selects the value of the **frequency input** signal for maximum reference, or better the reference set in **C029xP072a** (Master mode) or in **C048xP072a** (Slave mode). If motor 2 is active, **C071** and **C090** will be used instead of **C029** and **C048**; if motor 3 is active, the values set in **C115** and **C134** will be used.	

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

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

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

P073			
	Range	–32000 ÷ 32000	± 32000 rpm
	Default	–1500	–1500 rpm
	Level	ADVANCED	
	Address	673	
	Function	This parameter selects the value of the **Encoder input** for minimum reference, or better the reference set in **C028xP073a** (Master mode) or in **C047xP073a** (Slave mode). If motor 2 is active, the values set in **C071** and **C090** will be used instead of **C028** and **C047**; if motor 3 is active, the values set in **C114** and **C133** will be used.	

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

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

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

P074			
	Range	–32000 ÷ 32000	± 32000 rpm
	Default	+1500	+1500 rpm
	Level	ADVANCED	
	Address	674	
	Function	This parameter selects the value of the **Encoder input** for maximum reference, or better the reference set in **C029xP074a** (Master mode) or in **C048xP074a** (Slave mode). If motor 2 is active, **C072** and **C091** will be used instead of **C029** and **C048**; if motor 3 is active, the values set in **C114** and **C133** will be used.	

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

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

14. MULTISPEED MENU

14.1. Overview

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

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

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

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

14.2. List of Parameters P080 to P100

Table 21: List of parameters P080 to P100.

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

P080 Multispeed Function

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

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

P081÷P098	Range	–32000 ÷ 32000	±32000 rpm
	Default	0	0.00 rpm
	Level	From **P081** to **P085**: BASIC From **P087** to **P098**: ADVANCED	
	Address	681÷698	
	Function	This parameter sets the multispeed output speed selected through the relevant digital inputs (Table 84). The multispeed value is scaled based on the unit of measure set in **P100**. The reference resulting from the multispeed selected through the relevant digital inputs will be computed based on the setting of parameter **P080**.	

P099 Fire Mode Speed

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

P100 Multispeed Unit of Measure

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

CAUTION

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

15. PID MULTIREFERENCES MENU

15.1. Overview

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

Configuration example:

<u>PID Configuration Menu</u>

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

<u>Digital Inputs Menu</u>

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

<u>PID Multireferences Menu</u>

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

<u>PID Parameters Menu</u>

P257 Gain for PID scaling = 0.1

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

Supposing that AIN1 is set to 10%, the references below are obtained based on the combination of the digital inputs configured as multireferences, and based on the function allocated to parameter **P080a**:

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

if both digital inputs configured as Multireferences are activated, the overall reference is given from AIN1 analog input selected as the first PID reference (**C285**):

P080a	Multireference Function = Exclusive Preset Ref.	
MDI8	MDI7	Overall reference
0	0	0.0 bars
0	1	1.0 bars
1	0	1.5 bars
1	1	2.5 bars

When no Multireference input is activated, the overall reference is null:

P080a Multireference Function = Sum Ref.		
MDI8	MDI7	Overall reference
0	0	1.0 bar
0	1	2.0 bar
1	0	2.5 bar
1	1	3.5 bar

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

15.2. List of Parameters P080a to P099a

Table 22: List of parameters P080a ÷ P099a

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

P080a Multireference

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

P081a÷P087a PID Multireference 1÷7

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

P099a PID Reference in Fire Mode

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

16. PROHIBIT SPEED MENU

16.1. Overview

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

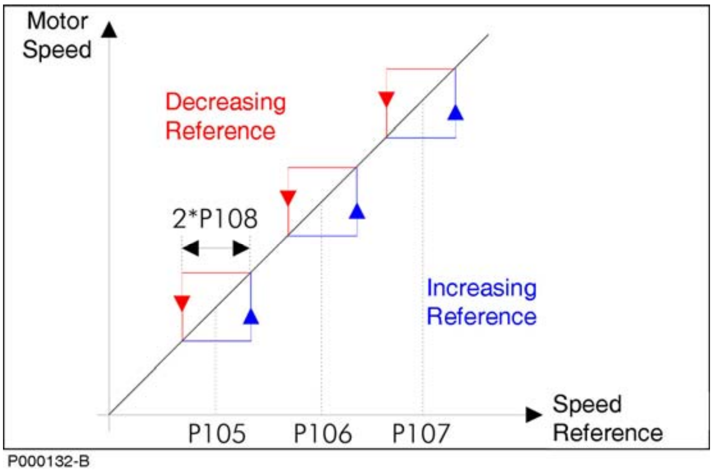


Figure 12: Prohibit Speed ranges.

Figure 12 illustrates different trends of the speed reference when it matches with the max. allowable value of a prohibit speed range when decreasing (red) or when it matches with the min. allowable value of a prohibit speed range when increasing (blue).

Example:

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

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

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

16.2. List of Parameters P105 to P108

Table 23: List of parameters P105 to P108.

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

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

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

P108 Hysteresis (band) of Prohibit Speed Ranges

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

17. REFERENCE VARIATION PERCENT MENU

17.1. Overview

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

Example:

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

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

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

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

Speed control (example):

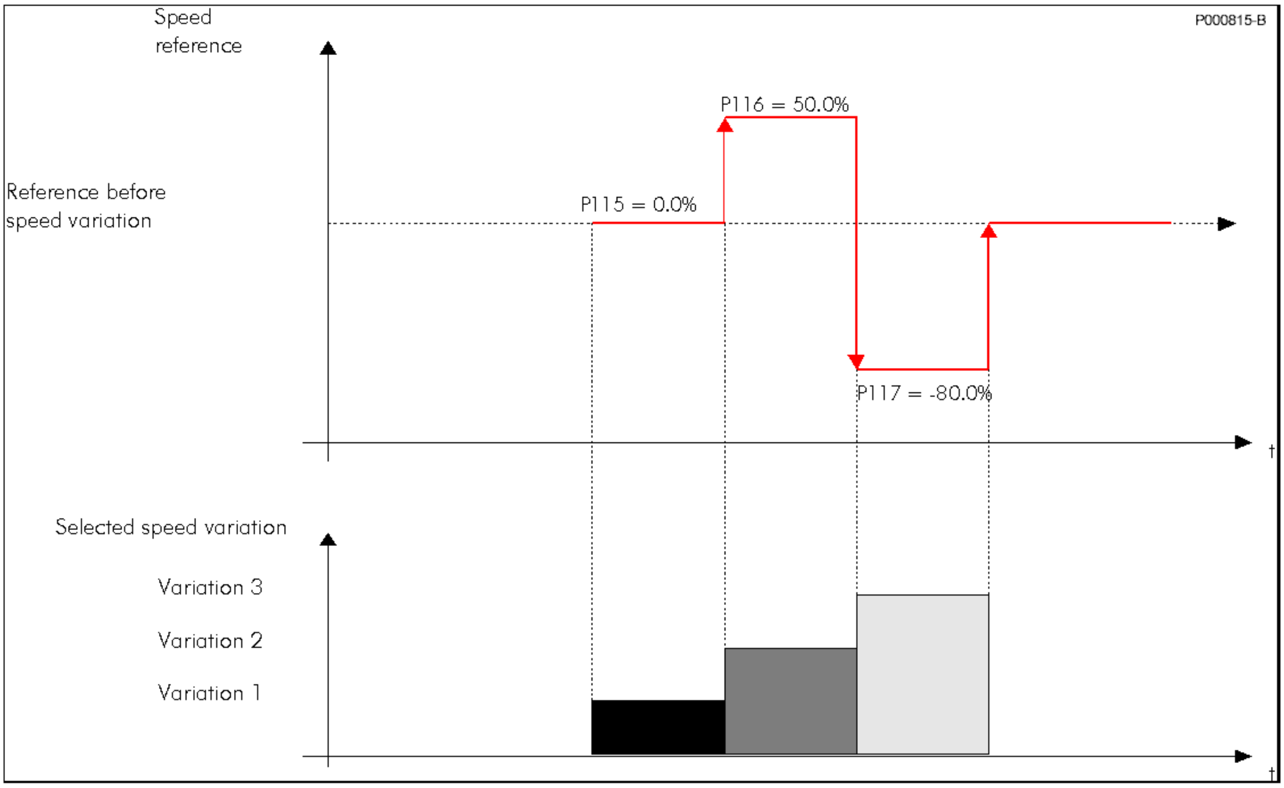


Figure 13: Speed Control (example).

17.2. List of Parameters P115 to P121

Table 24: List of parameters P115 to P121.

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

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

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

18. SPEED LOOP AND CURRENT BALANCING MENU

18.1. Overview

The SPEED LOOP AND CURRENT BALANCING MENU, for VTC and FOC controls, allows setting the parameter values of the speed regulators for the three connected motors and to manually adjust the motor current balancing (see parameter **P152**).
The speed regulator for each motor has two parameterization functions: two integral terms, two proportional terms and two speed error thresholds (expressed as a percentage of the motor rated 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: **max. integral time** and **min. proportional constant**.
The setup of min. integral time and max. proportional constant is enabled provided that two different error thresholds are used.

Example:

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

Error ≤ **P130**
For speed **errors** lower than or equal to 2% of the motor rated speed, the speed regulator adopts the min. coefficients, i.e. parameters **P126** (determining the lesser integral coefficient 1/**P126**) and **P128**.
Error ≥ **P131**
If the speed error exceeds the second error threshold, the speed regulator shall quickly make up for the greater error, so it uses the highest coefficients, i.e. **P125** (determining the greater integral coefficient 1/**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**)]

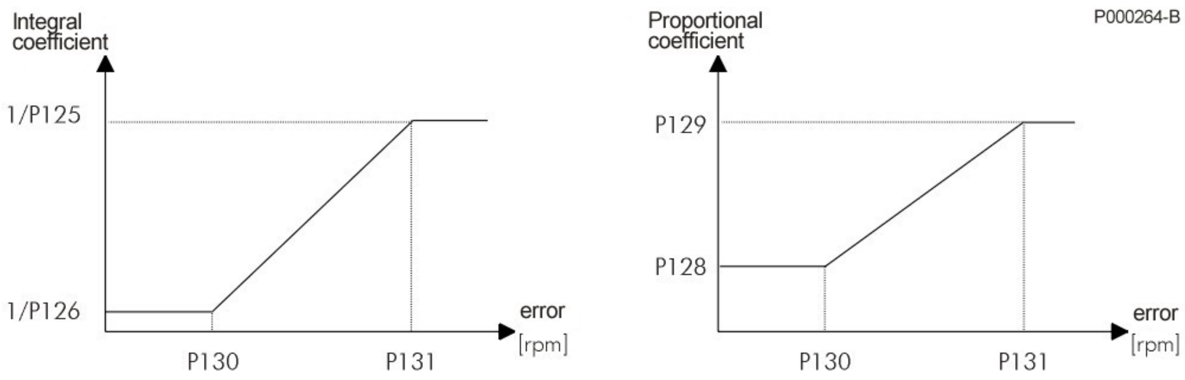


Figure 14: Dual Parameterization function (example).

18.2. List of Parameters P125 to P152

Table 25: List of parameters P125 to P152.

Parameter	FUNCTION	User Level	Default Values	MODBUS Address
P125	Mot1 Min. integral time	BASIC	500 ms	725
P126	Mot1 Max. integral time	BASIC	500 ms	726
P128	Mot1 Min. prop. coefficient	BASIC	10.00	728
P129	Mot1 Max. prop. coefficient	BASIC	10.00	729
P130	Mot1 Min. error threshold	BASIC	1.00%	730
P131	Mot1 Max. error threshold	BASIC	1.00%	731
P135	Mot2 Min. integral time	BASIC	500 ms	735
P136	Mot2 Max. integral time	BASIC	500 ms	736
P138	Mot2 Min. prop. coefficient	BASIC	10.00	738
P139	Mot2 Max. prop. coefficient	BASIC	10.00	739
P140	Mot2 Min. error threshold	BASIC	1.00%	740
P141	Mot2 Max. error threshold	BASIC	1.00%	741
P145	Mot3 Min. integral time	BASIC	500 ms	745
P146	Mot3 Max. integral time	BASIC	500 ms	746
P148	Mot3 Min. prop. coefficient	BASIC	10.00	748
P149	Mot3 Max. prop. coefficient	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) Min. Integral Time

P125 (Motor n.1) P135 (Motor n.2) P145 (Motor n.3)	Range	1÷ 32000	0.001÷ 32.000 [Disable] ms
	Default	500	500 ms
	Level	BASIC	
	Address	725 735 745	
	Control	VTC and FOC	
	Function	This parameter sets the min. integral time for the speed regulator. It 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).	

P126 (P136, P146) Max. Integral Time

P126 (Motor n.1) P136 (Motor n.2) P146 (Motor n.3)	Range	1÷ 32000	0.001÷ 32.000 [Disable] ms
	Default	500	500 ms
	Level	BASIC	
	Address	726 736 746	
	Control	VTC and FOC	
	Function	This parameter sets the max. integral time for the speed regulator.	

P128 (P138, P148) Min. Proportional Coefficient

P128 (Motor n.1) P138 (Motor n.2) P148 (Motor n.3)	Range	0 ÷ 65000	0.00 ÷ 650.00
	Default	1000	10.00
	Level	BASIC	
	Address	728,738,748	
	Control	VTC and FOC	
	Function	This parameter sets the min. proportional coefficient for the speed regulator. Default value (10): if a speed error of 1% occurs, the regulator will require 10% of the motor rated torque.	

P129 (P139, P149) Max. Proportional Coefficient

P129 (Motor n.1) P139 (Motor n.2) P149 (Motor n.3)	Range	0 ÷ 65000	0.00 ÷ 650.00
	Default	1000	10.00
	Level	BASIC	
	Address	729,739,749	
	Control	VTC and FOC	
	Function	This parameter sets the max. proportional coefficient for the speed regulator. Default value (10): if a speed error of 1% occurs, the regulator will require 10% of the motor rated 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) Min. Error Threshold

P130 (Motor n.1) P140 (Motor n.2) P150 (Motor n.3)	Range	0 ÷ 32000	0.00 ÷ 320.00
	Default	100	1.00%
	Level	BASIC	
	Address	730,740,750	
	Control	VTC and FOC	
	Function	This parameter determines the min. error threshold. In case of speed errors lower than or equal to the min. threshold, parameters P126 and P128 will be used.	

P131 (P141, P151) Max. Error Threshold

P131 (Motor n.1) P141 (Motor n.2) P151 (Motor n.3)	Range	0 ÷ 32000	0.00 ÷ 320.00
	Default	100	1.00%
	Level	BASIC	
	Address	731,741,751	
	Control	VTC and FOC	
	Function	This parameter sets the max. error threshold. If P130 = P131 or in case of speed errors greater than or equal to the max. threshold, parameters P125 and P129 will be used.	

P152 Symmetry Regulation of Three-phase Current

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

19. FOC REGULATORS MENU

19.1. Overview

NOTE Please refer to the **Motor Control** section as well.

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

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

19.2. List of Parameters P155 to P173

Table 26: List of parameters P155 to P173.

Parameter	FUNCTION	User Level	Default Values	MODBUS Address
P155	Current regulator proportional constant, Mot n.1	ENGINEERING	3.00	755
P156	Current regulator integral time, Mot n.1	ENGINEERING	20.0 ms	756
P158	Flux regulator proportional constant, Mot n.1	ENGINEERING	0.00	758
P159	Flux regulator integral time, Mot n.1	ENGINEERING	33 ms	759
P162	Current regulator proportional constant, Mot n.2	ENGINEERING	3.00	762
P163	Current regulator integral time, Mot n.2	ENGINEERING	20.0 ms	763
P165	Flux regulator proportional constant, Mot n.2	ENGINEERING	0.00	765
P166	Flux regulator integral time, Mot n.2	ENGINEERING	33 ms	766
P169	Current regulator proportional constant, Mot n.3	ENGINEERING	3.00	769
P170	Current regulator integral time, Mot n.3	ENGINEERING	20.0 ms	770
P172	Flux regulator proportional constant, Mot n.3	ENGINEERING	0.00	772
P173	Flux regulator integral time, Mot n.3	ENGINEERING	33 ms	773

P155 (P162, P169) Current Regulator Proportional Constant

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

NOTE

This parameter is <u>automatically computed and saved</u> when the Autotuning procedure is performed (see the AUTOTUNE MENU).

P156 (P163, P170) Current Regulator Integral Time

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

NOTE

This parameter is <u>automatically computed and saved</u> when the Autotuning procedure is performed (see the AUTOTUNE MENU).

P158 (P165, P172) Flux Regulator Proportional Constant

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

P159 (P166, P173) Flux Regulator Integral Time

P159 (Motor n.1) P166 (Motor n.2) P173 (Motor n.3)			
	Range	1 ÷ 32000	1.0 ÷ 32000. (Disabled)
	Default	33	33 ms
	Level	ENGINEERING	
	Address	759 766 773	
	Control	FOC	
	Function	**Ti** Integral time of flux regulator **PI** for motor n.1 (**P163** and **P170** relate to parameters 2 and 3). The regulator's structure is as follows: error = *Set_Point – Measure;* *integral_status* = *integral_status + error* ***Ki*****Ts**; *Output* = **Kp****error + integral_status;* where Kp is the proportional coefficient **Ki** is the integral coefficient = 1/Ti , where Ti is the integral time **Ts** is the regulator operating time (ranging from 200 to 400 microseconds based on carrier frequency).	

NOTE

Parameters P159-P166-P173 are <u>automatically recomputed and saved</u> whenever the Rotor Time Constant parameter (**C025**) is altered.

20. ANALOG AND FREQUENCY OUTPUTS MENU

20.1. Overview

NOTE

Please refer to the Sinus Penta's **Installation Instructions Manual** for the hardware description of the analog output and the frequency output or for the configuration of the dip-switches for voltage/current outputs.

NOTE

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

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

20.1.1. Factory-setting of the Analog Outputs

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

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

* Depending on the inverter size.

20.1.2. Analog Outputs

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

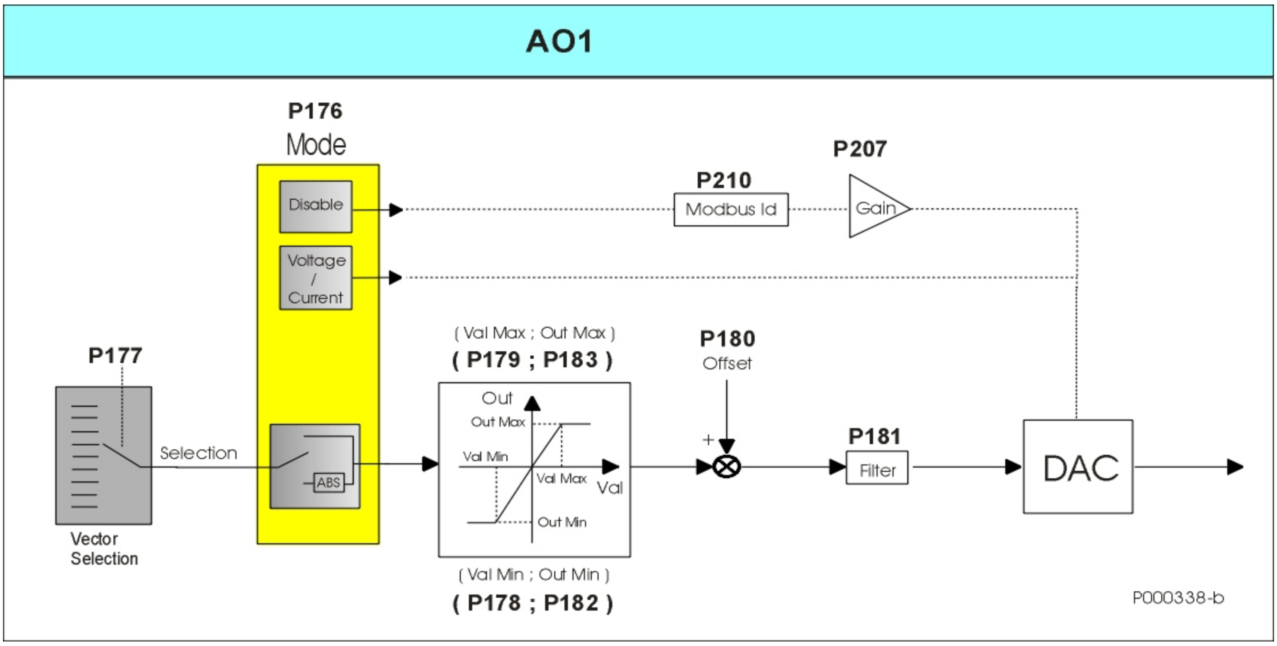


Figure 15: Typical structure of the Analog Outputs.

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

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

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

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

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

20.1.3. Frequency Output

When programming the frequency output, the setting of MDO1 in the Digital Outputs Menu is disabled. The figure below illustrates the structure of the frequency output. Parameterization is similar to the one used for the analog outputs.

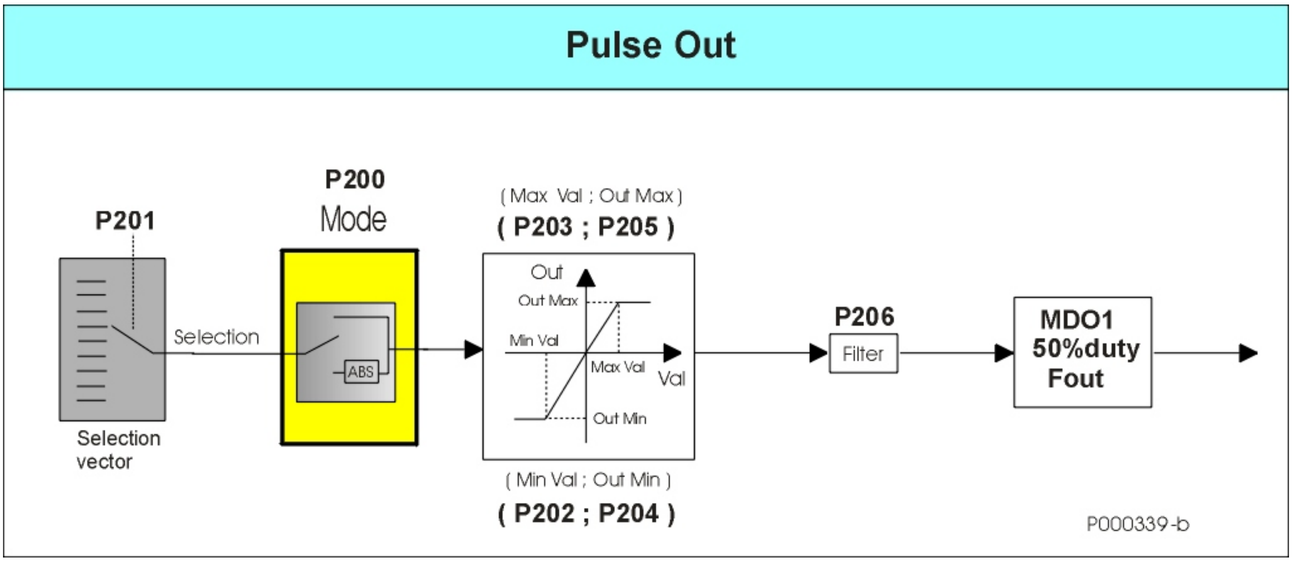


Figure 16: Structure of the Frequency Output.

20.2. Variables

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

Table 27: Variables to be selected for the Analog and Frequency Outputs.

SELECTION CODE		
Selection Value	FS Ref.	Description
0: Disable	100.00%	Disabled output
1: Speed	10000 rpm	Speed of the connected motor
2: Speed Ref.	10000 rpm	Speed reference at constant speed
3: Ramp Out	10000 rpm	"Ramped" speed reference
4: Mot. Freq.	1000.0 Hz	Frequency produced by the drive
5: Mot. Curr.	1000.0 A	Current RMS
6: Out Volt	1000.0 V	Output voltage RMS
7: OutPower	1000.0 kW	Output power
8: DC Vbus	1000.0 V	DC-link voltage
9: Torq.Ref	100.00%	Torque reference at constant speed
10: Torq.Dem	100.00%	Demanded torque
11: Torq.Out	100.00%	Evaluation of the torque output
12: Torq.Lim	100.00%	Setpoint of the torque limit
13: PID Ref%	100.00%	PID reference at constant speed
14: PID RMP%	100.00%	"Ramped" PID reference
15: PID Err%	100.00%	Error between PID reference and feedback
16: PID Fbk%	100.00%	Feedback to the PID
17: PID Out%	100.00%	Output of the PID
18: REF	100.00%	Analog input REF
19: AIN1	100.00%	Analog input AIN1
20: AIN2/PTC	100.00%	Analog input AIN2
21: Enc. In	10000 rpm	Speed read by the encoder used as a reference
22: PulseIn	100.00 kHz	Frequency input
23: Flux Ref	1.0000 Wb	Flux reference at constant speed
24: Flux	1.0000 Wb	Current flux reference
25: iq ref.	1000.0 A	Current reference in axis q
26: id ref.	1000.0 A	Current reference in axis d
27: iq	1000.0 A	Current measure in axis q
28: id	1000.0 A	Current measure in axis d
29: Volt.Vq	1000.0 V	Voltage in axis q
30: Volt Vd	1000.0 V	Voltage in axis d
31: Cosine	100.00%	Cosine waveform
32: Sine	100.00%	Sine waveform
33: Angle	1.0000 rad	Electric angle of delivered Vu
34: +10V	10.000 V	Voltage level +10V
35: –10V	10.000 V	Voltage level –10V
36: Flux Current	1000.0 A	Flux Current
37: Sqr Wave	100.00%	Square wave
38: Saw Wave	100.00%	Saw wave
39: Hts Temp.	100.00 °C	Temperature of the heatsink
40: Amb Temp.	100.00 °C	Ambient temperature
41÷49: RESERVED		RESERVED
50: PT100_1	100.00%	PT100 Channel 1
51: PT100_2	100.00%	PT100 Channel 2
52: PT100_3	100.00%	PT100 Channel 3
53: PT100_4	100.00%	PT100 Channel 4
54: I2t%	100.00%	Motor thermal capacity
55: XAIN4	100.00%	XAIN4 Analog input
56: XAIN5	100.00%	XAIN5 Analog input
57: OT Count	650000h	Maintenance Operation Time Counter
58: ST Count	650000h	Maintenance Supply Time Counter
59: RESERVED		RESERVED

Table 27 provides a brief description of each variable and its full-scale value (FS Ref.).

20.2.1. OPERATING MODE OF ANALOG AND FREQUENCY OUTPUTS

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

The following modes can be used for analog outputs:

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

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

Three operating modes can be selected for the Frequency Output:

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

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

20.2.2. ANALOG OUTPUT PROGRAMMING EXAMPLES

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

Example 1:

Table 28: Programming AO1 (0÷ 0V).

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

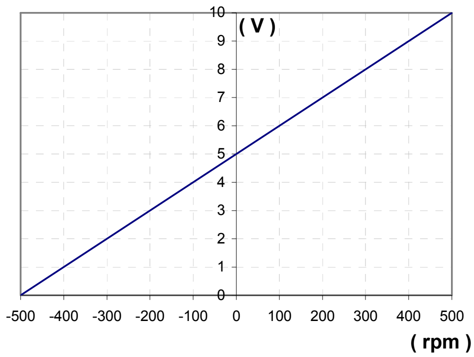


Figure 17: Curve (voltage; speed) implemented by AO1 (Example 1).

Example 2:

Table 29: Programming AO1 (ABS 0 ÷ 10V).

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

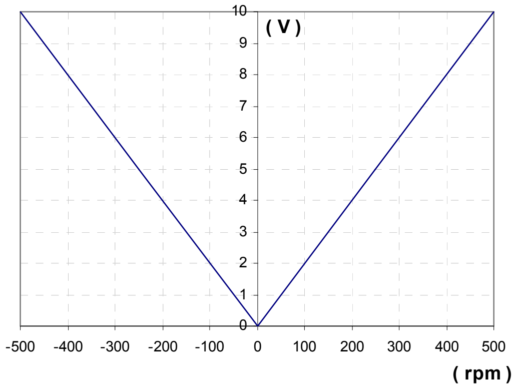


Figure 18: Curve (voltage; speed) implemented by AO1 (Example 2).

Example 3:

Table 30: Programming AO1 (ABS 0 ÷ 10V).

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

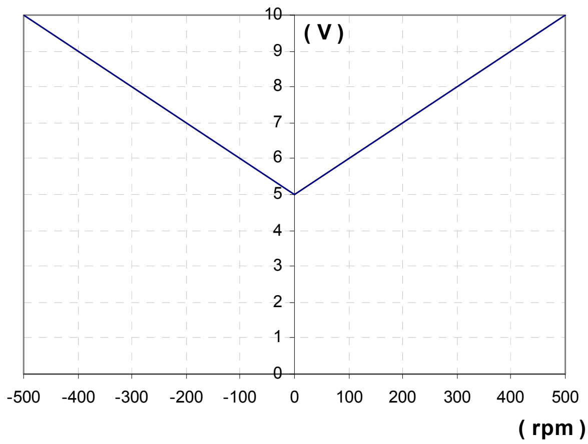


Figure 19: Curve (voltage; speed) implemented by AO1 (Example 3).

NOTE

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

Example 4:

Table 31: Programming AO1 (ABS 0 ÷ 10V).

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

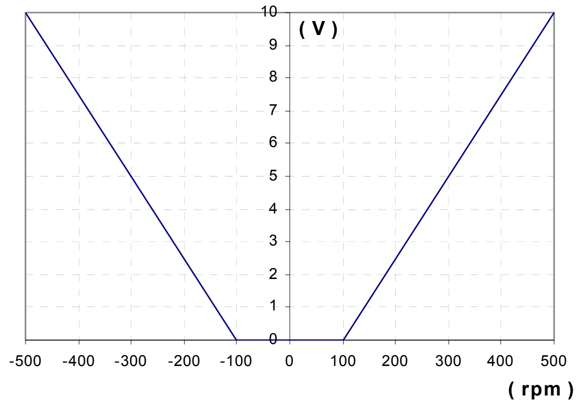


Figure 20: Curve (voltage; speed) implemented by AO1 (Example 4).

Example 5:

Table 32: Programming AO1 (± 10V).

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

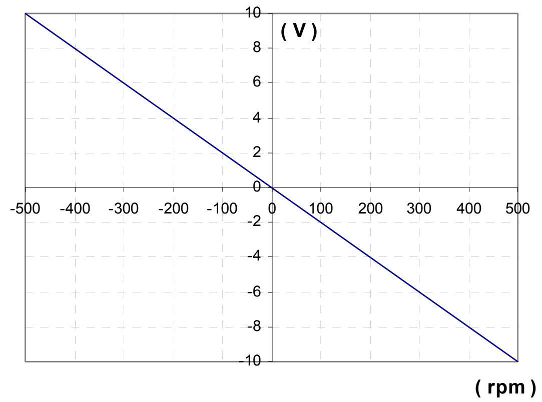


Figure 21: Curve (voltage; speed) implemented by AO1 (Example 5).

20.3. List of Parameters P176 to P215

Table 33: List of parameters P176 to P215.

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

P176 AO1Analog Output

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

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

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

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

P177 Selected Variable for AO1 Analog Output

P177	Range	0 ÷ 59	See Table 27
	Default	1	Motor speed
	Level	ADVANCED	
	Address	777	
	Function	Selects the variable to be allocated to AO1 digital output.	

P178 Min. value of AO1 Selected Variable

P178	Range	-32000 ÷ +32000 Depending on the value selected in P177	- 320.00% ÷ + 320.00 % of the full-scale value See Table 27
	Default	–1500	–15.00% of 10000 rpm = –1500 rpm
	Level	ADVANCED	
	Address	778	
	Function	Minimum value of the motor speed corresponding to the min. output value of AO1 set in **P182**.	

P179 Max. value of AO1 Selected Variable

P179	Range	-32000 ÷ +32000 Depending on the value selected in **P177**	- 320.00% ÷ + 320.00 % of the full-scale value See Table 27
	Default	+1500	+15.00% of 10000 rpm = +1500 rpm
	Level	ADVANCED	
	Address	779	
	Function	Maximum value of the motor speed corresponding to the min. output value of AO1 set in **P183**.	

P180 AO1 Analog Output Offset

P180	Range	–9999 ÷ +9999 Depending on the value selected in **P176**	–9.999 ÷ +9.999
	Default	0	0.000 V
	Level	ADVANCED	
	Address	780	
	Function	Offset value applied to AO1 analog output.	

P181 Filter for AO1 Analog Output

P181	Range	0 ÷ 65000	0.000 ÷ 65.000 sec.
	Default	0	0.000 sec.
	Level	ADVANCED	
	Address	781	
	Function	Value of the filter time constant applied to AO1 analog output.	

P182 Min. AO1 Output Value with Reference to P178

P182	Range	–100 ÷ +100 –200 ÷ +200 Depending on the value selected in **P176**	–10.0 ÷ +10.0 V –20.0 ÷ +20.0 mA
	Default	–100	–10.0 V
	Level	ADVANCED	
	Address	782	
	Function	Minimum output value obtained when the minimum value of the variable set in **P178** is implemented.	

P183 Max. AO2 Output Value with Reference to P179

P183	Range	–100 ÷ +100 –200 ÷ +200 Depending on the value selected in **P176**	–10.0 ÷ +10.0 V –20.0 ÷ +20.0 mA
	Default	+100	+10.0 V
	Level	ADVANCED	
	Address	783	
	Function	Maximum output value obtained when the maximum value of the variable set in **P179** is implemented.	

P184 AO2 Analog Output

P184	Range	0 ÷ 7	0: Disabled, 1: ± 10V, 2: 0 ÷ 10V, 3: 0 ÷ 20mA, 4: 4 ÷ 20mA, 5: ABS 0 ÷ 10V, 6: ABS 0 ÷ 20mA, 7: ABS 4 ÷ 20mA.
	Default	1	1: ± 10V
	Level	ADVANCED	
	Address	784	
	Function	Selects the operating mode of AO2 analog output.	

NOTE

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

P185 Selected Variable for AO2 Analog Output

P185	Range	0 ÷ 59	See Table 27
	Default	2	Reference at constant speed
	Level	ADVANCED	
	Address	785	
	Function	Selects the variable to be allocated to AO2 digital output.	

P186 Min. Value of AO2 Selected Variable

P186	Range	Depends on the value selected in **P185**	See Table 27
	Default	–1500	–1500 rpm
	Level	ADVANCED	
	Address	786	
	Function	Minimum value of the motor speed corresponding to the min. output value of AO2 set in **P190**.	

P187 Max. value of AO2 Selected Variable

P187	Range	Depends on the value selected in **P185**	See Table 27
	Default	+1500	+1500 rpm
	Level	ADVANCED	
	Address	787	
	Function	Maximum value of the motor speed corresponding to the min. output value of AO2 set in **P191**.	

P188 AO2 Analog Output Offset

P188	Range	–9999 ÷ +9999 Depends on the value selected in **P184**	-9.999 ÷ 9.999
	Default	0	0.000 V
	Level	ADVANCED	
	Address	788	
	Function	Offset value applied to AO2 analog output.	

P189 Filter for AO2 Analog Output

P189	Range	0 ÷ 65000	0.000÷65.000 sec.
	Default	0	0.000 sec.
	Level	ADVANCED	
	Address	789	
	Function	Value of the filter time constant applied to AO2 analog output.	

P190 Min. AO2 Output Value with Reference to P186

P190	Range	–100 ÷ +100 –200 ÷ +200 Depends on the value selected in **P184**	–10.0 ÷ +10.0 V –20.0 ÷ +20.0 mA
	Default	–100	–10.0 V
	Level	ADVANCED	
	Address	790	
	Function	Minimum output value obtained when the minimum value of the variable set in **P186** is implemented.	

P191 Max. AO2 Output Value with Reference to P187

P191	Range	-100 ÷ +100 –200 ÷ +200 Depends on the value selected in **P184**	–10.0 ÷ +10.0 V –20.0 ÷ +20.0 mA
	Default	+100	+10,0 V
	Level	ADVANCED	
	Address	791	
	Function	Maximum output value obtained when the maximum value of the variable set in **P187** is implemented.	

P192 AO3 Analog Output

P192	Range	0 ÷ 7	0: Disabled, 1: ± 10V, 2: 0 ÷ 10V, 3: 0 ÷ 20mA, 4: 4 ÷ 20mA, 5: ABS 0 ÷ 10V, 6: ABS 0 ÷ 20mA, 7: ABS 4 ÷ 20mA.
	Default	2	2: 0 ÷ 10V
	Level	ADVANCED	
	Address	792	
	Function	Selects the operating mode of AO3 analog output.	

NOTE

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

P193 Selected Variable for AO3 Analog Output

P193			
	Range	0 ÷ 59	See Table 27
	Default	5	5: Motor current
	Level	ADVANCED	
	Address	793	
	Function	Selects the variable to be allocated to AO3 analog output.	

P194 Min. Value of AO3 Selected Variable

P194			
	Range	Depends on the value selected through **P193**	See Table 27
	Default	0	0 A
	Level	ADVANCED	
	Address	794	
	Function	Minimum value of the motor speed corresponding to the min. output value of AO3 set in **P198**.	

P195 Max. Value of AO3 Selected Variable

P195			
	Range	Depends on the value selected through **P193**	See Table 27
	Default	Inverter Imax	Max. drive current depending on the drive size
	Level	ADVANCED	
	Address	795	
	Function	Maximum value of the motor speed corresponding to the min. output value of AO3 set in **P199**.	

P196 AO3 Analog Output Offset

P196			
	Range	Depends on the value selected through **P192**	See Table 27
	Default	0	0.000 V
	Level	ADVANCED	
	Address	796	
	Function	Offset value applied to AO3 analog output.	

P197 Filter for AO3 Analog Output

P197			
	Range	0 ÷ 65000 sec.	0.000 ÷ 65.000 sec.
	Default	0	0.000 sec.
	Level	ADVANCED	
	Address	797	
	Function	Value of the filter time constant applied to AO3 analog output.	

P198 Min. AO3 Output Value with Reference to P194

P198	Range	–100 ÷ +100 –200 ÷ +200 Function according to the selection of **P192**	 –10.0 ÷ +10.0 V –20.0 ÷ +20.0 mA
	Default	0	00.0 V
	Level	ADVANCED	
	Address	798	
	Function	Minimum output value obtained when the minimum value of the variable set in **P194** is implemented.	

P199 Max. AO3 Output Value with Reference to P195

P199	Range	–100 ÷ +100 –200 ÷ +200 Function according to selection of **P192**	 –10.0 ÷ +10.0 V –20.0 ÷ +20.0 mA
	Default	+100	+10.0 V
	Level	ADVANCED	
	Address	799	
	Function	Maximum output value obtained when the maximum value of the variable set in **P195** is implemented.	

P200 FOUT Output in [MDO1] Frequency

P200	Range	0 ÷ 2	0: Disabled, 1: Pulse, 2: ABS Pulse
	Default	0	0: Disabled
	Level	ADVANCED	
	Address	800	
	Function	Selects the operating mode of FOUT frequency output.	

NOTE

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

P201 Selected Variable for FOUT Frequency Output

P201	Range	0 ÷ 40	See Table 27
	Default	0	Motor speed
	Level	ADVANCED	
	Address	801	
	Function	Selects the variable to be allocated to FOUT frequency output.	

P202 Min. FOUT Value of Selected Variable

P202	Range	Depends on the value selected through **P201**	See Table 27
	Default	0	0
	Level	ADVANCED	
	Address	802	
	Function	Minimum value of the selected variable.	

P203 Max. FOUT Value of Selected Variable

P203			
	Range	Depends on the value selected through **P201**	See Table 27
	Default	0	0
	Level	ADVANCED	
	Address	803	
	Function	Maximum value of the selected variable.	

P204 Min. FOUT Output Value with Reference to P202

P204			
	Range	1000÷10000	10.00÷100.00 kHz
	Default	1000	10.00 kHz
	Level	ADVANCED	
	Address	804	
	Function	Minimum output value obtained when the minimum value of the variable set in **P202** is implemented.	

P205 Min. FOUT Output Value with Reference to P203

P205			
	Range	1000÷10000	10.00÷100.00 kHz
	Default	10000	100.00 kHz
	Level	ADVANCED	
	Address	805	
	Function	Maximum output value obtained when the maximum value of the variable set in **P203** is implemented.	

P206 Filter for FOUT Frequency Output

P206			
	Range	0 ÷ 65000	0.000 ÷ 65.000 sec
	Default	0	0.000 sec.
	Level	ADVANCED	
	Address	806	
	Function	Value of the filter time constant applied to FOUT frequency output.	

P207 AO1: Gain P208 AO2: Gain P209 AO3: Gain P210 AO1: Variable MODBUS Address P211 AO2: Variable MODBUS Address P212 AO3: Variable MODBUS Address	RESERVED

P213 Amplitude of Sinusoidal Analog Output Signal

P213			
	Range	0 ÷ 1000	0 ÷ 100.0%
	Default	1000	100.0%
	Level	ENGINEERING	
	Address	813	
	Function	Amplitude of the sinusoidal analog output signal when Sine or Cosine variables are selected.	

P214 Frequency of Sinusoidal Analog Output Signal

P214	Range	0 ÷ 20000	0 ÷ 200.00Hz
	Default	100	1.00Hz
	Level	ENGINEERING	
	Address	814	
	Function	Frequency of the sinusoidal analog output signal when Sine or Cosine variables are selected.	

P215 Frequency of Saw Wave Analog Output Signal

P215	Range	0 ÷ 20000	0 ÷ 200.00Hz
	Default	100	1.00Hz
	Level	ENGINEERING	
	Address	815	
	Function	Frequency of saw wave analog output signal when Sine or Cosine variables are selected. This can be used as the carrier frequency when setting MDO1 or MDO2 in PWM mode (see the example given in the DIGITAL OUTPUTS MENU).	

21. TIMERS MENU

21.1. Overview

The Timers menu allows setting enable and disable delay times for digital inputs/outputs.

NOTE For the ENABLE digital input, no disable delay is allowed, because the logic status of the ENABLE command is used directly by the hardware activating IGBT switching; when no ENABLE command is sent, the output power stage is instantly deactivated.

NOTE The reset function for the alarms on the leading edges of MDI3 is not delayed.

NOTE Any auxiliary alarm set to the digital inputs is not delayed.

NOTE Five timers are available; the use can set an enabling/disable delay for each of them. The same timer may also be assigned to multiple digital inputs/outputs.

NOTE The ENABLE –S function cannot be delayed.

Example 1:

The drive enable (MDI1 START) depends on a signal coming from a different source. An activation delay of 2 seconds and a deactivation delay of 5 seconds are needed. To do so, set two delay times for activation and deactivation for the same timer and assign it to MDI1 (START) digital input. In the example below, timer 1 is used.

P216	2.0 sec	Activation delay T1
P217	5.0 sec	Deactivation delay T1
P226	0x0001	Timer assigned to MDI1 (START)

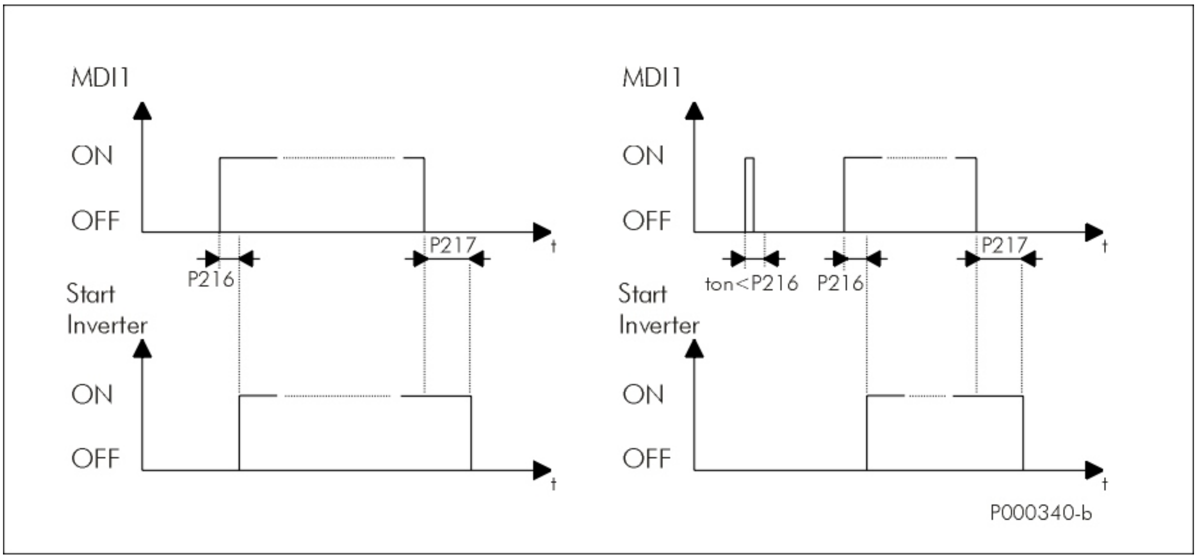


Figure 22: Using Timers (example).

Figure 23 shows two possible operating modes:

- on the left: application of the delay times set for the drive enabling/disabling;
- on the right: the start signal persists for a shorter time than the delay set for enabling; in this case, the Start function is not enabled. The Start function will be enabled only when **MDI1** digital input is ON for a time longer than the time set in **P216**.

21.2. List of Parameters P216 to P229

Table 34: List of parameters P216 to P229.

Parameter	FUNCTION	User Level	Default Values	MODBUS Address
P216	T1 Enable delay	ENGINEERING	0.0	816
P217	T1 Disable delay	ENGINEERING	0.0	817
P218	T2 Enable delay	ENGINEERING	0.0	818
P219	T2 Disable delay	ENGINEERING	0.0	819
P220	T3 Enable delay	ENGINEERING	0.0	820
P221	T3 Disable delay	ENGINEERING	0.0	821
P222	T4 Enable delay	ENGINEERING	0.0	822
P223	T4 Disable delay	ENGINEERING	0.0	823
P224	T5 Enable delay	ENGINEERING	0.0	824
P225	T5 Disable delay	ENGINEERING	0.0	825
P226	Timer assigned to inputs MDI1÷4	ENGINEERING	0: No timer assigned	826
P227	Timer assigned to inputs MDI5÷8	ENGINEERING	0: No timer assigned	827
P228	Timer assigned to outputs MDO1÷4	ENGINEERING	0: No timer assigned	828
P229	Timer assigned to virtual outputs MPL1÷4	ENGINEERING	0: No timer assigned	829

P216 T1 Enable delay

P216			
	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	816	
	Function	This parameter sets T1 enable time. Using **P226** or **P227**, if **timer T1** is assigned to a digital input having a particular function, P216 represents the delay occurring between the input closure and the function activation. Use **P228** to assign timer 1 to a digital output; in that case, the digital input energizing will be delayed according to the time set in **P216**.	

P217 T1 Disable delay

P217			
	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	817	
	Function	This parameter sets T1 disabling time. Using **P226** or **P227**, if **timer T1** is assigned to a digital input having a particular function, this parameter represents the delay occurring between the input closure and the function deactivation. Use **P228** to assign timer 1 to a digital output; in that case, the digital input de-energizing will be delayed according to the time set in **P217**.	

P218 T2 Enable delay

P218	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	818	
	Function	This parameter sets T2 enable time. (Operation as per **P216**.)	

P219 T2 Disable delay

P219	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	819	
	Function	This parameter sets T2 disabling time. (Operation as per **P217**.)	

P220 T3 Enable delay

P220	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	820	
	Function	This parameter sets T3 enable time. (Operation as per **P216**.)	

P221 T3 Disable delay

P221	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	821	
	Function	This parameter sets T3 disable time. (Operation as per **P217**.)	

P222 T4 Enable delay

P222	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	822	
	Function	This parameter sets T4 enable time. (Operation as per **P216**.)	

P223 T4 Disable delay

P223	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	823	
	Function	This parameter sets T4 disable time. (Operation as per **P217**.)	

P224 T5 Enable delay

P224	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	824	
	Function	This parameter sets T5 enable time. (Operation as per **P216**.)	

P225 T5 Disable delay

P225	Range	0 ÷ 60000	0.0 ÷ 6000.0 sec
	Default	0	0.0
	Level	ENGINEERING	
	Address	825	
	Function	This parameter sets T5 disable time. (Operation as per **P217**.)	

P226 Timers Assigned to Inputs MDI1÷4

P226	Range	[0; 0; 0; 0] ÷ [5; 5; 5; 5]	0: No timer assigned 1 ÷ 5: T1 ÷ T5
	Default	[0; 0; 0; 0]	0: No timer assigned
	Level	ENGINEERING	
	Address	826	
	Function	The first group of four digital inputs may be assigned to any of the five timers and the same timer may be assigned to multiple inputs. Select “zero” to avoid delaying the digital inputs. Setting via serial link: see codification table below.	

Table 35: Codification of P226: Timers assigned to digital inputs MDI 1÷4.

bits [15..12]	bits [11..9]	bits [8..6]	bits [5..3]	bits [2..0]
not used	MDI4	MDI3	MDI2	MDI1

Codification example for P226:
MDI1=Timer T2
MDI2=No timer assigned
MDI3=Timer T2
MDI4=Timer T5
⇒ value in **P226** 101 010 000 010 bin = 2690 dec

P227 Timers Assigned to Inputs MDI5÷8

P227	Range	[0; 0; 0; 0] ÷ [5; 5; 5; 5]	0: No timer assigned 1 ÷ 5: T1 ÷ T5
	Default	[0; 0; 0; 0]	0: No timer assigned
	Level	ENGINEERING	
	Address	827	
	Function	The second group of four digital inputs may be assigned to any of the five timers and the same timer may be assigned to multiple inputs. Select “zero” to avoid delaying the digital inputs. Setting via serial link: see codification in **P226**.	

P228 Timers Assigned to Outputs MDO1÷4

P228			
	Range	[0; 0; 0; 0] ÷ [5; 5; 5; 5]	0: No timer assigned 1 ÷ 5: T1 ÷ T5
	Default	[0; 0; 0; 0]	0: No timer assigned
	Level	ENGINEERING	
	Address	828	
	Function	The digital outputs may be assigned to any of the five timers and the same timer may be assigned to multiple outputs. Select "zero" to avoid delaying the digital outputs. Setting via serial link: see codification in P226.	

P229 Timers Assigned to Virtual Outputs MPL 1÷4

P229			
	Range	[0; 0; 0; 0] ÷ [5; 5; 5; 5]	0: No timer assigned 1 ÷ 5: T1 ÷ T5
	Default	[0; 0; 0; 0]	0: No timer assigned
	Level	ENGINEERING	
	Address	829	
	Function	The virtual digital outputs may be assigned to any of the five timers and the same timer may be assigned to multiple outputs. Select "zero" to avoid delaying the virtual digital outputs. Setting via serial link: see codification in P226.	

22. PID PARAMETERS MENU

22.1. Overview

This menu defines the parameters for the digital PID regulator integrated in the drive.
The PID regulator may be used to control a physical variable which is external to the drive; the variable measure shall be available in the system and must be connected to the "feedback" input.
The PID regulator is used to keep the reference and the control variable constant (feedback); to do so, the PID regulator controls three internal variables, which are described below:

- ✓ Proportional term: this the variable detecting the instant difference between the reference and the measured value of the physical variable to be controlled ("error ");
- ✓ Integral term: this is the variable keeping track of the "history" of the detected errors (summation of all errors);
- ✓ Derivative term: this is the variable keeping track of the evolution of the error or the controlled variable (difference between two consecutive errors or between two consecutive values of the feedbacked variable);

The weighed summation of these terms represents the output signal of the PID regulator.
The weight of these three terms may be defined by the user with the parameters below.

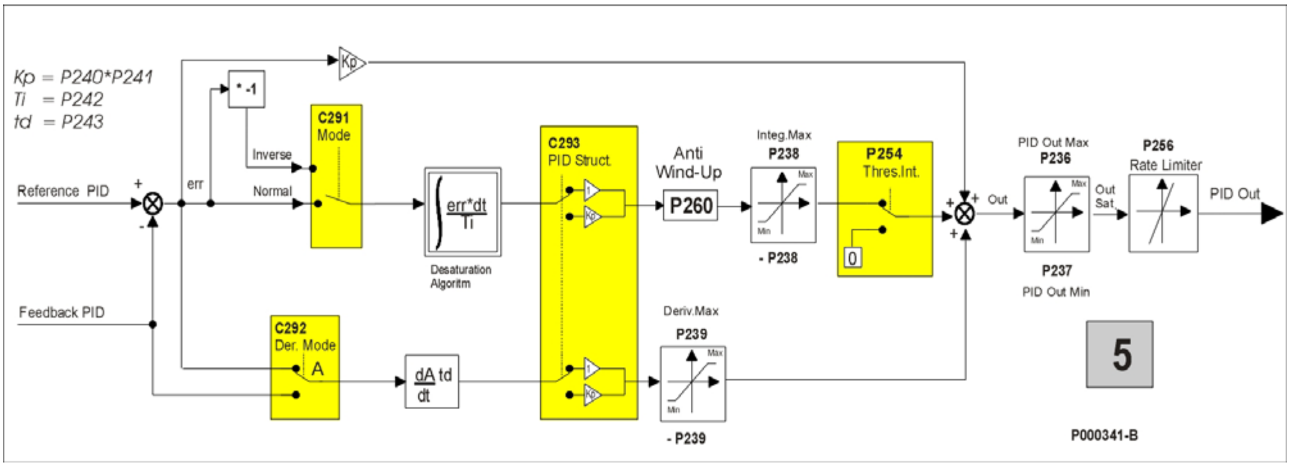


Figure 23: PID Block Diagram.

NOTE

In **LOCAL mode,** the PID regulator is disabled if it is used to correct the reference or the voltage values (**C294 = 2: Sum Reference** or **C294 =3: Sum Voltage**).

NOTE

In **LOCAL mode,** if the drive reference is the PID output **C294=Reference** and the Type parameter on the Keypad page in Local mode is **P266=Ref.Active+Spd**, the PID reference can be altered by activating the Local mode from the Keypad page. Press the LOC/REM key again when the drive is disabled (or the MDI LOC/REM key if it is programmed as a pushbutton: **C180a=Pushbutton**) to disable the PID and to set the speed reference directly from the Keypad page.

22.2. PID Regulator Tuning – Method of Ziegler and Nichols

Tuning a PID regulator consists in selecting and allocating values to PID parameters in order to adjust the operation of the system to the technical requirements of the process and to the equipment restrictions.
One of the possible PID tuning procedures is the *Method of Ziegler and Nichols.*

This method implies the following steps:

1. Set the integral action and the derivative action to zero: Ti (P242) = 0, Td (P243) = 0.
2. Assign very low values to Kp (P240), then apply a little step to the reference signal (setpoint) selected with C285/286/287.
3. Gradually increase the value of Kp until permanent oscillation is attained in the PID loop.
4. Tune the parameters for a **P, PI** or **PID** regulator based on the table below—where Kp_c is the value of the proportional gain corresponding to the permanent oscillation (critical gain) and T_c is the period of the permanent oscillation:

	Kp (P240)	Ti (P242)	Td (P243)
P	0.5 Kp_c		
PI	0.45 Kp_c	T_c/1.2	
PID	0.6 Kp_c	T_c/2	T_c/8

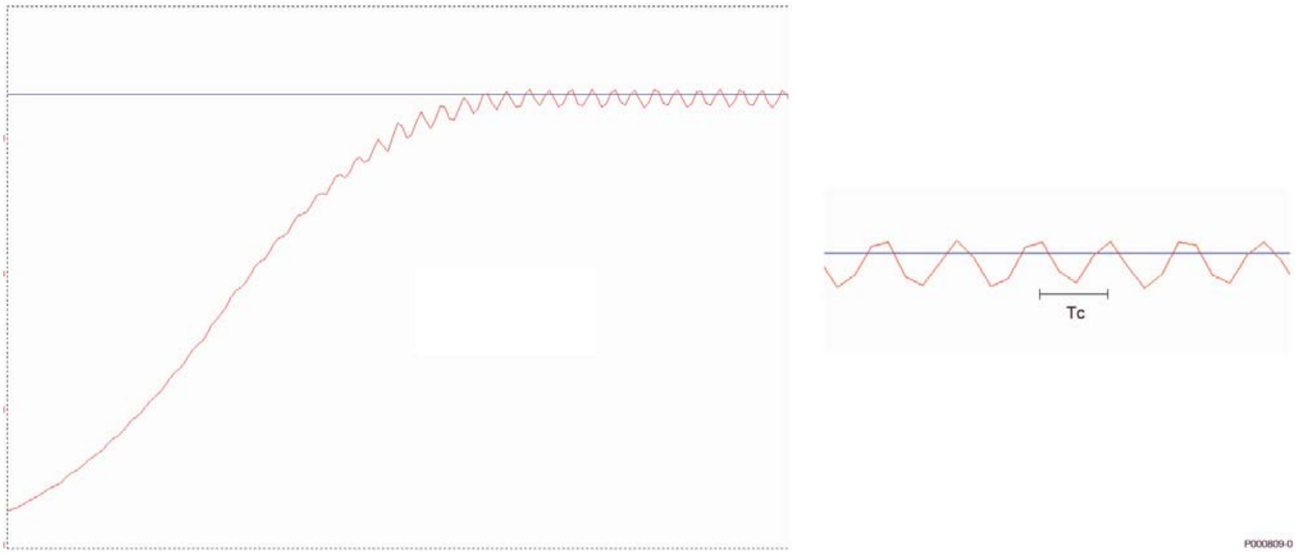


Figure 24: Permanent oscillation with Kp_c critical gain.

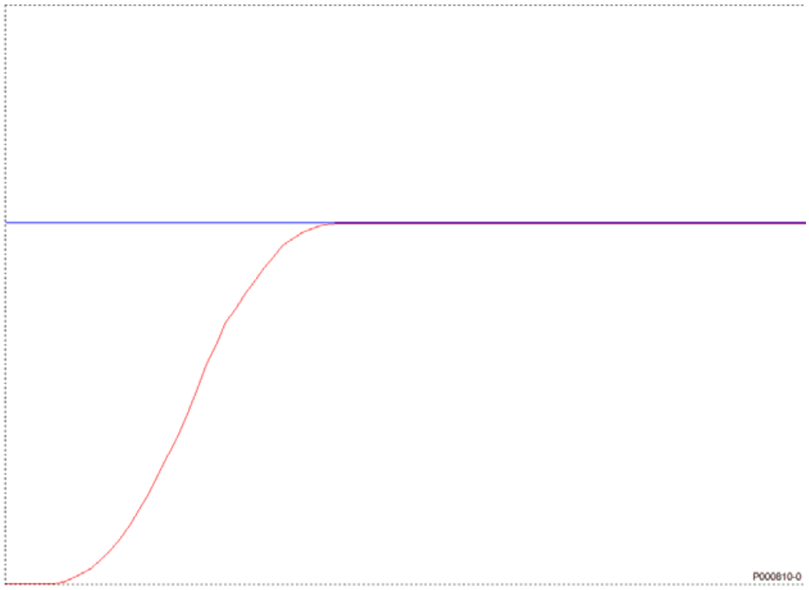


Figure 25: Response to a system tuned with the method of Ziegler and Nichols.

NOTE The method of Ziegler and Nichols is not always applicable, because some systems do not produce any oscillations, even in presence of large proportional gains.
However, leading a system close to instability can be very dangerous.

22.3. Manual Tuning of the PI Regulator

The PI regulator con be manually tuned when the tuning method of Ziegler and Nichols is not applicable. The sections below cover the following:

- how the transient is affected from the proportional action when the integral action is kept constant in a PI regulator;
- how the transient is affected from the integral action when the proportional action is kept constant in a PI regulator;
- how the transient is affected from the derivative action in a PID regulator.

22.3.1. Proportional Action (P)

Symbol	Tuning function	Main goal
Kp	An input variance (error) produces an output variance proportional to the variance amplitude	Changes the tuning variable based on the variable being tuned

PI Regulator Ti=Constant	Response to the step	Response time
Small Kp	Overshoot	Shorter
Optimum Kp	Optimum	Optimum
Large Kp	Undershoot	Longer

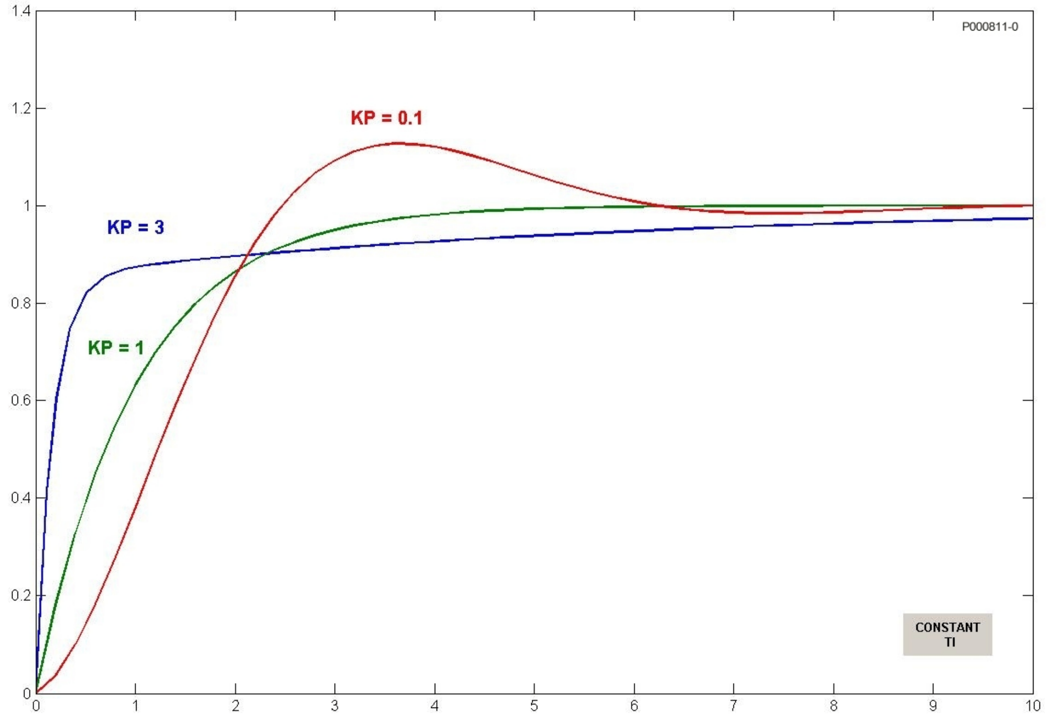


Figure 26: Response to the step based on the value of Kp when Ti is kept constant.

When Kp is increased, the error is reduced at constant rate, but the transient can also be adversely affected. Adverse effects can be a longer transient with stronger oscillations due to the damping reduction, or even instability. This is shown in the figure below:

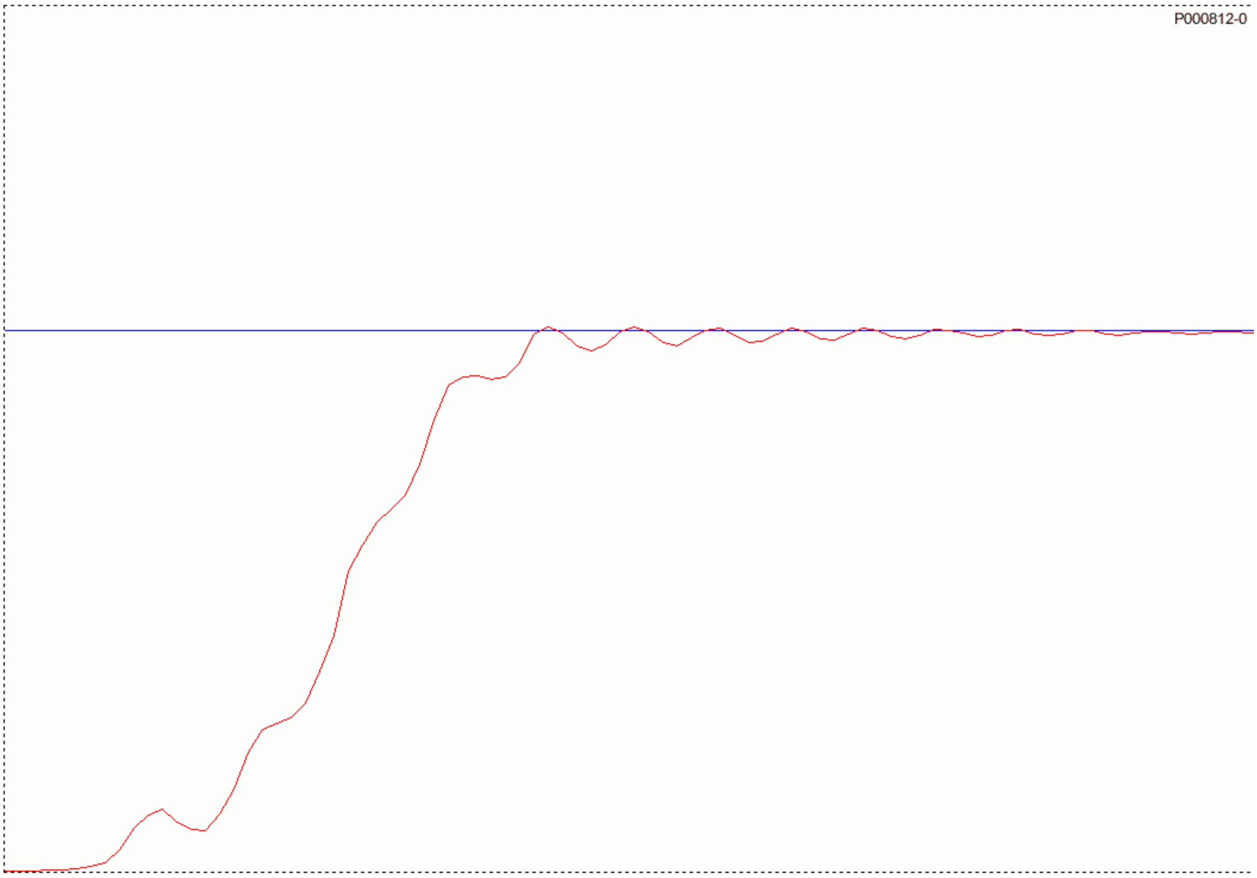


Figure 27: Response to the step when Kp is too large.

22.3.2. INTEGRAL ACTION (I)

Symbol	Tuning function	Main goal
Ti	As soon as an input variance occurs (Error), an output variance occurs. The variation rate is proportional to the error magnitude.	Sets the tuning point (eliminates the offset from the proportional action).

PI Regulator	Response to the step	Response time
Small Kp	Overshoot	Shorter
Optimum Kp	Optimum	Optimum
Large Kp	Undershoot	Longer

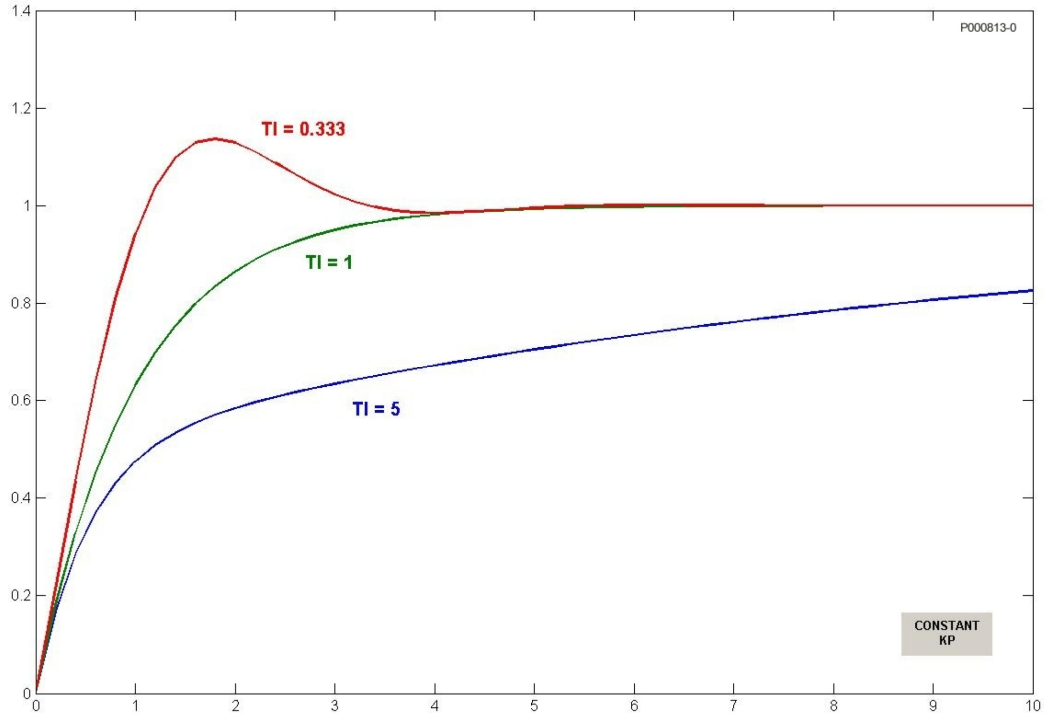


Figure 28: Response to the step based on the value of Ti when Kp is kept constant.

The figure below represents the response of the PI regulator when the values for Kp and Ti are lower than the optimum value computed with the *method of Ziegler and Nichols*.

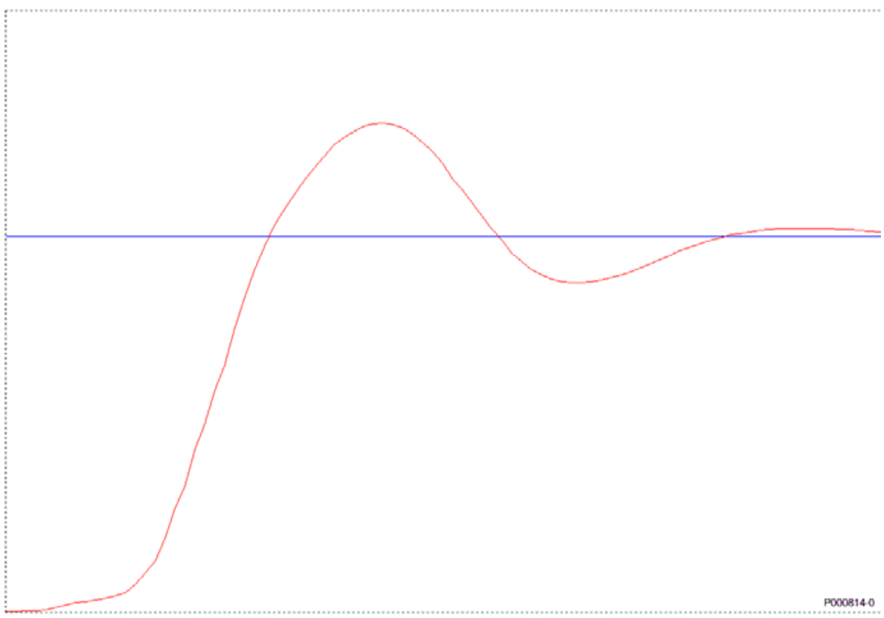


Figure 29: Response to the step when the values of Kp and Ti are too small.

22.3.3. DERIVATIVE ACTION (D)

Symbol	Tuning function	Main goal
Td	An input variance (error) generates an output variance proportional to the variance rate	Decreases the response time for the return to the tuning point

The derivative action set with Td increases the stability of the system, thus increasing the transient response. The derivative action tends to get an earlier response, but it increases the system sensitivity to the disturbance overriding the error signal.

22.3.4. TUNING ACTIONS AT CONSTANT SPEED

When the system is operating at constant speed, the system response shall be the most accurate as possible (minimum error) and shall adjust any little reference variations.

When at constant speed, if the system does not promptly respond to little reference variations, a shorter integral time may solve this problem. Otherwise, when little and long-lasting oscillations affect the reference value, setting a longer integral time could be the right solution.

22.4. Anti-windup

The major benefit of the integral action is to ensure null errors at steady speed. However, just like the derivative action, the integral action shall be applied with caution to avoid worse performance.
A case in point is the output saturation occurring at the same time as an excessive integral action. When the output saturates, the control action is limited, so the error is still remarkable. If the error persists, the actuator will saturate, because the longer the time the error persists, the stronger the integral action is; this phenomenon is called "windup".
In case of output saturation, the integral term can reach very high values; as a result, the error shall have opposite sign for a long period before exiting from saturation.

The PID regulator of the Penta drive is provided with an Anti-windup function which compensates the effect described above. This Anti-windup action is described below (P=proportional term; I=integral term; D=derivative term).

The output is always calculated as follows:
OUT ← P + I + D

When output saturation occurs:
OUT ← OUTsat

The integral term is forced based on the following:
I ← OUTsat – P – D
(which is the Anti-windup function).

This prevents the integral term from reaching very high values; the integral term is then kept constantly in line with the saturated output value OUTsat that is present at each moment; any variations of the error (i.e. the P) that allows exiting from saturation have immediate effect to the output, without having to wait for a long time before discharging the integral term itself.
The effect of the Anti-windup can be adjusted with parameter **P260**; if **P260**<1, the effect is reduced and the system is less sensitive to error variations; if **P260**=0, the effect is cancelled.

The value of **P260**=1 is correct for the applications requiring to quickly exit from saturation.
On the other hand, reducing **P260** can be useful when output variations are to be avoided for negligible error variations.

22.5. List of Parameters P236 to P260

Table 36: List of parameters P236 to P260.

Parameter	FUNCTION	User Level	Default Values	MODBUS Address
P236	Max. value of PID output	ENGINEERING	+100.00%	836
P237	Min. value of PID output	ENGINEERING	–100.00%	837
P237a	Wake-up Mode	ENGINEERING	0: [Disabled]	858
P237b	Wake-up Level	ENGINEERING	0.00%	859
P238	Max. value of PID integral term	ENGINEERING	+100.00%	838
P239	Max. value of PID derivative term	ENGINEERING	+100.00%	839
P240	PID proportional constant	ENGINEERING	1.000	840
P241	Multiplicative factor of **P240**	ENGINEERING	0:1.0	841
P242	PID Integral time (multiples of **P244**)	ENGINEERING	500*Tc (ms)	842
P243	PID Derivative time (multiples of **P244**)	ENGINEERING	0*Tc (ms)	843
P244	Cycle time of PID regulator: Tc	ENGINEERING	5 ms	844
P245	Min. value of PID reference	ENGINEERING	0.00%	845
P246	Max. value of PID reference	ENGINEERING	+100.00%	846
P247	Min. value of PID feedback	ENGINEERING	0.00%	847
P248	Max. value of PID feedback	ENGINEERING	+100.00%	848
P249	PID reference ramp up time	ENGINEERING	0 s	849
P250	PID reference ramp down time	ENGINEERING	0 s	850
P251	Unit of measure of PID ramp	ENGINEERING	1: [0.1s]	851
P252	PID ramp start rounding off	ENGINEERING	50%	852
P253	PID ramp end rounding off	ENGINEERING	50%	853
P254	Integral term activation threshold	ENGINEERING	0.00%	854
P255	**START** Disable delay with PID Out=**P237**	ENGINEERING	0: [Disabled]	855
P256	PID output gradient limit	ENGINEERING	1 ms	856
P257	Gain for PID measure scaling	ENGINEERING	1.000	857
P260	Gain for Anti-windup	ENGINEERING	1.00	860

P236 Max. Value of PID Output

P236	Range	–10000 ÷ +10000	–100.00 ÷ +100.00 %
	Default	+10000	+100.00 %
	Level	ENGINEERING	
	Address	836	
	Function	This is the max. allowable value of PID regulator output. This value is expressed as a percentage; its allocation depends on parameter **C294**, defining PID action. Example: if **C294** = **External Out**, the PID regulator delivers a reference obtained based on the controlled variable and its setpoint. In this case, the PID output can be brought outside through an analog output. The matching between **P236** and the output value (see the ANALOG AND FREQUENCY OUTPUTS MENU) is user-defined. If **C294** = **Reference**, the PID regulator output is the motor speed/torque reference (the system will ignore any other reference source), parameter **P236** is a percentage referring to the max. value, considered as an absolute value, between the max. and the min. speed/torque reference of the active motor. If **C294** = **Add Reference**, the percentage in **P236** relates to the instant value of the speed/torque reference to be adjusted. If a Frequency control is used, the PID regulator can be used to adjust the drive output voltage; in this case, **P236** relates to the instant voltage value (E.g. If a drive delivers 50V and an adjustment of 10% is implemented, the drive will deliver 55V).	

P237 Min. Value of PID Output

P237	Range	–10000 ÷ +10000	–100.00 ÷ +100.00 %
	Default	–10000	–100.00 %
	Level	ENGINEERING	
	Address	837	
	Function	This is the min. allowable value of PID regulator output. For the value percent of **P237**, see the description of parameter **P236**.	

P237a Wake-up Mode

P237a	Range	0 ÷ 4	0: Disabled 1: Feedback < **P237b** 2: Feedback > **P237b** 3: Error < **P237b** 4: Error > **P237b**
	Default	0	0: Disabled
	Level	ENGINEERING	
	Address	858	
	Function	If this parameter is disabled, the PID control re-activates only when the PID output exceeds the value set in parameter **P237**. If this parameter is enabled, the PID control re-activates when: **P237a**=1: the Feedback value drops below the level set with **P237b**; **P237a**=2: the Feedback value exceeds the level set with **P237b**; **P237a**=3: the Error value drops below the level set with **P237b**; **P237a**=4: the Error value exceeds the level set with **P237b**.	

P237b Wake-up Level

P237b			
	Range	–10000 ÷ +10000	–100.00 ÷ +100.00 %
	Default	0	0.00 %
	Level	ENGINEERING	
	Address	859	
	Function	Level of the Feedback or Error signal allowing re-activating the PID control (see P237a).	

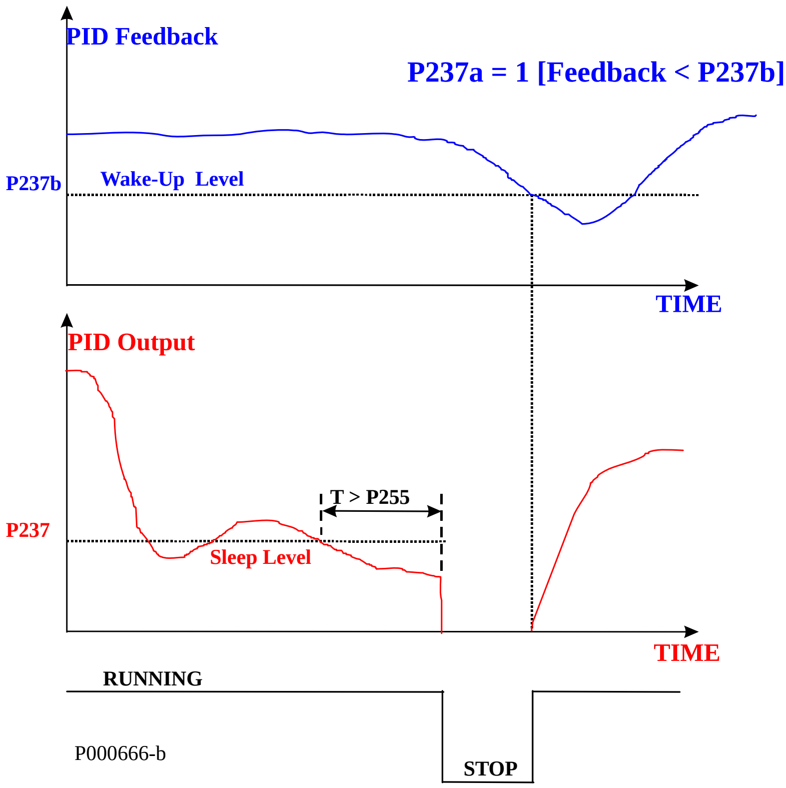


Figure 30: PID Sleep and Wake-up Mode when P237a is set to 1.

P238 Max. Value of Integral Term

P238			
	Range	0 ÷ 10000	–100.00 ÷ +100.00 %
	Default	10000	+100.00 %
	Level	ENGINEERING	
	Address	838	
	Function	This is the max. allowable value of the integral term. It is to be considered as an absolute value; the output value resulting from the integral term ranges from + P238 to – P238.	

P239 Max. Value of Derivative Term

P239	Range	0 ÷ 10000	–100.00 ÷ +100.00 %
	Default	10000	+100.00 %
	Level	ENGINEERING	
	Address	839	
	Function	This is the max. allowable value of the derivative term; it is to be considered as an absolute value; the output value resulting from the derivative term ranges from + **P239** to – **P239**.	

P240 PID Proportional Constant

P240	Range	0 ÷ 65000	0 ÷ 65.000
	Default	1000	1.000
	Level	ENGINEERING	
	Address	840	
	Function	This is the value of the proportional coefficient. The PID regulator will use Kp resulting from the product of **P240** multiplied by **P241** (multiplicative factor).	

P241 Multiplicative Factor of P240

P241	Range	0÷2	0: 1.0 1: 10.0 2: 100.0
	Default	0	0: 1.0
	Level	ENGINEERING	
	Address	841	
	Function	Multiplicative factor of the proportional coefficient. This is used to obtain a wider range for the proportional coefficient used in PID regulator and ranging from 0.000 to 6500.0. Supposing that the default values are used for **P240** and **P241**, the proportional coefficient used in the PID regulator is unitary: in case an error of 1% occurs between the reference and the controlled variable, the proportional term, representing one of the three values of the regulator output, will be 1%.	

P242 PID Integral Time (Multiples of P244)

P242	Range	0 ÷ 65000	0: Disabled ÷ 65000 * Tc (ms)
	Default	500	500* Tc (ms)
	Level	ENGINEERING	
	Address	842	
	Function	**Ti** constant dividing the integral term of PID regulator: **Ki** = 1/**Ti** = 1/(**P242***Ts) It is expressed in sampling time units **Ts** (see **P244**). If this parameter is set to zero, the integral action is cancelled.	

P243 PID Derivative Time (Multiples of P244)

P243	Range	0 ÷ 65000	0 ÷ 65.000 * Tc (ms)
	Default	0	0*Tc (ms)
	Level	ENGINEERING	
	Address	843	
	Function	Constant multiplying the derivative term of PID regulator. If this parameter is set to zero, the derivative action is disabled.	

P244 Cycle Time of PID Regulator: Tc

P244			
	Range	5 ÷ 65000	0 ÷ 65000 ms
	Default	5	5 ms
	Level	ENGINEERING	
	Address	844	
	Function	This parameter sets the cycle time of PID regulator. It is expressed in ms (multiples of 5 only). Example: if **P244** = 1000 ms, the PID regulator cycle will be executed every second, and the output will be refreshed every second as well.	

P245 Min. Value of PID Reference

P245			
	Range	–10000 ÷ +10000	±100.00%
	Default	0	0.00%
	Level	ENGINEERING	
	Address	845	
	Function	This parameter defines the min. allowable value of the PID reference. The PID references are to be considered as percentage values. If analog references are selected, **P245** relates to the minimum value of the selected analog input. Example: Select AIN1 analog input as the PID reference and suppose that its max. and min. values are +10V and –10V respectively. If **P245** is –50%, this means that the PID reference will be saturated at –50% for voltage values lower than –5V.	

P246 Max. Value of PID Reference

P246			
	Range	–10000 ÷ +10000	±100.00%
	Default	+10000	+100.00%
	Level	ENGINEERING	
	Address	846	
	Function	This parameter defines the max. allowable value of the PID reference. See the description of **P245**.	

P247 Min. Value of PID Feedback

P247			
	Range	–10000 ÷ +10000	±100.00%
	Default	0	0.00%
	Level	ENGINEERING	
	Address	847	
	Function	This parameter defines the min. allowable value of the PID feedback. See the description of **P245**.	

P248 Max. Value of PID Feedback

P248			
	Range	–10000 ÷ +10000	±100.00%
	Default	+10000	+100.00%
	Level	ENGINEERING	
	Address	848	
	Function	This parameter defines the max. allowable value of the PID feedback. See the description of **P245**.	

P249 PID Reference Ramp Up Time

P249	Range	0 ÷ 32700	Function of **P251**
	Default	0	0 s
	Level	ENGINEERING	
	Address	849	
	Function	This parameter defines the ramp up time of the PID regulator reference from 0% to the max. allowable absolute value (max. {|**P245**|,|**P246**|}).	

P250 PID Reference Ramp Down Time

P250	Range	0 ÷ 32700	Function of **P251**
	Default	0	0 s
	Level	ENGINEERING	
	Address	850	
	Function	This parameter defines the ramp down time of the PID regulator reference, from max. allowable value (max. {|**P245**|,|**P246**|}) to 0%.	

P251 Unit of measure of PID Ramp

P251	Range	0 ÷ 3	0: 0.01 s 1: 0.1 s 2: 1.0 s 3: 10.0 s
	Default	1	1: 0.10 s
	Level	ENGINEERING	
	Address	851	
	Function	This parameter defines the unit of measure for the PID reference ramp times. It defines the unit of measure for the time of the third ramp of the PID reference **P249** and **P250**, so that the allowable range becomes 0s – 327000s.	

Example:

P251		Range P249 – P250	
Value	Codification	Min.	Max.
0	0.01 s	0	327.00 s
1	0.1s	0	3270.0 s
2	1.0 s	0	32700 s
3	10.0 s	0	327000 s

NOTE

Factory-setting: the PID reference ramp is zero; if a given ramp time is set up, the ramp will be rounded off (50% at the beginning and at the end of the ramp). See parameters **P252** and **P253**.

P252 PID Ramp Start Rounding Off

P252			
	Range	0 ÷ 100	0 % ÷ 100%
	Default	50	50%
	Level	ENGINEERING	
	Address	852	
	Function	This parameter sets the time period of the rounding off applied to the first stage of the ramps. It is expressed as a percentage of the ramp up/down time. Example: ramp up of 5sec.: P252 = 50% means that the speed reference is limited in acceleration for the first 2.5 sec of the ramp up.	

NOTE When **P252** is used, the preset ramp time is increased by (**P252**%)/2.

P253 PID Ramp End Rounding Off

P253			
	Range	0 ÷ 100	0 % ÷ 100%
	Default	50	50%
	Level	ENGINEERING	
	Address	853	
	Function	As P252, but P253 sets the rounding off applied at the end of the ramps.	

NOTE When P253 is used, the preset ramp time is increased by (P253%)/2.

P254 Integral Term Activation Threshold

P254			
	Range	0.0 ÷ 5000	0.0 % ÷ 500.0%
	Default	0	0.0 %
	Level	ENGINEERING	
	Address	854	
	Function	This parameter sets a threshold value below which the integrator is kept to zero. It has effect only when the PID regulator is used as a reference corrector or generator. In this case, the threshold percentage value refers to the max. speed (or torque) absolute value set for the active motor. The integral term is not calculated when the speed (or torque) percentage value expressed as an absolute value is lower than the value set in **P254**. If **P254** is set to zero, the integrator is always activated.	

P255 START Disable Delay with PID Out=P237

P255	Range	0 ÷ 60000	0: Disabled 1 ÷ 60000 s
	Default	0	0: Disabled
	Level	ENGINEERING	
	Address	855	
	Function	This parameter sets the max. time for the drive operation when the PID regulator output continuously operates at its min. value (**P237**). If this is true for a time equal to the time set in **P255**, the drive is automatically put on stand-by until 1) the PID output value exceeds the min. value (if **P237a**=Disabled); 2) the Feedback or the Error drops below the Wake-up level in **P237b** (if **P237a**=1 or =3 respectively); 3) when the Feedback or the Error exceeds the Wake-up level in **P237b** (if **P237a**=2 or =4 respectively). If **C149** is set as External Out or **P255** is set to zero, this function is disabled.	

P256 PID Output Gradient Limit

P256	Range	1 ÷ 65000	1 ÷ 65000 msec
	Default	1	1ms
	Level	ENGINEERING	
	Address	856	
	Function	This parameter limits the max. acceleration for the PID regulator output. The max. acceleration for the PID regulator output is equal to **100% / P256** [%/msec].	

P257 Gain for PID Measure Scaling

P257	Range	0 ÷ 32000	0.000 ÷ 32.000
	Default	1	1.000
	Level	ENGINEERING	
	Address	857	
	Function	Gain for the scaling of PID measures **M023 ÷ M025**. This gain has effect only on the measures above. It does not affect the PID operation. This parameter allows scaling if you want to display PID measures with a different unit of measure: **M023 = M020 * P257** **M024 = M021 * P257**	

P260 Anti Wind-Up Gain

P260	Range	0 ÷ 100	0.00 ÷ 1.00
	Default	100	1.00
	Level	ENGINEERING	
	Address	860	
	Function	Value of the Anti Wind-Up coefficient that freezes the integral term of the PID when its output is being saturated (see Anti-windup). When leaving **P260**=1.00, Anti Wind-Up is complete (I ← OUTsat – P – D). If **P260**=0.00, Anti Wind-Up is inhibited (the integral term reaches the value of ±**P238** based on the error sign). Intermediate values for **P260** give intermediate effects.	

23. PID2 PARAMETERS MENU

23.1. Overview

This menu defines the parameters of the digital regulator PID2 as well as the parameters used in 2-zone mode.

To activate the PID2 regulator, set C291a = 7: 2 PID (PID CONFIGURATION MENU).
Once activated, the PID2 regulator has the same functionality and operates in line with the standard PID (PID PARAMETERS MENU). The output of the standard PID regulator is algebraically summed with the output of the PID2 regulator.
Add "200" to the parameter codes pertaining to the standard PID to obtain the relevant parameter codes for PID2. Example: P236 for standard PID corresponds to P436 for PID2.

To enable the 2-zone mode, set C291a = 5: 2-Zone MIN or 6: 2-Zone MAX (PID CONFIGURATION MENU).
Once the 2-zone mode is enabled, the standard PID regulator operates on the system with the larger error (minimum feedback in respect to its reference, 2-Zone MIN) or with the smaller error (maximum feedback in respect to its reference, 2-Zone MAX).
In 2-zone mode, parameters P236..P260 pertain to the system where the error results from the reference selected with C285 and from the feedback selected with C288, whilst parameters P436..P460 pertain to the system where the error results from the reference selected with C286 and from the feedback selected with C289.

NOTE The PID2 regulator is disabled when operating in 2-zone mode.

Please refer to the block-diagram in Figure 63.

23.2. List of Parameters P436 to P460

Table 37: List of parameters P436 to P460.

Parameter	FUNCTION	User Level	DEFAULT VALUES	MODBUS Address
P436	Max. value of PID2 output	ENGINEERING	+100.00%	1346
P437	Min. value of PID2 output	ENGINEERING	–100.00%	1347
P437a	Wake-up Mode	ENGINEERING	0: [Disabled]	1282
P437b	Wake-up Level	ENGINEERING	0.00%	1283
P438	Max. value of PID2 integral term	ENGINEERING	+100.00%	1348
P439	Max. value of PID2 derivative term	ENGINEERING	+100.00%	1349
P440	PID2 proportional constant	ENGINEERING	1.000	1350
P441	Multiplicative factor of **P440**	ENGINEERING	0:1.0	1351
P442	PID2 Integral time (multiples of **P444**)	ENGINEERING	500*Tc (ms)	1352
P443	PID2 Derivative time (multiples of **P444**)	ENGINEERING	0*Tc (ms)	1353
P444	Cycle time of PID2 regulator: Tc	ENGINEERING	5 ms	1354
P445	Min. allowable value of PID2 reference	ENGINEERING	0.00%	1355
P446	Max. allowable value of PID2 reference	ENGINEERING	+100.00%	1356
P447	Min. allowable value of PID2 feedback	ENGINEERING	0.00%	1357
P448	Max. allowable value of PID2 feedback	ENGINEERING	+100.00%	1358
P449	PID2 reference ramp up time	ENGINEERING	0 s	1359
P450	PID2 reference ramp down time	ENGINEERING	0 s	1360
P451	Unit of measure of PID2 ramp	ENGINEERING	1: [0.1s]	1361
P452	PID2 ramp start rounding off	ENGINEERING	50%	1362
P453	PID2 ramp end rounding off	ENGINEERING	50%	1363
P454	Integral term activation threshold	ENGINEERING	0.00%	1364
P455	**START** Disable delay with PID Out=**P437**	ENGINEERING	0: [Disabled]	1284
P456	PID2 output gradient limit	ENGINEERING	1 ms	1368
P457	Gain for PID2 measure scaling	ENGINEERING	1.000	1369
P460	Gain for Anti Wind-Up	ENGINEERING	1.00	1370

NOTE Parameters **P437a**, **P437b** and **P455** are overridden if the Two PIDs mode is selected with "summed outputs" (**C291a = 7: 2 PID** and **C171a = 0: Disabled**).

24. DIGITAL OUTPUTS MENU

24.1. Overview

The Digital Outputs menu includes the parameters allowing configuring the drive digital outputs (MDO1, MDO2, MDO3 and MDO4).

NOTE The Digital Outputs menu may be accessed only if the user level is ADVANCED or ENGINEERING.

NOTE For a detailed hardware description of the digital outputs, please refer to the Sinus Penta's Installation Instructions manual.

NOTE MDO1 digital output can be programmed only if the frequency output is not set up (**P200** = Disable; see the ANALOG AND FREQUENCY OUTPUTS MENU).

NOTE XMDI digital outputs (values from 13 to 20 in the parameters relating to the control functions) can be set up only after setting XMDI/O in parameter **R023**.

24.1.1. Factory Settings

The factory settings are as follows:
MDO1 is a zero speed relay (it energizes when a preset threshold is exceeded).
MDO2 controls an electromechanical brake used for crane applications (it energizes to release the brake).
MDO3 de-energizes (fail-safe logic) in case of "Inverter Alarm".
MDO4 energizes in case of "Inverter Run Ok" (Drive running – no standby).

24.1.2. Structure of the Digital Outputs

A digital output is composed of two logic blocks allowing data processing before implementing the actual digital output. Block 2 depends on the settings in parameters **P277a** (**P286a, P295a, P304a**).

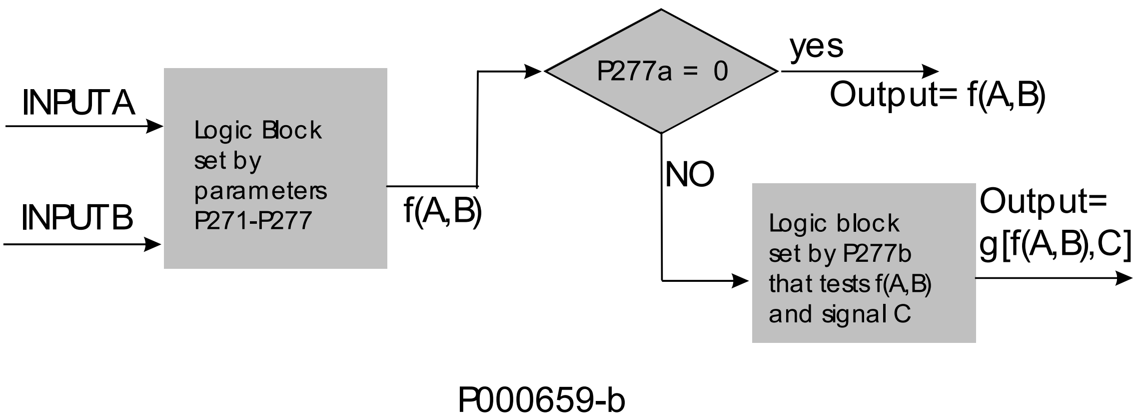


Figure 31: Block-diagram of the digital outputs.

Operating modes set in MDO1 (2,3,4) Digital Output: P270, (P279, P288, P297)

The user can select one of the following operating modes:

Table 38: Digital Output Mode.

DISABLE	The selected digital output is disabled.
DIGITAL	The digital output depends on a selected digital signal and on the logic output function (True/False). See Examples 1 and 2.
DOUBLE DIGITAL	The digital output depends on 2 selected digital signals, on the logic function calculating the output value and on the logic output function (True/False).
ANALOG	The digital output depends on a selected analog variable, which is tested through Test A and Test B, thus obtaining 2 digital signals; starting from their value, the selected logic function calculates the output value, whereas the True/False logic output function calculates the end value. See Example 3.
DOUBLE ANALOG	The digital outputs depends on 2 selected analog variables: Test A is performed for variable A, whilst Test B is performed for variable B, thus obtaining 2 digital signals; starting from their value, the selected logic function calculates the output value, whereas the logic output function True/False calculates the end value.
DOUBLE FULL	As DOUBLE ANALOG or DOUBLE DIGITAL mode, but both digital signals and analog variables can be selected. If you select a digital signal, its value (TRUE or FALSE) is used to calculate the selected logic function. If you select an analog variable, the test selected for this variable is performed, and its result (TRUE or FALSE) is used to calculate the selected logic function.
BRAKE	As ABS BRAKE below, although the selected variables are not expressed as absolute values, but depend on the selected tests.
ABS BRAKE	The ABS BRAKE mode allows controlling the electromechanical brake of a motor used for lifting applications. To enable the relevant output, make sure that all the conditions depending on the drive status are true (see the description at the end of this section). The ABS BRAKE mode is applied by selecting the measured (or estimated) speed value [51] as variable A and the output torque [60] as variable B. Variables are considered as absolute values. See Example 4.
ABS LIFT	As ABS BRAKE, but the brake unlocks (digital output open) when a given torque value is attained, which is automatically determined based on the last torque value required in the previous stroke.
PWM MODE	The PWM mode may be selected for digital outputs MDO1 and MDO2 only (it cannot be selected for relay digital outputs MDO3 and MDO4). The digital output becomes a low-frequency PWM output with a duty–cycle proportional to the value of the selected analog output. See Example 5.

Variable A Selected for MDO1 (2,3,4): P271, (P280, P289, P298)

This selects the digital signal or the analog variable used for Test A (set with **P273/P282/P291/P300**).
The whole list of the selectable items and their description appears at the end of this section (see Table 39).
If a digital signal is selected, Test A is not performed: therefore, the comparison value for Test A (set with **P275/P284/P293/P302**) has no meaning.

NOTE

This parameter can be accessed only if the operating mode of the digital output concerned is other than zero. Example: MDO1 **P270**≠0.

Variable B selected for MDO1 (2,3,4): P272, (P281, P290, P299)

This selects a different digital signal or the analog variable used for Test B (set with **P274/P283/P292/P301**).
The whole list of the selectable items and their description appears at the end of this section (see Table 39).
If a digital signal is selected, Test B is not performed: therefore, the comparison value for Test B (set with **P276/P285/P294/P303**) has no meaning.

NOTE

This parameter cannot be accessed if the operating mode of the digital output concerned is equal to 3 or 9. Example: MDO1 **P270**=3 OR **P270**=9.

Table 39: List of the selectable digital inputs and analog outputs.

Selectable digital signals (BOOLEAN):

Selectable Value	Description
D0: Disable	Always FALSE: 0
D1: Run Ok	Drive running (no standby)
D2: Ok On	Inverter ok: no alarms tripped
D3: Alarm	Drive alarm tripped
D4: Run ALR	Drive KO: alarm tripped when the drive is running
D5: Fwd Run	Speed (measured or estimated) higher than +0.5 rpm
D6: Rev Run	Speed (measured or estimated) lower than –0.5 rpm
D7: Lim. MOT	Drive in limiting mode operating as a motor
D8: Lim.GEN	Drive in limiting mode operating as a generator
D9: Limiting	Drive in limiting mode (generator or motor)
D10: Prec. Ok	Capacitor Precharge relay closure and command return test
D11: PID MAX	PID output max. saturation
D12: PID MIN	PID output min. saturation
D13: MDI 1	Selected MDI1digital input (remote OR physical)
D14: MDI 2	Selected MDI2 digital input (remote OR physical)
D15: MDI 3	Selected MDI3 digital input (remote OR physical)
D16: MDI 4	Selected MDI4 digital input (remote OR physical)
D17: MDI 5	Selected MDI5 digital input (remote OR physical)
D18: MDI 6	Selected MDI6 digital input (remote OR physical)
D19: MDI 7	Selected MDI7 digital input (remote OR physical)
D20: MDI 8	Selected MDI8 digital input (remote OR physical)
D21: MDI ENABLE	Selected ENABLE digital input (remote AND physical)
D22: MDI ENABLE S	Selected ENABLE S digital input (remote AND physical)
D23: MDI 1 Delayed	MDI1 Digital input (remote OR physical) DELAYED by MDI timers
D24: MDI 2 Delayed	MDI1 Digital input (remote OR physical) DELAYED by MDI timers
D25: MDI 3 Delayed	MDI1 Digital input (remote OR physical) DELAYED by MDI timers
D26: MDI 4 Delayed	MDI1 Digital input (remote OR physical) DELAYED by MDI timers
D27: MDI 5 Delayed	MDI5 Digital input (remote OR physical) DELAYED by MDI timers
D28: MDI 6 Delayed	MDI6 Digital input (remote OR physical) DELAYED by MDI timers
D29: MDI 7 Delayed	MDI7 Digital input (remote OR physical) DELAYED by MDI timers
D30: MDI 8 Delayed	MDI8 Digital input (remote OR physical) DELAYED by MDI timers
D31: ENABLE DL	ENABLE Digital input (remote AND physical) DELAYED by MDI timers

D32: Trk.Err	Speed tracking error: |SetPoint – Measure| > Error_Par exceeding one timeout
D33: Fan Flt	Fault of the cooling fan
D34: Fbus C1	Command 1 from fieldbus
D35: Fbus C2	Command 2 from fieldbus
D36: Fbus C3	Command 3 from fieldbus
D37: Fbus C4	Command 4 from fieldbus
D38: FireMod	Fire Mode function
D39: Local	LOCAL Mode
D40: Speed OK	Constant speed reference reached
D41: Fan ON	Fan activation command
D42: XMDI1	XMDI1 Auxiliary digital input
D43: XMDI2	XMDI2 Auxiliary digital input
D44: XMDI3	XMDI3 Auxiliary digital input
D45: XMDI4	XMDI4 Auxiliary digital input
D46: XMDI5	XMDI5 Auxiliary digital input
D47: XMDI6	XMDI6 Auxiliary digital input
D48: XMDI7	XMDI7 Auxiliary digital input
D49: XMDI8	XMDI8 Auxiliary digital input
D50: MPL 1 Delayed	Virtual digital input resulting from MPL1 output DELAYED from MPL Timers
D51: MPL 2 Delayed	Virtual digital input resulting from MPL2 output DELAYED from MPL Timers
D52: MPL 3 Delayed	Virtual digital input resulting from MPL3 output DELAYED from MPL Timers
D53: MPL 4 Delayed	Virtual digital input resulting from MPL4 output DELAYED from MPL Timers
D54: OTM Elapsed	Maintenance Operation Time elapsed
D55: STM Elapsed	Maintenance Supply Time elapsed
D56: MDO 1 Delayed	Virtual digital input resulting from MDO1 output DELAYED from MDO Timers
D57: MDO 2 Delayed	Virtual digital input resulting from MDO2 output DELAYED from MDO Timers
D58: MDO 3 Delayed	Virtual digital input resulting from MDO3 output DELAYED from MDO Timers
D59: MDO 4 Delayed	Virtual digital input resulting from MDO4 output DELAYED from MDO Timers

Selectable analog variables:

Selectable Value	Full-scale Value	Kri	Description
A60: GROUND			Analog 0 Volt
A61: Speed	10000 rpm	1	Motor speed
A62: Spd REF.	10000 rpm	1	Speed reference at constant speed
A63: RampOut	10000 rpm	1	Speed reference when ramps are over
A64: MotFreq	1000.0 Hz	10	Frequency produced by the drive
A65: MotCurr	1000.0 A	10	Current RMS
A66: OutVolt	1000.0 V	10	Output voltage RMS
A67: Out Pow	1000.0 kW	10	Output power
A68: DC Vbus	1000.0 V	10	DC-link voltage
A69: Torq.REF	100.00 %	100	Torque reference at constant speed
A70: Torq.DEM	100.00 %	100	Torque demand
A71: Torq.OUT	100.00 %	100	Estimation of the torque output
A72: Torq.LIM	100.00 %	100	Torque limit setpoint
A73: PID REF	100.00 %	100	PID reference at constant speed
A74: PID RMP	100.00 %	100	PID reference when ramps are over
A75: PID Err	100.00 %	100	Error between PID reference and PID feedback
A76: PID Fbk	100.00 %	100	PID feedback
A77: PID Out	100.00 %	100	PID output
A78: REF	100.00 %	100	Analog input REF
A79: AIN1	100.00 %	100	Analog input AIN1
A80: AIN2/Pt	100.00 %	100	Analog input AIN2/PTC
A81: EncIn	10000 rpm	1	Speed read from encoder and used as a reference
A82: PulseIn	100.00 kHz	100	Frequency input
A83: Flux REF	1.0000 Wb	10000	Flux reference at constant speed
A84: Flux	1.0000 Wb	10000	Active flux reference
A85: Iq REF	1000.0 A	10	Current reference over axis q
A86: Id REF	1000.0 A	10	Current reference over axis d
A87: Iq	1000.0 A	10	Current measure over axis q
A88: Id	1000.0 A	10	Current measure over axis d
A89: Volt Vq	1000.0 V	10	Voltage over axis q
A90: Volt Vd	1000.0 V	10	Voltage over axis d
A91: Cosine	100.00 %	100	Waveform: Cosine
A92: Sine	100.00 %	100	Waveform: Sine
A93: Angle	100.00 %	100	Electric angle of delivered Vu
A94: +10V			Analog +10 Volt
A95: –10V			Analog –10 Volt
A96: Reserved			
A97: SqrWave	100.00 %	100	Square wave
A98: Saw Wave	100.00 %	100	Saw wave
A99: HtsTemp.	100.00 °C	100	Heatsink temperature
A100: AmbTemp.	100.00 °C	100	Ambient temperature
A101 ÷ A109: Reserved			
A110: PT100_1	320.00 °C	100	PT100 channel 1
A111: PT100_2	320.00 °C	100	PT100 channel 2
A112: PT100_3	320.00 °C	100	PT100 channel 3
A113: PT100_4	320.00 °C	100	PT100 channel 4
A114: I2t%	100.00 %	100	Motor thermal capacity
A115: XAIN4	100.00 %	100	XAIN4 analog input
A116: XAIN5	100.00 %	100	XAIN5 analog input
A117: OT Counter	320000h	1	Maintenance Operation Time counter
A118: ST Counter	320000h	1	Maintenance Supply Time counter
A119: Reserved			
Minimum value = –3.2*Full-scale value Maximum value = 3.2*Full-scale value MODBUS value = Parameter value*Kri			

Testing Variable A for MDO1 (2,3,4): P273, (P282, P291, P300)

If an analog variable is selected, a logic TEST is performed to obtain a TRUE/FALSE Boolean signal.
Seven different tests are available, that can be performed for selected variable A and its comparing value A:

Table 40: Test functions.

GREATER THAN	Selected variable > comparing value
GREATER THAN/EQUAL TO	Selected variable ≥ comparing value
LOWER	Selected variable < comparing value
LOWER THAN/EQUAL TO	Selected variable ≤ comparing value
ABS, GREATER THAN	Absolute value (selected variable) > comparing value
ABS, GREATER THAN/EQUAL TO	Absolute value (selected variable) ≥ comparing value
ABS, LOWER	Absolute value (selected variable) < comparing value
ABS, LOWER THAN/EQUAL TO	Absolute value (selected variable) ≤ comparing value

NOTE This parameter can be accessed only if the operating mode of the selected digital output is > 2. Example: MDO1 **P270**>2.

Testing Variable B for MDO1 (2,3,4): P274, (P283, P292, P301)

If an analog variable is selected, a logic TEST is performed to obtain a TRUE/FALSE Boolean signal.
Seven different tests are available, that can be performed for selected variable B and its comparing value B (see Table 40).

NOTE This parameter can be accessed only if the operating mode of the selected digital output is > 2 and < 9. Example: MDO1 2 < **P270** < 9.

Reference threshold for P271 (P280, P289, P298) in MDO1: P275, (P284, P293, P302)

This defines the comparing value of Test A with the first selected variable.

NOTE This parameter can be accessed only if the operating mode of the selected digital output is > 2. Example: MDO1 **P270**>2.

Reference threshold for P272 (P281, P290, P299) in MDO2 (3,4): P276, (P285, P294, P303)

This defines the comparing value of Test B with the first selected variable.

NOTE This parameter can be accessed only if the operating mode of the selected digital output is > 2. Example: MDO1 **P270**>2.

MDO1: Function Applied to the Result of Tests A and B: P277, (P286, P295, P304)

A logic function is applied to the two Boolean signals obtained in order to obtain the output TRUE/FALSE Boolean signal.
Six different tests may be performed for variable (A) using the comparing value and variable (B).

(A) OR (B): The selected digital output is enabled when at least one of the two conditions below is true (this function also allows enabling the selected digital input based on one test only).

(A) OR (B)		
Test A	Test B	Output
0	0	0
1	0	1
0	1	1
1	1	1

(A) SET (B) RESET: The selected digital output is activated as the output of a Flip Flop Set Reset whose inputs are signal A and signal B. This function can be used in case of hysteresis. The output status (Q) depends on the previous value (Q hold) and on the result of the two tests. Test A is the Set command; Test B is the Reset command.
Example: Suppose that the output enables only when the motor speed exceeds 50rpm and disables when the motor speed drops below 5 rpm. To do so, assign the first condition to Test A, representing the Set command for Flip Flop (**P271** = Motor Speed, **P273** >, **P275** = 50rpm), and assign the second condition to Test B, representing the Reset command (**P272** = Motor Speed, **P274** <=, **P276** = 5rpm). A more detailed example is given at the end of this section.

Flip Flop Set Reset			
Q hold	Test A (Set)	Test B (Reset)	Output Q
0	0	1	0
0	0	0	0
0	1	1	0
0	1	0	1
1	0	1	0
1	0	0	1
1	1	1	1
1	1	0	1

(A) AND (B): The selected digital output enables when both conditions are true.

(A) AND (B)		
Test A	Test B	Output
0	0	0
1	0	0
0	1	0
1	1	1

(A) XOR (B): The selected digital output enables when either one condition or the other is true (but not when both conditions are true at a time).

(A) XOR (B)		
Test A	Test B	Output
0	0	0
1	0	1
0	1	1
1	1	0

(A) NOR (B): The selected digital output enables when no condition is true. The NOR function between two variables corresponds to the AND of the same false variables, i.e. (A)NOR (B) = (/A) AND (/B).

(A) NOR (B)		
Test A	Test B	Output
0	0	1
1	0	0
0	1	0
1	1	0

(A) NAND (B): The selected digital output enables when no condition is true or when only one of the two conditions is true. The NAND function between two variables corresponds to the OR of the same false variables, i.e. (A)NAND (B) = (/A) OR (/B).

(A) NAND (B)		
Test 1	Test 2	Output
0	0	1
1	0	1
0	1	1
1	1	0

NOTE This parameter can be accessed only if the operating mode of the selected digital output is > 2 and <9. Example: MDO1 2<**P270**<9.

Function applied to the result of f(A,B) C for MDO1 P277a, (P286a, P295a, P304a)

Once the Boolean signal resulting from f(A,B) is obtained, an additional logic function can be applied to obtain the output TRUE//FALSE Boolean signal.
If parameter **P277a** is disabled, the output of f(A,B) goes directly to the corresponding digital output; if parameter P277a is enabled, the output of the output of f(A,B) becomes one of the two inputs of the second programmed block.
The user can choose one of the six Boolean tests above for the first variable - f(A,B) – and for the second variable (C).
See Example 6.

MDO1 (2,3,4): Logic applied to MDO1 (2,3,4): P278, (P287, P296, P305)

The logic of the Boolean signal can be reversed at the end of the processing chain.
The user can choose whether the logic level of the digital output is POSITIVE or NEGATIVE.
(0) FALSE = a logic negation is applied (NEGATIVE logic)
(1) TRUE = no negation is applied (POSITIVE logic)

NOTE This parameter can be accessed only if the operating mode of the selected digital output is other than zero. Example: MDO1 **P270**≠0.

24.2. Programmable Operating Modes (Diagrams)

The diagrams shown in the figures illustrate the operating structure of MDO1 digital output; the remaining digital outputs (MDO2, MDO3, and MDO4) will follow the same logics, as implemented in the relevant parameters.

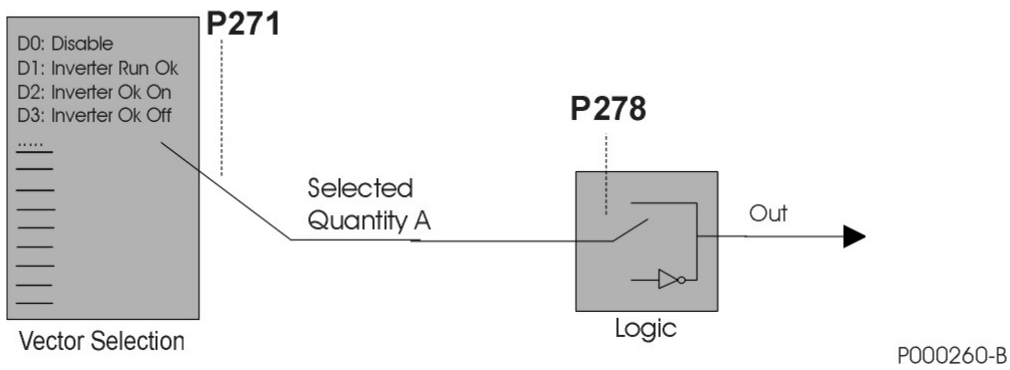


Figure 32: DIGITAL Mode.

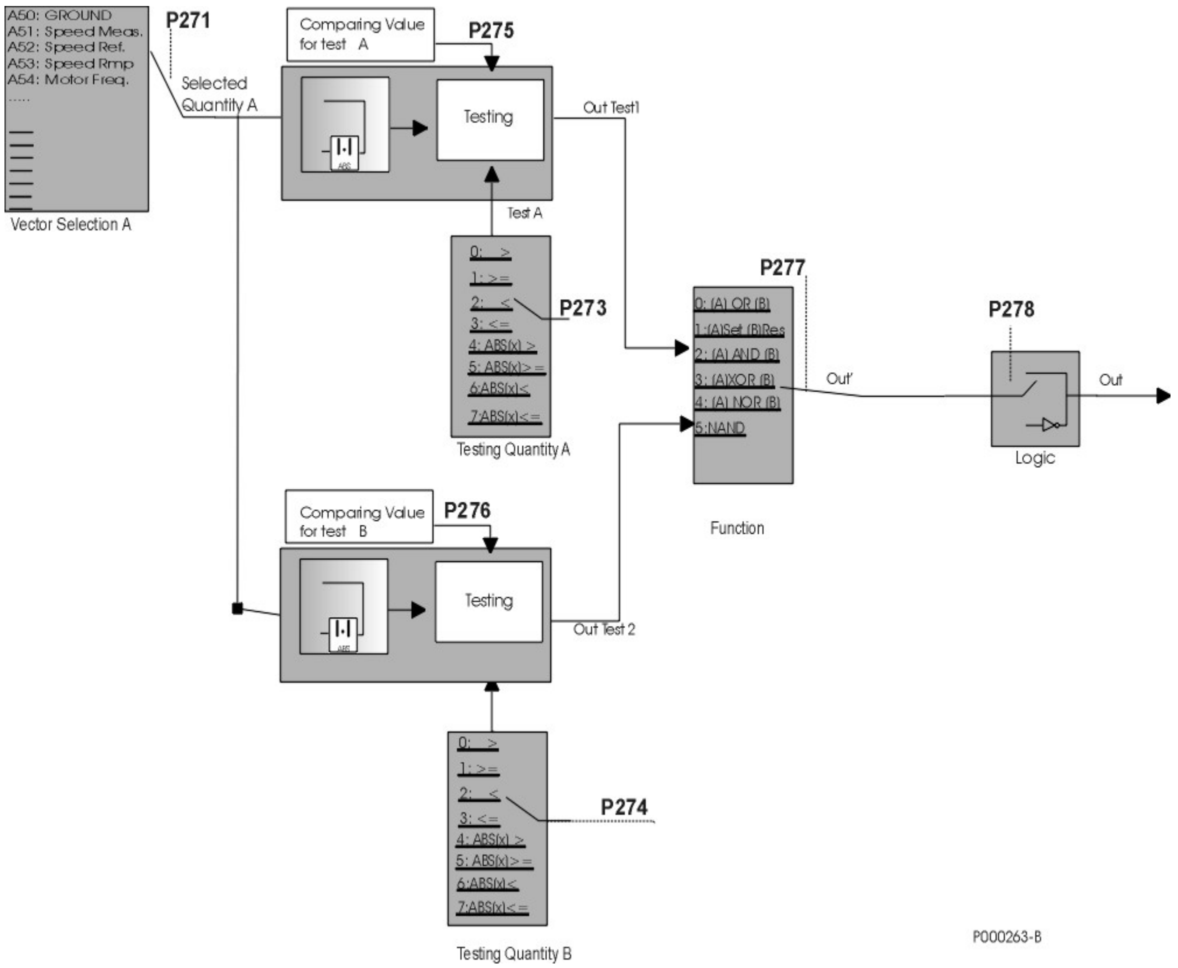


Figure 33: ANALOG Mode.

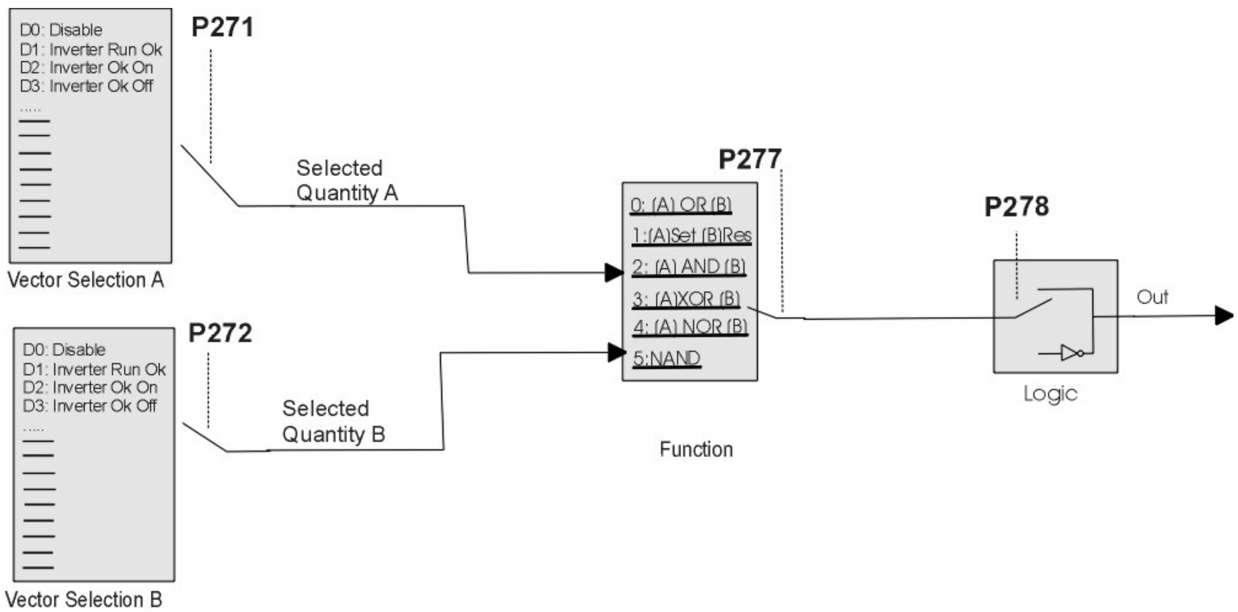


Figure 34: DOUBLE DIGITAL Mode.

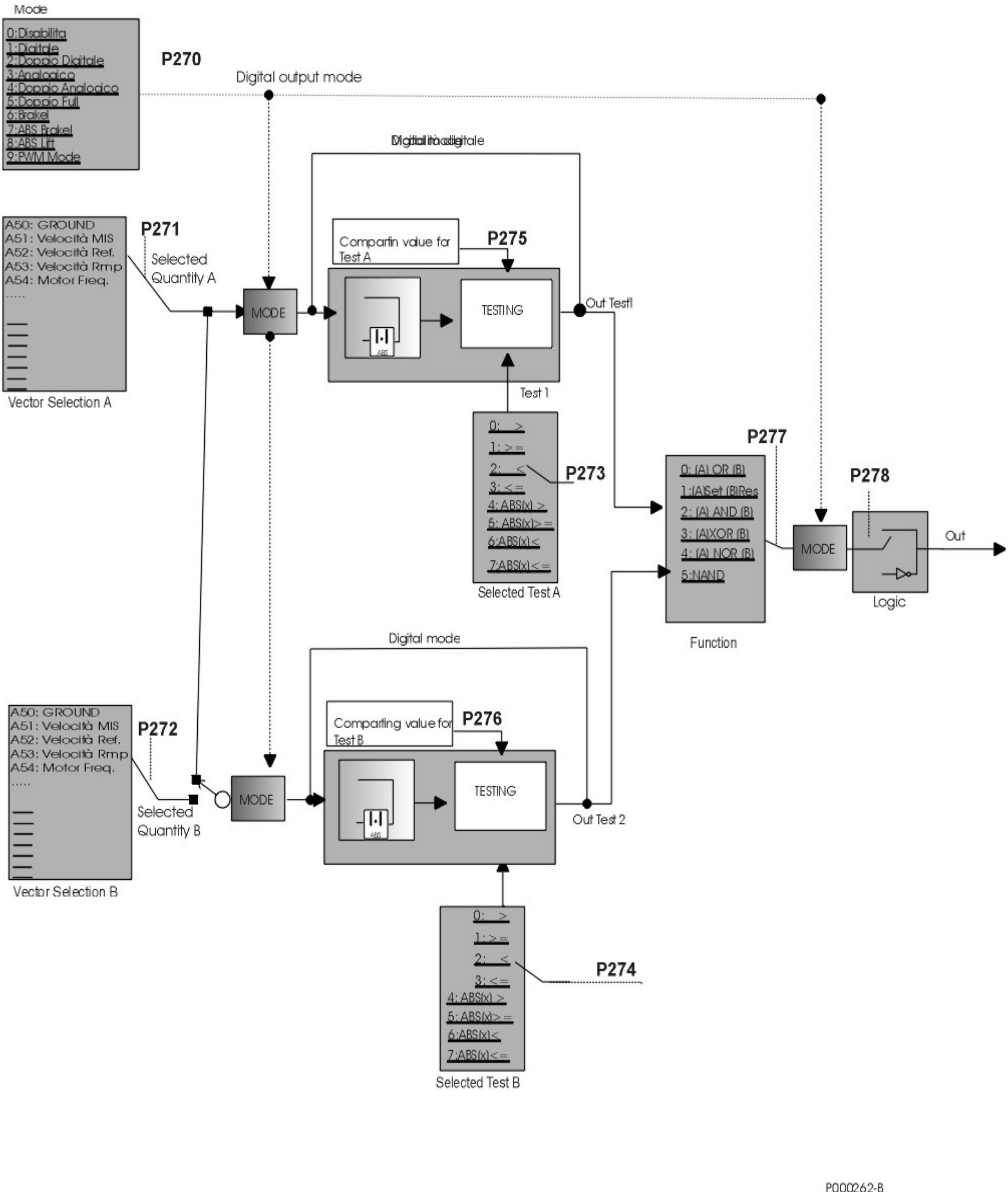


Figure 35: General structure of the parameterization of a digital output.

24.3. Examples

This section illustrates some examples.
A table stating the set up of the parameters used is given for each example.
Parameters highlighted in grey have no effect due to their preset selection.

Example 1: Digital output for Inverter Alarm digital command (MDO3 digital output default setting).

Table 41: DGO parameterization for drive State OK.

P288	MDO3: Digital output mode	DIGITAL
P289	MDO3: Variable A selection	D3: Inverter Alarm
P290	MDO3: Variable B selection	
P291	MDO3: Testing variable A	
P292	MDO3: Testing variable B	
P293	MDO3: Comparing value for Test A	
P294	MDO3: Comparing value for Test B	
P295	MDO3: Function applied to the result of the two tests	
P295a	MDO3: Variable C selection	D0: Disabled
P295b	MDO3: Function applied to the result of f(A,B) and C test	
P296	MDO3: Output logic level	FALSE

The digital output status depends on the Boolean variable "Inverter Alarm", which is TRUE only when an alarm trips. This output is a fail-safe contact: the relay energizes if the drive is on and no alarms tripped.

Example 2: Digital output for Drive Run OK digital command (MDO4 digital output default setting).

Table 42: DGO parameterization for drive Run OK.

P297	MDO4: Digital output mode	DIGITAL
P298	MDO4: Variable A selection	D1: Drive Run Ok
P299	MDO4: Variable B selection	
P300	MDO4: Testing variable A	
P301	MDO4: Testing variable B	
P302	MDO4: Comparing value for Test A	
P303	MDO4: Comparing value for Test B	
P304	MDO4: Function applied to the result of the two tests	
P295a	MDO3: Variable C selection	D0: Disabled
P295b	MDO3: Function applied to the result of f(A,B) and C test	
P305	MDO4: Output logic level	TRUE

The digital output status depends on the Boolean variable "Drive Run Ok", which is TRUE only when the drive is modulating (IGBTs on).

Example 3: Digital output for speed thresholds

Suppose that a digital output energizes if the motor speed exceeds 100rpm as an absolute value, and de-energizes when the motor speed is lower than or equal to 20rpm (as an absolute value). Parameter P270 sets ABS mode, so that the selected variables are considered as absolute values. The condition "greater than" is selected for test 1, and "lower than/equal to" is selected for test 2.

Table 43: DGO parameterization for speed thresholds.

P270	MDO1: Digital output mode	ANALOG
P271	MDO1: Variable A selection	A61: Speed MEA
P272	MDO1: Variable B selection	
P273	MDO1: Testing variable A	ABS(x) >
P274	MDO1: Testing variable B	ABS (x) ≤
P275	MDO1: Comparing value for Test A	100.00 rpm
P276	MDO1: Comparing value for Test B	20.00 rpm
P277	MDO1: Function applied to the result of the two tests	(A) Set (B) Reset
P277a	MDO1: Variable C selection	D0: Disabled
P277b	MDO1: Function applied to the result of f(A,B) and C test	
P278	MDO1: Output logic level	TRUE

Both tests are performed over the motor speed; **P271**, **P272** are set to "motor speed". The values of reference for the two tests are 100rpm and 20rpm; the function applied is Flip Flop Set Reset and the output is considered as a true logic. Test 1 is the Set signal of the Flip Flop and Test 2 is the Reset signal.

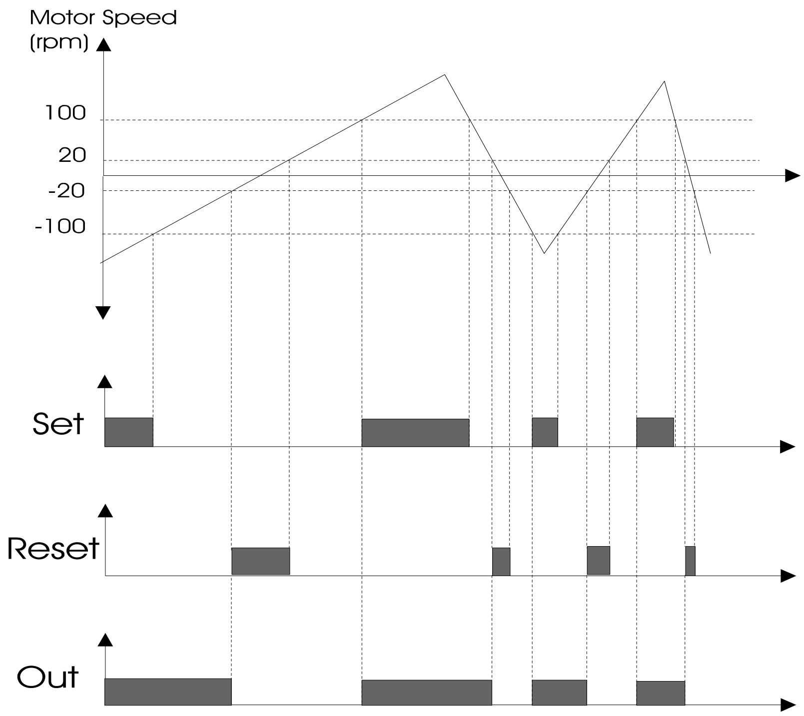


Figure 36: Digital output for speed thresholds (example).

Example 4: Digital output for electromechanical brake for lifting applications (programming example related to MDO4 digital output).

Table 44: DGO parameterization for electromechanical brake command.

P297	MDO4: Digital output mode	ABS BRAKE
P298	MDO4: Variable A selection	A71: Torque Output
P299	MDO4: Variable B selection	A61: Speed MEA
P300	MDO4: Testing variable A	>
P301	MDO4: Testing variable B	≤
P302	MDO4: Comparing value for Test A	20.00%
P303	MDO4: Comparing value for Test B	50.00 rpm
P304	MDO4: Function applied to the result of the two tests	(A) Set (B) Reset
P304a	MDO4: Variable C selection	D0: Disabled
P304b	MDO4: Function applied to the result of f(A,B) and C test	
P305	MDO4: Output logic level	TRUE

The digital output energizes only if no alarm trips. The torque demand is greater than **P302** = 20.00% (Set). The digital output de-energizes if an alarm trips or if the decelerating speed is lower than the speed value set in **P303** = 50rpm (Reset).

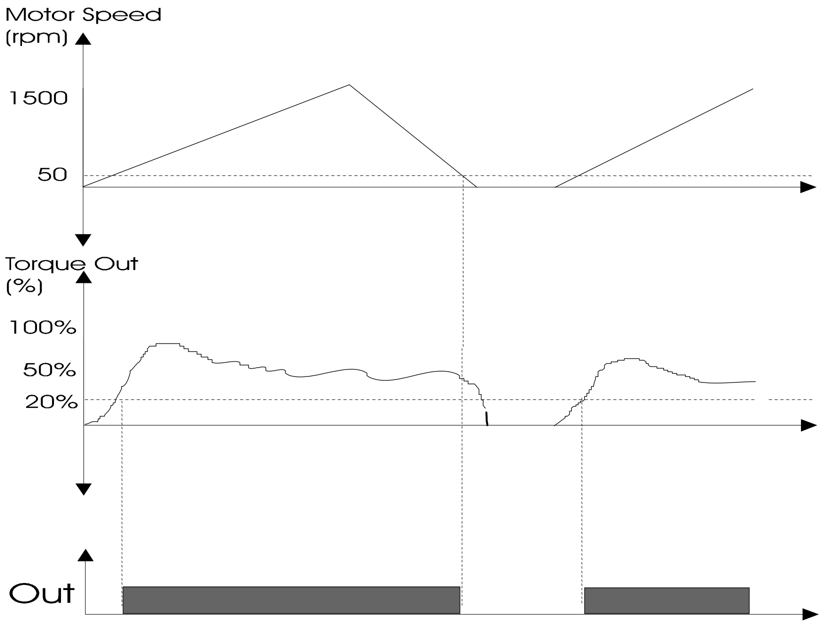


Figure 37: Electromechanical brake command (example).

CAUTION Always use the NO contact of the digital output for the electromechanical brake command.

NOTE For details about the electromechanical brake used for lifting applications, see also the BRIDGE CRANE MENU.

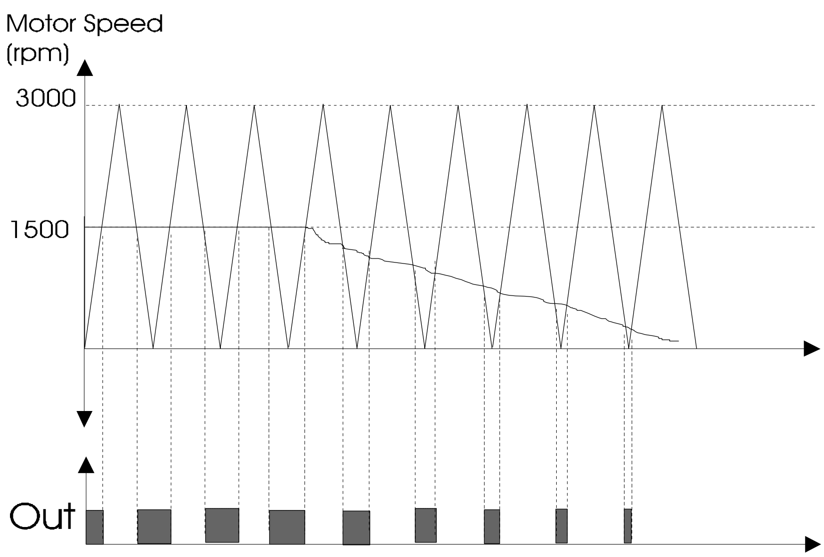
<u>Example 5: Using the PWM Function.</u>

Suppose that the motor of a machine tool is controlled by a drive. The tool must be lubricated based on the cutting speed. At max. cutting speed, the electrovalve controlling lubrication must work for 0.5 sec with a frequency of 1Hz (time period of 1 sec.): at max. speed, a duty cycle of 50% (Ton/T) is required, with a time period of 1 second; the time when the electrovalve opens is inversely proportional to the cutting speed.
Spd1 is the max. cutting speed and dtc1 is the duty cycle required; the saw carrier frequency required for PWM must be 1 Hz (**P213**), the min. value must be 0rpm (when speed = 0rpm, the electrovalve is disabled) and max. value = Spd1 100/ dtc1 = 2*Spd1.
Supposing that the tool can rotate in both directions, that Spd1 = 1500rpm and that MDO2 digital output is used, parameters are set as follows:

Table 45: DGO parameterization for the PWM function.

P270	MDO1: Digital output mode	PWM MODE
P271	MDO1: Variable A selection	A62: Speed Ref.
P272	MDO1: Variable B selection	
P273	MDO1: Testing variable A	>
P274	MDO1: Testing variable B	
P275	MDO1: Comparing value for Test A	3000.00 rpm
P276	MDO1: Comparing value for Test B	0.0 rpm
P277	MDO1: Function applied to the result of the two tests	
P277a	MDO1: Variable C selection	D0: Disabled
P277b	MDO1: Function applied to the result of f(A,B) and C test	
P278	MDO1: Output logic level	TRUE
P215	Saw signal frequency	0.01Hz

Parameter **P215** in the ANALOG AND FREQUENCY OUTPUTS MENU sets the frequency of the saw wave, i.e. the PWM frequency of the digital output.
In PWM mode, parameter **P275** sets the max. value (peak value) of the saw wave, while parameter **P276** sets the min. value of the saw wave.
The test selected with **P273** is performed between the analog variable selected in **P271** and the saw wave.



Example 6: Digital output indicating the READY state to a PLC supervisor – using Inputs A, B, C

This example shows how to activate a digital output based on the logic AND of 3 inputs A,B,C—particularly the ENABLE input, the ENABLE S (Safety) input for redundancy and the condition of "Inverter Ok On".
An additional block applied to f(A,B) and C is used:

Table 46: DGO parameterization for the Ready state of a PLC supervisor.

P270	MDO1: Digital output mode	DOUBLE DIGITAL
P271	MDO1: Variable A selection	D21: MDI Enable
P272	MDO1: Variable B selection	D22: MDI Enable S
P273	MDO1: Testing variable A	
P274	MDO1: Testing variable B	
P275	MDO1: Comparing value for Test A	
P276	MDO1: Comparing value for Test B	
P277	MDO1: Function applied to the result of the two tests	(A) AND (B)
P277a	MDO1: Variable C selection	D2: Inverter Ok On
P277b	MDO1: Function applied to the result of f(A,B) and C test	f(A,B) AND (C)
P278	MDO1: Output logic level	VERA

24.4. List of Parameters P270 to P305

Table 47: List of parameters P270 to P305.

Parameter	FUNCTION	User Level	DEFAULT VALUES	MODBUS Address
P270	MDO1: Digital output mode	ADVANCED	3:ANALOG	870
P271	MDO1: Selecting variable A	ADVANCED	A61: Speed	871
P272	MDO1: Selecting variable B	ADVANCED	A61: Speed	872
P273	MDO1: Testing variable A	ADVANCED	0: >	873
P274	MDO1: Testing variable B	ADVANCED	3: ≤	874
P275	MDO1: Comparing value for Test A	ADVANCED	50 rpm	875
P276	MDO1: Comparing value for Test B	ADVANCED	10 rpm	876
P277	MDO1: Function applied to the result of the 2 tests	ADVANCED	1: (A) SET (B) RESET	877
P277a	MDO1: Selecting variable C	ADVANCED	0: Disable	642
P277b	MDO1: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	643
P278	MDO1: Output logic level	ADVANCED	1: TRUE	878
P279	MDO2: Digital output mode	ADVANCED	6: BRAKE	879
P280	MDO2: Selecting variable A	ADVANCED	A71: Trq Output	880
P281	MDO2: Selecting variable B	ADVANCED	A61: Speed	881
P282	MDO2: Testing variable A	ADVANCED	0: >	882
P283	MDO2: Testing variable B	ADVANCED	3: ≤	883
P284	MDO2: Comparing value for Test A	ADVANCED	20%	884
P285	MDO2: Comparing value for Test B	ADVANCED	50 rpm	885
P286	MDO2: Function applied to the result of the 2 tests	ADVANCED	1: (A) SET (B) RESET	886
P286a	MDO2: Selecting variable C	ADVANCED	0: Disable	644
P286b	MDO2: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	645
P287	MDO2: Output logic level	ADVANCED	1: TRUE	887
P288	MDO3: Digital output mode	ADVANCED	1: DIGITAL	888
P289	MDO3: Selecting variable A	ADVANCED	D3: Inverter Alarm	889
P290	MDO3: Selecting variable B	ADVANCED	D3: Inverter Alarm	890
P291	MDO3: Testing variable A	ADVANCED	0: >	891
P292	MDO3: Testing variable B	ADVANCED	0: >	892
P293	MDO3: Comparing value for Test A	ADVANCED	0	893
P294	MDO3: Comparing value for Test B	ADVANCED	0	894
P295	MDO3: Function applied to the result of the 2 tests	ADVANCED	0: (A) OR (B)	895
P295a	MDO3: Selecting variable C	ADVANCED	0: Disable	646
P295b	MDO3: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	647
P296	MDO3: Output logic level	ADVANCED	0: FALSE	896
P297	MDO4: Digital output mode	ADVANCED	1: DIGITAL	897
P298	MDO4: Selecting variable A	ADVANCED	D1: Inverter Run Ok	898
P299	MDO4: Selecting variable B	ADVANCED	D1: Inverter Run Ok	899
P300	MDO4: Testing variable A	ADVANCED	0: >	900
P301	MDO4: Testing variable B	ADVANCED	0: >	901
P302	MDO4: Comparing value for Test A	ADVANCED	0	902
P303	MDO4: Comparing value for Test B	ADVANCED	0	903
P304	MDO4: Function applied to the result of the 2 tests	ADVANCED	0: (A) OR (B)	904
P304a	MDO4: Selecting variable C	ADVANCED	0: Disable	648
P304b	MDO4: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	649
P305	MDO4: Output logic level	ADVANCED	1: TRUE	905

P270 MDO1: Digital Output Mode

P270	Range	0 ÷ 9	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT 9: PWM MODE
	Default	3	3: ANALOG
	Level	ADVANCED	
	Address	870	
	Function	This parameter defines the operating mode of **digital output 1**. The different operating modes are described at the beginning of this chapter.	

NOTE MDO1 Digital output can be programmed only if the frequency output is not set up: **P200** = Disable (see ANALOG AND FREQUENCY OUTPUTS MENU).

P271 MDO1: Selecting Variable A

P271	Range	0 ÷ 119	See Table 39
	Default	61	A61: Speed MEA
	Level	ADVANCED	
	Address	871	
	Function	This parameter selects the digital signal used to calculate the value of **MDO1** digital output. It selects an analog variable used to calculate the value of **MDO1**digital output if one of the "analog" operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P272 MDO1: Selecting Variable B

P272	Range	0 ÷ 119	See Table 39
	Default	61	A61: Speed MEA
	Level	ADVANCED	
	Address	872	
	Function	This parameter selects the second digital signal used to calculate the value of **MDO1** digital output. It selects an analog variable used to calculate the value of **MDO1** digital input if one of the "analog" operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P273 MDO1: Testing Variable A

P273	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	873	
	Function	This parameter defines the test to be performed for the variable detected by **P271** using **P275** as a comparing value.	

P274 MDO1: Testing Variable B

P274	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	3	3: ≤
	Level	ADVANCED	
	Address	874	
	Function	This parameter defines the test to be performed for the variable detected by **P272** using **P276** as a comparing value.	

P275 MDO1: Comparing Value for Test A

P275	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A*, see Table 39.
	Default	50	50 rpm
	Level	ADVANCED	
	Address	875	
	Function	This parameter defines the comparing value with the selected variable for test A.	

P276 MDO1: Comparing Value for Test B

P276	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B*, see Table 39.
	Default	10	10 rpm
	Level	ADVANCED	
	Address	876	
	Function	This parameter defines the comparing value with the selected variable for test B.	

P277 MDO1: Function Applied to the Result of the 2 Tests

P277	Range	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	877	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P277a MDO1: Selecting Variable C

277a	Range	0 ÷ 59	See Table 39
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	642	
	Function	This parameter selects the digital signal used to calculate the value of MDO1 digital output. The digital signals that can be selected are given in Table 39.	

P277b MDO1: Function Applied to the Result of f(A,B) C

P277b	Range	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: f(A,B)\ OR (C) 7: f(A,B) OR (C\) 8: f(A,B)\ AND (C) 9: f(A,B) AND (C\) 10: f(A,B) RESET (C) SET RISING EDGE 11: f(A,B) SET (C) RESET FALLING EDGE 12: f(A,B) RESET (C) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	643	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P278 MDO1: Output Logic Level

P278			
	Range	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ADVANCED	
	Address	878	
	Function	MDO1 digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P279 MDO2: Digital Output Mode

P279			
	Range	0 ÷ 9	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT 9: PWM MODE
	Default	6	1: BRAKE
	Level	ADVANCED	
	Address	879	
	Function	This parameter defines the operating mode of **digital output 2.** The different operating modes are described at the beginning of this chapter.	

P280 MDO2: Selecting Variable A

P280			
	Range	0 ÷ 119	See Table 39
	Default	71	A71: Torque Output
	Level	ADVANCED	
	Address	880	
	Function	This parameter selects the digital signal used to calculate the value of **MDO2** digital output. It selects an analog variable used to calculate the value of **MDO2** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P281 MDO2: Selecting Variable B

P281			
	Range	0 ÷ 119	See Table 39
	Default	61	A61: Speed MEA
	Level	ADVANCED	
	Address	881	
	Function	This parameter selects the second digital signal used to calculate the value of **MDO2** digital output. It selects an analog variable used to calculate the value of **MDO2** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P282 MDO2: Testing Variable A

P282	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	882	
	Function	This parameter defines the test to be performed for the variable detected by **P280** using **P284** as a comparing value.	

P283 MDO2: Testing Variable B

P283	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	3: ≤
	Level	ADVANCED	
	Address	883	
	Function	This parameter defines the test to be performed for the variable detected by **P281** using **P285** as a comparing value.	

P284 MDO2: Comparing Value for Test A

P284	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A,* see Table 39.
	Default	2000	20%
	Level	ADVANCED	
	Address	884	
	Function	This parameter defines the comparing value with the selected variable for test A.	

P285 MDO2: Comparing Value for Test B

P285	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B,* see Table 39.
	Default	50	50 rpm
	Level	ADVANCED	
	Address	885	
	Function	This parameter defines the comparing value with the selected variable for test B.	

P286 MDO2: Function Applied to the Result of the 2 Tests

P286	Range	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	886	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P286a MDO2: Selecting Variable C

P286a	Range	0 ÷ 59	See Table 39
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	644	
	Function	This parameter selects the digital signal used to calculate the value of MDO2 digital output. The digital signals that can be selected are given in Table 39.	

P286b MDO2: Function Applied to the Result of f(A,B) C

P286b	Range	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: f(A,B)\ OR (C) 7: f(A,B) OR (C\) 8: f(A,B)\ AND (C) 9: f(A,B) AND (C\) 10: f(A,B) RESET (C) SET RISING EDGE 11: f(A,B) SET (C) RESET FALLING EDGE 12: f(A,B) RESET (C) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	645	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P287 MDO2: Output Logic Level

P287	Range	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ADVANCED	
	Address	887	
	Function	MDO2 digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P288 MDO3: Digital Output Mode

P288	Range	0 ÷ 8	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT
	Default	1	1: DIGITAL
	Level	ADVANCED	
	Address	888	
	Function	This parameter defines the operating mode of **digital output 3**. The different operating modes are described at the beginning of this chapter.	

P289 MDO3: Selecting Variable A

P289	Range	0 ÷ 119	See Table 39
	Default	3	D3: Inverter Alarm
	Level	ADVANCED	
	Address	889	
	Function	This parameter selects the digital signal used to calculate the value of **MDO3** digital output. It selects an analog variable used to calculate the value of **MDO3** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P290 MDO3: Selecting Variable B

P290	Range	0 ÷ 119	See Table 39
	Default	3	D3: Inverter Alarm
	Level	ADVANCED	
	Address	890	
	Function	This parameter selects the second digital signal used to calculate the value of **MDO3** digital output. It selects an analog variable used to calculate the value of digital input **MDO3** if one of the “analog” operating modes is selected. Digital signals and analog variables detailed in Table 39.	

P291 MDO3: Testing Variable A

P291	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	891	
	Function	This parameter defines the test to be performed for the variable detected by **P289** using **P293** as a comparing value.	

P292 MDO3: Testing Variable B

P292	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	892	
	Function	This parameter defines the test to be performed for the variable detected by **P290** using **P294** as a comparing value.	

P293 MDO3: Comparing Value for Test A

P293	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A,* see Table 39.
	Default	0	0
	Level	ADVANCED	
	Address	893	
	Function	This parameter defines the comparing value with the variable selected for test A.	

P294 MDO3: Comparing Value for Test B

P294	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B*, See Table 39.
	Default	0	0
	Level	ADVANCED	
	Address	894	
	Function	This parameter defines the comparing value with the variable selected for test B.	

P295 MDO3: Function Applied to the Result of the 2 Tests

P295	Range	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	0	0: (A) OR (B)
	Level	ADVANCED	
	Address	895	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P295a MDO3: Selecting Variable C

P295a	Range	0 ÷ 59	See Table 39
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	646	
	Function	This parameter selects the digital signal used to calculate the value of MDO3 digital output. The digital signals that can be selected are given in Table 39.	

P295b MDO3: Function Applied to the Result of f(A,B) C

P295b	Range	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: f(A,B)\ OR (C) 7: f(A,B) OR (C\) 8: f(A,B)\ AND (C) 9: f(A,B) AND (C\) 10: f(A,B) RESET (C) SET RISING EDGE 11: f(A,B) SET (C) RESET FALLING EDGE 12: f(A,B) RESET (C) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	647	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P296 MDO3: Output Logic Level

P296	Range	0–1	0: FALSE 1: TRUE
	Default	0	0: FALSE
	Level	ADVANCED	
	Address	896	
	Function	MDO3 digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P297 MDO4: Digital Output Mode

P297	Range	0 ÷ 8	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT
	Default	1	1: DIGITAL
	Level	ADVANCED	
	Address	897	
	Function	This parameter defines the operating mode of **digital output 4**. The different operating modes are described at the beginning of this chapter.	

P298 MDO4: Selecting Variable A

P298	Range	0 ÷ 119	See Table 39.
	Default	1	D1: Inverter Run Ok
	Level	ADVANCED	
	Address	898	
	Function	This parameter selects the digital signal used to calculate the value of **MDO4** digital output. It selects an analog variable used to calculate the value of **MDO4** digital input if one of the "analog" operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P299 MDO4: Selecting Variable B

P299	Range	0 ÷ 119	See Table 39
	Default	1	D1: Inverter Run Ok
	Level	ADVANCED	
	Address	899	
	Function	This parameter selects the second digital signal used to calculate the value of **MDO4** digital output. It selects an analog variable used to calculate the value of **MDO4** digital input if one of the "analog" operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P300 MDO4: Testing Variable A

P300	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	900	
	Function	This parameter defines the test to be performed for the variable detected by **P298** using **P302** as a comparing value.	

P301 MDO4: Testing Variable B

P301	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	901	
	Function	This parameter defines the test to be performed for the variable detected by **P299** using **P303** as a comparing value.	

P302 MDO4: Comparing Value for Test A

P302	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A*, see Table 39
	Default	0	0
	Level	ADVANCED	
	Address	902	
	Function	This parameter defines the comparing value with the selected variable for test A.	

P303 MDO4: Comparing Value for Test B

P303	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B*, see Table 39.
	Default	0	0
	Level	ADVANCED	
	Address	903	
	Function	This parameter defines the comparing value with the selected variable for test B.	

P304 MDO4: Function Applied to the Result of the 2 Tests

P304	Range	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	0	0: (A) OR (B)
	Level	ADVANCED	
	Address	904	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P304a MDO4: Selecting Variable C

P304a	Range	0 ÷ 59	See Table 39.
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	648	
	Function	This parameter selects the digital signal used to calculate the value of **MDO4** digital output. The digital signals that can be selected are given in Table 39.	

P304b MDO4: Function Applied to the Result of f(A,B) C

P304b	Range	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: f(A,B)\ OR (C) 7: f(A,B) OR (C\) 8: f(A,B)\ AND (C) 9: f(A,B) AND (C\) 10: f(A,B) RESET (C) SET RISING EDGE 11: f(A,B) SET (C) RESET FALLING EDGE 12: f(A,B) RESET (C) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	649	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P305 MDO4: Output Logic Level

P305	Range	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ADVANCED	
	Address	905	
	Function	MDO4 digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

25. AUXILIARY DIGITAL OUTPUTS MENU

25.1. Overview

This menu includes the parameters allowing allocating the control functions implemented via the digital inputs located on I/O expansion boards. This menu can be viewed only after enabling data acquisition from the expansion boards.

25.2. List of Parameters P306 to P317

Table 48: List of parameters P306 to P317.

Parameter	FUNCTION	User Level	DEFAULT VALUES	MODBUS Address
P306	XMDO1: Signal selection	ENGINEERING	D0: Disable	906
P307	XMDO1: Output logic level	ENGINEERING	1: True	907
P308	XMDO2: Signal selection	ENGINEERING	D0: Disable	908
P309	XMDO2: Output logic level	ENGINEERING	1: True	909
P310	XMDO3: Signal selection	ENGINEERING	D0: Disable	910
P311	XMDO3: Output logic level	ENGINEERING	1: True	911
P312	XMDO4: Signal selection	ENGINEERING	D0: Disable	912
P313	XMDO4: Output logic level	ENGINEERING	1: True	913
P314	XMDO5: Signal selection	ENGINEERING	D0: Disable	914
P315	XMDO5: Output logic level	ENGINEERING	1: True	915
P316	XMDO6: Signal selection	ENGINEERING	D0: Disable	916
P317	XMDO6: Output logic level	ENGINEERING	1: True	917

P306 XMDO1: Signal Selection

P306			
	Range	0 ÷ 59	See Table 39
	Default	0	D0: Disable
	Level	ENGINEERING	
	Address	906	
	Function	Selects the digital signal used to calculate the value of **XMDO1** digital output. It selects an analog variable used to calculate the value of **XMDO1** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P307 XMDO1: Output Logic Level

P307			
	Range	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ENGINEERING	
	Address	907	
	Function	**XMDO1** digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P308 XMDO2: Signal Selection

P308	Range	0 ÷ 59	See Table 39
	Default	0	D0: Disable
	Level	ENGINEERING	
	Address	908	
	Function	Selects the digital signal used to calculate the value of **XMDO2** digital output. It selects an analog variable used to calculate the value of **XMDO2** digital input if one of the "analog" operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P309 XMDO2: Output Logic Level

P309	Range	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ENGINEERING	
	Address	909	
	Function	**XMDO2** digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P310 XMDO3: Signal Selection

P310	Range	0 ÷ 59	See Table 39
	Default	0	D0: Disable
	Level	ENGINEERING	
	Address	910	
	Function	Selects the digital signal used to calculate the value of **XMDO3** digital output. It selects an analog variable used to calculate the value of **XMDO3** digital input if one of the "analog" operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P311 XMDO3: Output Logic Level

P311	Range	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ENGINEERING	
	Address	911	
	Function	**XMDO3** digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P312 XMDO4: Signal Selection

P312	Range	0 ÷ 59	See Table 39
	Default	0	D0: Disable
	Level	ENGINEERING	
	Address	912	
	Function	Selects the digital signal used to calculate the value of **XMDO4** digital output. It selects an analog variable used to calculate the value of **XMDO4** digital input if one of the "analog" operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P313 XMDO4: Output Logic Level

P313	Range	0–1	0: TRUE 1: FALSE
	Default	1	1: FALSE
	Level	ENGINEERING	
	Address	913	
	Function	**XMDO4** digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P314 XMDO5: Signal Selection

P314	Range	0 ÷ 59	See Table 39
	Default	0	D0: Disable
	Level	ENGINEERING	
	Address	914	
	Function	Selects the digital signal used to calculate the value of **XMDO5** digital output. It selects an analog variable used to calculate the value of **XMDO5** digital input if one of the "analog" operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P315 XMDO5: Output Logic Level

P315	Range	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ENGINEERING	
	Address	915	
	Function	**XMDO5** digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P316 XMDO6: Signal Selection

P316			
	Range	0 ÷ 59	See Table 39
	Default	0	D0: Disable
	Level	ENGINEERING	
	Address	916	
	Function	Selects the digital signal used to calculate the value of **XMDO6** digital output. It selects an analog variable used to calculate the value of **XMDO6** digital input if one of the "analog" operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P317 XMDO6: Output Logic Level

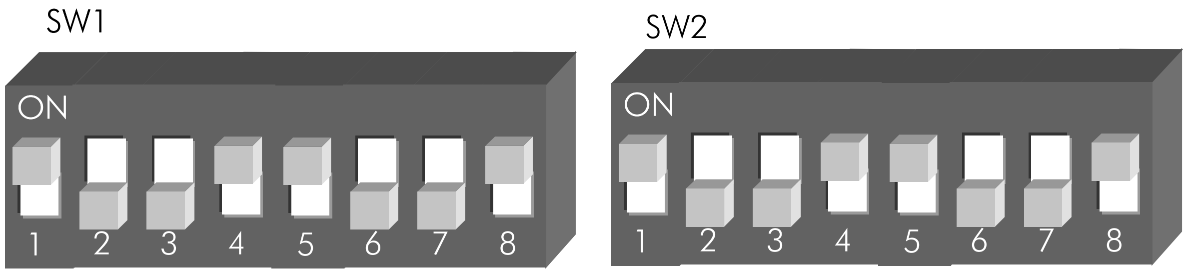
P317			
	Range	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ENGINEERING	
	Address	917	
	Function	**XMDO6** digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

26. MEASURE CONTROL FROM PT100

26.1. Overview

This menu relates to ES847 control board. It can be viewed only if **R023** (I/O board setting) = PT100 (see the EXPANSION BOARD CONFIGURATION MENU).
The analog inputs can be linked to measure sensors.

NOTE Set DIP-Switches 1 and 2 as follows for proper data acquisition from PT100:



26.2. List of Parameters P318 to P325

Table 49: List of parameters P318 to P325.

Parameter	FUNCTION	User Level	DEFAULT VALUES	MODBUS Address
P320	Channel 1: measure mode	ADVANCED	0: no input	920
P321	Channel 1: measure offset	ADVANCED	0.0 °C	921
P322	Channel 2: measure mode	ADVANCED	0: no input	922
P323	Channel 2: mesaure offset	ADVANCED	0.0 °C	923
P324	Channel 3: measure mode	ADVANCED	0: no input	924
P325	Channel 3: mesaure offset	ADVANCED	0.0 °C	925
P326	Channel 4: measure mode	ADVANCED	0: no input	926
P327	Channel 4: mesaure offset	ADVANCED	0.0 °C	927

P320 Channel 1: Measure Mode

P320			
	Range	0 ÷ 1	0: no input 1: val PT100
	Default	0	0: no input
	Level	ADVANCED	
	Address	920	
	Function	This parameter selects the type of analog signal available in terminals 27–28 in ES847 expansion board. **0**: no signal is used. The P parameter relating to the analog input disappears. **1**: val PT100. The acquired signal is transformed into degrees centigrade. See Measure **M069.**	

P321 Channel 1: Measure Offset

P321			
	Range	–30000 ÷ 30000	–300.00 ÷ 300.00
	Default	0	0.0 °C
	Level	ADVANCED	
	Address	921	
	Function	Value of the measure offset for channel 1: an offset can be applied to the measure to correct possible errors.	

P322 Channel 2: Measure Mode

P322			
	Range	0 ÷ 1	0: no input 1: val PT100
	Default	0	0: no input
	Level	ADVANCED	
	Address	922	
	Function	This parameter selects the type of analog signal available in terminals 29–30 in ES847 expansion board. **0**: no signal is used. The P parameter relating to the analog input disappears. **1**: val PT100. The acquired signal is transformed into degrees centigrade. See Measure **M070.**	

P323 Channel 2: Measure Offset

P323			
	Range	–30000 ÷ 30000	–300.00 ÷ 300.00
	Default	0	0.0 °C
	Level	ADVANCED	
	Address	923	
	Function	Value of the measure offset for channel 2: an offset can be applied to the measure to correct possible errors.	

P324 Channel 3: Measure Mode

P324			
	Range	0 ÷ 1	0: no input 1: val PT100
	Default	0	0: no input
	Level	ADVANCED	
	Address	924	
	Function	This parameter selects the type of analog signal available in terminals 31–32 in ES847 expansion board. **0**: no signal is used. The P parameter relating to the analog input disappears. **1**: val PT100. The acquired signal is transformed into degrees centigrade. See Measure **M071**.	

P325 Channel 3: Measure Offset

P325			
	Range	–30000 ÷ 30000	–300.00 ÷ 300.00
	Default	0	0.0 °C
	Level	ADVANCED	
	Address	925	
	Function	Value of the measure offset for channel 3: an offset can be applied to the measure to correct possible errors.	

P326 Channel 4: Measure Mode

P326			
	Range	0 ÷ 1	0: no input 1: val PT100
	Default	0	0: no input
	Level	ADVANCED	
	Address	926	
	Function	This parameter selects the type of analog signal available in terminals 33–34 in ES847 expansion board. **0**: no signal is used. The P parameter relating to the analog input disappears. **1**: val PT100. The acquired signal is transformed into degrees centigrade. See Measure **M072**.	

P327 Channel 4: Measure Offset

P327			
	Range	–30000 ÷ 30000	–300.00 ÷ 300.00
	Default	0	0.0 °C
	Level	ADVANCED	
	Address	927	
	Function	Value of the measure offset for channel 4: an offset can be applied to the measure to correct possible errors.	

27. FIELDBUS PARAMETERS MENU

27.1. Overview

This menu allows selecting the Third measure and the Fourth measure from the Fieldbus.
The list of the selectable measures is the same as the list in the MEASURES MENU.
The First measure and the Second measure are fixed (Output Current and Motor Speed) (see Exchanged P).

27.2. List of Parameters P330 to P331

Table 50: List of parameters P330 to P331.

Parameter	FUNCTION	User Level	Default Values	MODBUS Address
P330	Third measure from the Fieldbus	ENGINEERING	13:Torque Out %	930
P331	Fourth measure from the Fieldbus	ENGINEERING	23: PID Out%	931

P330 Third Measure from the Fieldbus

P330			
	Range	0-91	See Table 51
	Default	13	M012 :[Torque Out %]
	Level	ENGINEERING	
	Address	930	
	Function	Third measure exchanged via Fieldbus.	

P331 Fourth Measure from the Fieldbus

P331			
	Range	0-91	See Table 51
	Default	23	M022 :[PID Out %]
	Level	ENGINEERING	
	Address	931	
	Function	Fourth measure exchanged via Fieldbus.	

Table 51: List of Programmable Measures for P330 ÷ P331.

0	NONE	46	M045 Fbus.TrqLimRef
1	M000 Speed Ref	47	M046 SerPID Ref
2	M001 dcm.Spd.Ref	48	M047 FbusPID Ref
3	M002 Ramp Out	49	M048 SerPID Fbk
4	M003 dcm.Rmp.Out	50	M049 FbusPID Fbk
5	M004 Motor Speed	51	M050 Encoder Ref
6	M005 dcm.Mot.Spd	52	M051 Freq.In Ref
7	M006 Mot.Freq.	53	M052 Op.Time Lo
8	M007 Torq.Ref	54	M053 Op.Time Hi
9	M008 Torq.Demand	55	M054 Sply.Time Lo
10	M009 Torq.Out	56	M055 Sply.Time Hi
11	M010 Torq.Ref %	57	M056 Digital Out
12	M011 Torq.Dem.%	58	M057 Freq.Out
13	M012 Torq.Out %	59	M058 Analog Out AO1
14	M013 T.Lim.Ref	60	M059 Analog Out AO2
15	M014 T.Lim.RmpOut	61	M060 Analog Out AO3
16	M015 T.Lim.Ref %	62	M061 Aux. Dig.OUT
17	M016 T.Lim.RmpOut %	63	M062 Amb.Temp.
18	M017 Flux Ref	64	M036a Aux.Ser. Dig.IN
19	M018 PID Ref %	65	M064 Hts.Temp.
20	M019 PID RmpOut %	66	M065 OP Counter
21	M020 PID Fbk %	67	M066 SP Counter
22	M021 PID Err %	68	M036b Aux.FBus. Dig.IN
23	M022 PID Out %	69	M022a PID2 Out %
24	M023 PID Ref	70	M069 PT100 Temp.1
25	M024 PID Fbk	71	M070 PT100 Temp.2
26	M056a Virtual Dig.Out	72	M071 PT100 Temp.3
27	M026 Mot.Current	73	M072 PT100 Temp.4
28	M027 Out Volt	74	M073 -----------------
29	M028 Power Out	75	M074 -----------------
30	M029 Vbus-DC	76	M075 -----------------
31	M030 V Mains	77	M076 -----------------
32	M031 Delay.Dig.IN	78	M077 -----------------
33	M032 Istant.Dig.IN	79	M026a I2t
34	M033 Term. Dig.IN	80	M039a Analog In XAIN4
35	M034 Ser. Dig.IN	81	M039b Analog In XAIN5
36	M035 Fbus. Dig.IN	82	M018a PID2 Ref %
37	M036 Aux. Dig.IN	83	M019a PID2 RmpOut %
38	M037 Analog In REF	84	M020a PID2 Fbk %
39	M038 Analog In AIN1	85	M084 -----------------
40	M039 Analog In AIN2	86	M021a PID2 Err %
41	M040 Ser.SpdRef	87	M023a PID2 Ref
42	M041 dcm.Ser.SpdRef	88	M024a PID2 Fbk
43	M042 Fbus.SpdRef	89	M088 -----------------
44	M043 dcm.Fbus.SpdRef	90	M089 Status
45	M044 Ser.TrqLimRef	91	M090 Alarm

28. VIRTUAL DIGITAL OUTPUTS (MPL) MENU

28.1. Overview

The Virtual Digital Outputs menu includes the parameters allowing configuring the virtual digital outputs (MPL1..4) of the Sinus Penta drive.
Virtual digital outputs are logic blocks (no hardware output is provided) allocating more complex logic functions to outputs MDO1..4: MPL virtual outputs can be feedbacked at the input of a new block (hardware or virtual block), thus allowing implementing more complex functionality.

NOTE The Virtual Digital Outputs menu may be accessed only if the user level is ADVANCED or ENGINEERING.

NOTE XMDI auxiliary digital outputs (values from 13 to 20 in the parameters relating to the control functions) can be set up only after setting XMDI/O in parameter **R023**.

28.1.1. Factory Setting

MPL1 energizes when the ENABLE input is present; MPL2 energizes when a fan fault trips; MPL3 energizes when the Fire Mode is activated; MPL4 is factory set as disabled.

28.1.2. Structure of the Virtual Digital Outputs

A virtual digital output is composed of two logic blocks allowing data processing before implementing the actual digital output. Block 2 depends on the settings in parameters **P357a** (**P366a**, **P375a**, **P384a**).

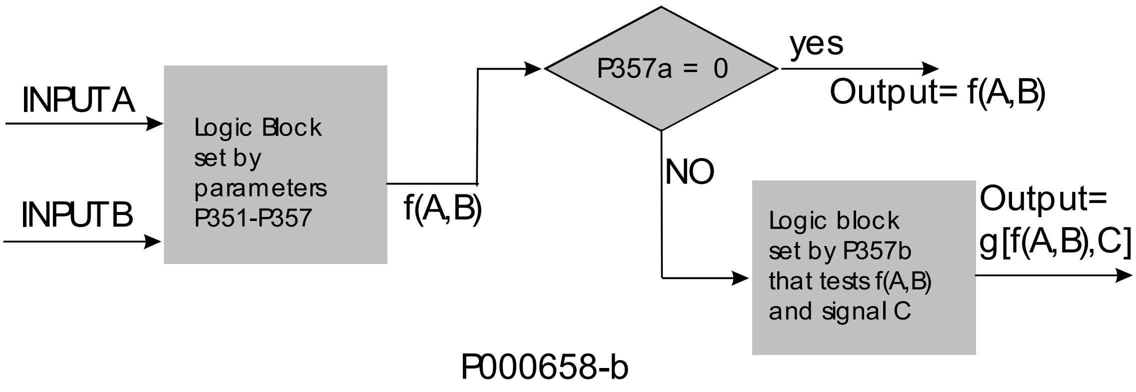


Figure 38: Block diagram of the virtual digital outputs (MPL).

<u>Operating modes set in MPL1 (2, 3, 4): P350, (P359, P368, P377)</u>

The user can select one of the following operating modes:

Table 52: Digital Output Modes.

DISABLING	The selected digital output is disabled.
DIGITAL	The digital output depends on a selected digital signal and on the logic output function (True/False).
DOUBLE DIGITAL	The digital output depends on 2 selected digital signals, on the logic function calculating the output value and on the logic output function (True/False).
ANALOG	The digital output depends on a selected analog variable, which is tested through Test A and Test B, thus obtaining 2 digital signals; starting from their value, the selected logic function calculates the output value, whereas the True/False logic output function calculates the end value.
DOUBLE ANALOG	The digital outputs depends on 2 selected analog variables: Test A is performed for variable A, whilst Test B is performed for variable B, thus obtaining 2 digital signals; starting from their value, the selected logic function calculates the output value, whereas the logic output function True/False calculates the end value.
DOUBLE FULL	As DOUBLE ANALOG or DOUBLE DIGITAL mode, but both digital signals and analog variables can be selected. If you select a digital signal, its value (TRUE or FALSE) is used to calculate the selected logic function. If you select an analog variable, the test selected for this variable is performed, and its result (TRUE or FALSE) is used to calculate the selected logic function.
BRAKE	As ABS BRAKE below, although the selected variables are not expressed as absolute values, but depend on the selected tests.
ABS BRAKE	The ABS BRAKE mode allows controlling the electromechanical brake of a motor used for lifting applications. To enable the relevant output, make sure that all the conditions depending on the drive status are true (see the description at the end of this section). The ABS BRAKE mode is applied by selecting the measured (or estimated) speed value [51] as variable A and the output torque [60] as variable B. Variables are considered as absolute values.
ABS LIFT	As ABS BRAKE, but the brake unlocks (digital output open) when a given torque value is attained, which is automatically determined based on the last torque value required in the previous stroke.

<u>Variable A Selected for MPL1 (2, 3, 4): P351, (P360, P369, P378)</u>

Selects the digital signal or the analog variable used for Test A (set with **P353** / **P362** / **P371** / **P380**).
The whole list of the selectable items and their description are stated in Table 39.
If a digital signal is selected, Test A is not performed: therefore, the comparison value for Test A (set with **P355** / **P364** / **P373** / **P382**) has no meaning.

NOTE — This parameter can be accessed only if the operating mode of the digital output concerned is other than zero. Example: MPL1 **P350**≠0.

<u>Variable B selected for MPL1 (2, 3, 4): P352, (P361, P370, P379)</u>

This selects a different digital signal or the analog variable used for Test B (set with **P354** / **P363** / **P372** / **P381**).
The whole list of the selectable items and their description are stated in Table 39.

If a digital signal is selected, Test B is not performed: therefore, the comparison value for Test B (set with **P356** / **P365** / **P374** / **P383**) has no meaning.

NOTE — Parameter **P352** cannot be accessed if the operating mode of the virtual digital output concerned is 3 or 9 . Example: MPL1 **P350**=3 OR **P350**=9.

<u>Testing Variable A for MPL1 (2, 3, 4): P353, (P362, P371, P380)</u>

If an analog variable is selected, a logic TEST is performed to obtain a TRUE/FALSE Boolean signal.
Seven different tests are available, that can be performed for selected variable A and its comparing value A:

Table 53: Test functions.

GREATER THAN	Selected variable > comparing value
GREATER THAN/EQUAL TO	Selected variable ≥ comparing value
LOWER	Selected variable < comparing value
LOWER THAN/EQUAL TO	Selected variable ≤ comparing value
ABS, GREATER THAN	Absolute value (selected variable) > comparing value
ABS, GREATER THAN/EQUAL TO	Absolute value (selected variable) ≥ comparing value
ABS, LOWER	Absolute value (selected variable) < comparing value
ABS, LOWER THAN/EQUAL TO	Absolute value (selected variable) ≤ comparing value

NOTE This parameter can be accessed only if the operating mode of the selected digital output is > 2. Example: MPL1 **P350**>2.

<u>Testing variable B for MPL1 (2, 3, 4): P354, (P363, P372, P381)</u>

If an analog variable is selected, a logic TEST is performed to obtain a TRUE/FALSE Boolean signal.
Seven different tests are available, that can be performed for selected variable B and its comparing value B (see Table 39).

NOTE This parameter can be accessed only if the operating mode of the selected digital output is > 2 and < 9. Example: MPL1 2<**P350**<9.

<u>Reference threshold for P351 (P360, P369, P378) in MPL1: P355, (P364, P373, P382)</u>

Defines the comparing value of Test A with the first selected variable.

NOTE This parameter can be accessed only if the operating mode of the selected digital output is > 2. Example: MPL1 **P350**>2.

<u>Reference threshold for P352 (P361, P370, P379) in MPLx: P356, (P365, P374, P383)</u>

Defines the comparing value of Test B with the first selected variable.

NOTE This parameter can be accessed only if the operating mode of the selected digital output is > 2. Example: MPL1 **P350**>2.

MPL1: Function applied to the result of Tests A and B: P357, (P366, P375, P384)

A logic function is applied to the two Boolean signals obtained in order to obtain the output TRUE/FALSE Boolean signal. Six different tests may be performed for variable (A) using the comparing value and variable (B).

(A) OR (B): The selected digital output is enabled when at least one of the two conditions below is true (this function also allows enabling the selected digital input based on one test only).

(A) OR (B)		
Test A	Test B	Output
0	0	0
1	0	1
0	1	1
1	1	1

(A) SET (B) RESET: The selected digital output is activated as the output of a Flip Flop Set Reset whose inputs are signal A and signal B. This function can be used in case of hysteresis. The output status (Q) depends on the previous value (Q hold) and on the result of the two tests. Test A is the Set command; Test B is the Reset command.
Example: Suppose that the output enables only when the motor speed exceeds 50rpm and disables when the motor speed drops below 5 rpm. To do so, assign the first condition to Test A, representing the Set command for Flip Flop (**P351** = Motor Speed, **P353** >, **P355** = 50rpm), and assign the second condition to Test B, representing the Reset command (**P352** = Motor Speed, **P354** ≤, **P356** = 5rpm). A more detailed example is given at the end of this section.

Flip Flop Set Reset			
Q hold	Test A (Set)	Test B (Reset)	Output Q
0	0	1	0
0	0	0	0
0	1	1	0
0	1	0	1
1	0	1	0
1	0	0	1
1	1	1	1
1	1	0	1

(A) AND (B): The selected digital output enables when both conditions are true.

(A) AND (B)		
Test A	Test B	Output
0	0	0
1	0	0
0	1	0
1	1	1

(A) XOR (B): The selected digital output enables when either one condition or the other is true (but not when both conditions are true at a time).

(A) XOR (B)		
Test A	Test B	Output
0	0	0
1	0	1
0	1	1
1	1	0

<u>(A) NOR (B)</u>: The selected digital output enables when no condition is true. The NOR function between two variables corresponds to the AND of the same false variables, i.e. (A) NOR (B) = (/A) AND (/B).

(A) NOR (B)		
Test A	Test B	Output
0	0	1
1	0	0
0	1	0
1	1	0

<u>(A) NAND (B)</u>: The selected digital output enables when no condition is true or when only one of the two conditions is true. The NAND function between two variables corresponds to the OR of the same false variables, i.e. (A) NAND (B) = (/A) OR (/B).

(A) NAND (B)		
Test 1	Test 2	Output
0	0	1
1	0	1
0	1	1
1	1	0

NOTE — This parameter can be accessed only if the operating mode of the selected digital output is > 2 and <9. Example: MPL1 2<**P350**<9.

<u>Function applied to the result of f(A,B) C for MPL1: P357a, (P366a, P375a, P384a)</u>

Once the Boolean signal resulting from f(A,B) is obtained, an additional logic function can be applied to obtain the output TRUE//FALSE Boolean signal.
If parameter **P357a** is disabled, the output of f(A,B) goes directly to the corresponding digital output; if parameter **P357a** is enabled, the output of the output of f(A,B) becomes one of the two inputs of the second programmed block.
The user can choose one of the six Boolean tests above for the first variable—f(A,B)—and for the second variable (C).

<u>Logic applied to MPL1 (2, 3,4): P358, (P367, P376, P385)</u>
The logic of the Boolean signal can be reversed at the end of the processing chain.
The user can choose whether the logic level of the digital output is POSITIVE or NEGATIVE.
(0) FALSE = a logic negation is applied (NEGATIVE logic).
(1) TRUE = no negation is applied (POSITIVE logic).

NOTE — This parameter can be accessed only if the operating mode of the selected digital output is other than zero. Example: MPL1 **P350**≠0

NOTE — Please refer to Programmable Operating Modes (Diagrams) relating to the digital outputs.

28.2. Operating Diagram of the Virtual Digital Outputs

Virtual digital outputs are software outputs that can be used as digital inputs from the following items:

- digital inputs
- digital outputs
- auxiliary digital outputs
- virtual digital outputs themselves.

They can be used for special functionality of the system, thus avoiding loop wiring on the same control board.

Example:

It can be necessary to control the state of the hardware ENABLE contact of the system to cause an external alarm to trip when MPL1 is selected in parameter C164 (DIGITAL INPUTS MENU).

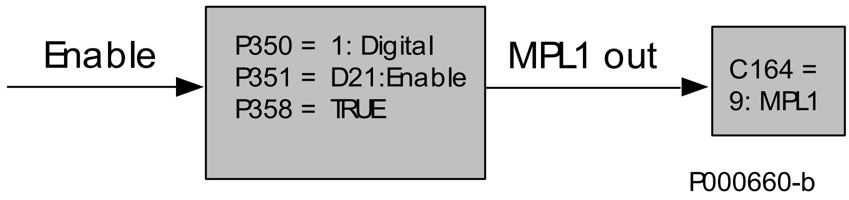


Figure 39: Example of MPL functionality.

For more details about possible configurations of the virtual digital outputs, see Programmable Operating Modes (Diagrams).

Examples

This section covers some examples for the supervision of pumping systems with the PID control algorithm.
The settings of the parameters being used are given in the tables below: the parameters highlighted in grey have no effect.

Example 1: Dry Run Detection

For most pumps, especially submersible bore-hole pumps, it must be assured that the pump is stopped in case of dry run. This is assured by the Dry Run Detection feature. How Does It Work?
Dry run detection is based on power/frequency monitoring. Stop (trip) due to dry run is initiated under the following conditions:

Table 54: MPL parameterization for Dry Run Detection.

P359	MPL2: Digital output mode	DOUBLE ANALOG
P360	MPL2: Selecting variable A	A67: Output Power
P361	MPL2: Selecting variable B	A76: PID Feedback
P362	MPL2: Testing variable A	<
P363	MPL2: Testing variable B	<
P364	MPL2: Comparing value for Test A	Min. operating PWR [*]
P365	MPL2: Comparing value for Test B	Min. FBK value [*]
P366	MPL2: Function applied to the result of the 2 tests	(A) AND (B)
P366a	MPL2: Selecting variable C	D11: PID Out Max
P366b	MPL2: Function applied to the result of f(A,B) C	f(A,B) AND (C)
P367	MPL2: Output logic level	TRUE

NOTE It is recommended that a TIMEOUT be entered for Dry Run Detection. Enter a timeout for MPL2 output (see TIMERS MENU).

P368	MPL3: Digital output mode	DOUBLE ANALOG
P369	MPL3: Selecting variable A	A67: Output Power
P370	MPL3: Selecting variable B	A76: PID Feedback
P371	MPL3: Testing variable A	≥
P372	MPL3: Testing variable B	<
P373	MPL3: Comparing value for Test A	Min. operating PWR [*]
P374	MPL3: Comparing value for Test B	Min. FBK value [*]
P375	MPL3: Function applied to the result of the 2 tests	(A) AND (B)
P375a	MPL3: Selecting variable C	D51: MPL2
P375b	MPL3: Function applied to the result of f(A,B) C	f(A,B) OR (C)
P376	MPL3: Output logic level	TRUE

NOTE MPL3 detects when piping is clogged or faulty or when the delivery/pressure sensor is malfunctioning (e.g. the pump membrane is locked) when the sensor is located downstream of the mains.

P377	MPL4: Digital output mode	DOUBLE FULL
P378	MPL4: Selecting variable A	D51: MPL3
P379	MPL4: Selecting variable B	A76: PID Feedback
P380	MPL4: Testing variable A	
P381	MPL4: Testing variable B	≥
P382	MPL4: Comparing value for Test A	
P383	MPL4: Comparing value for Test B	Min. FBK value [*]
P384	MPL4: Function applied to the result of the 2 tests	(A) Set (B) Reset
P384a	MPL4: Selecting variable C	D0: Disabled
P384b	MPL4: Function applied to the result of f(A,B) C	
P385	MPL4: Output logic level	See steps 1. and 2. below

Virtual digital output MPL4 locks the system operation in two modes:

1. Virtually connecting the output to an external alarm input (P385=FALSE; C164=12: MPL4)
2. Disabling the PID (P385=TRUE; C171=12: MPL4)

On the other hand, when the malfunctioning signal is sent to the PLC supervisor, the same parameterization in MPL4 shall be entered in the digital output concerned.

NOTE

[*]
Min. Operating PWR = Min. power required for the pump delivery.
Min. FBK value = the min. feedback value shall be ≥ P237 (minimum PID).

NOTE

When the Sleep Mode (see PID PARAMETERS MENU) and the Dry Run Detection mode are activated simultaneously, the delay time for the Dry Run Detection mode shall be shorter than the Sleep Mode time.

Example 2: Pipe Fill Function.

The PIPE FILL function avoids water hammer in irrigation pipes. To avoid water hammer, pipes must be filled very slowly for air drainage. To do so, force a minimum rate reference, thus obtaining the minimum delivery of the pumping system. Once the min. rate is attained, the feedback starts increasing; when the filling pressure is attained, the system can start operating in normal conditions.

Table 55: MPL parameterization for Pipe Fill function.

P368	MPL3: Digital output mode	DOUBLE ANALOG
P369	MPL3: Selecting variable A	Analog input allocated to PID FBK
P370	MPL3: Selecting variable B	Analog input allocated to PID FBK
P371	MPL3: Testing variable A	<
P372	MPL3: Testing variable B	≥
P373	MPL3: Comparing value for Test A	PIPE FILL value [*]
P374	MPL3: Comparing value for Test B	PIPE FILL value [*]
P375	MPL3: Function applied to the result of the 2 tests	(A) Set (B) Reset
P375a	MPL3: Selecting variable C	D0: Disabled
P375b	MPL3: Function applied to the result of f(A,B) C	
P376	MPL3: Output logic level	TRUE

P377	MPL4: Digital output mode	DIGITAL
P378	MPL4: Selecting variable A	D51: MPL3
P379	MPL4: Selecting variable B	
P380	MPL4: Testing variable A	
P381	MPL4: Testing variable B	
P382	MPL4: Comparing value for Test A	
P383	MPL4: Comparing value for Test B	
P384	MPL4: Function applied to the result of the 2 tests	
P384a	MPL4: Selecting variable C	D0: Disabled
P384b	MPL4: Function applied to the result of f(A,B) C	
P385	MPL4: Output logic level	TRUE

P009	Acceleration time 1	Ramp for normal operation [*]
P010	Deceleration time 1	Ramp for normal operation [*]
P011	Acceleration time 2	Ramp for PIPE FILL [*]
P012	Deceleration time 2	Ramp for PIPE FILL [*]
P080	Multispeed function	0: Preset Speed
P081	Output speed 1 (Mspd1)	Min. operating speed [*]
C182	MDI Multiprogramming enable	Enabled
C155	MDI for multispeed 0 selection	12: MPL4
C167	MDI for multiramp 0 selection	9: MPL1
C171	MDI for PID disable	9: MPL1

NOTE

[*]
PIPE FILL value = Measure read from the analog input allocated to the feedback when pipes are full.
Ramp for normal operation = Ramp required for normal operation.
Ramp for PIPE FILL = Ramp required while filling the pipes.
Min. operating speed = Min. speed required for the correct delivery of the pump.

28.3. List of Parameters P350 to P385

Table 56: List of parameters P350 to P385.

Parameter	FUNCTION	User Level	DEFAULT VALUES	MODBUS Address
P350	MPL1: Digital output mode	ADVANCED	1: DIGITAL	950
P351	MPL1: Selecting variable A	ADVANCED	D21: MDI Enable	951
P352	MPL1: Selecting variable B	ADVANCED	D0: DISABLE	952
P353	MPL1: Testing variable A	ADVANCED	0: >	953
P354	MPL1: Testing variable B	ADVANCED	0: >	954
P355	MPL1: Comparing value for Test A	ADVANCED	0	955
P356	MPL1: Comparing value for Test B	ADVANCED	0	956
P357	MPL1: Function applied to the result of the 2 tests	ADVANCED	0: (A) OR (B)	957
P357a	MPL1: Selecting variable C	ADVANCED	0: Disable	932
P357b	MPL1: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	933
P358	MPL1: Output logic level	ADVANCED	1: TRUE	958
P359	MPL2: Digital output mode	ADVANCED	1: DIGITAL	959
P360	MPL2: Selecting variable A	ADVANCED	D33: Fan Fault	960
P361	MPL2: Selecting variable B	ADVANCED	D0: DISABLE	961
P362	MPL2: Testing variable A	ADVANCED	0: >	962
P363	MPL2: Testing variable B	ADVANCED	0: >	963
P364	MPL2: Comparing value for Test A	ADVANCED	0	964
P365	MPL2: Comparing value for Test B	ADVANCED	0	965
P366	MPL2: Function applied to the result of the 2 tests	ADVANCED	0: (A) OR (B)	966
P366a	MPL2: Selecting variable C	ADVANCED	0: Disable	934
P366b	MPL2: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	935
P367	MPL2: Output logic level	ADVANCED	1: TRUE	967
P368	MPL3: Digital output mode	ADVANCED	1: DIGITAL	968
P369	MPL3: Selecting variable A	ADVANCED	D38: Fire Mode	969
P370	MPL3: Selecting variable B	ADVANCED	D0: DISABLE	970
P371	MPL3: Testing variable A	ADVANCED	0: >	971
P372	MPL3: Testing variable B	ADVANCED	0: >	972
P373	MPL3: Comparing value for Test A	ADVANCED	0	973
P374	MPL3: Comparing value for Test B	ADVANCED	0	974
P375	MPL3: Function applied to the result of the 2 tests	ADVANCED	0: (A) OR (B)	975
P375a	MPL3: Selecting variable C	ADVANCED	0: Disable	936
P375b	MPL3: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	937
P376	MPL3: Output logic level	ADVANCED	1: TRUE	976
P377	MPL4: Digital output mode	ADVANCED	0: DISABLE	977
P378	MPL4: Selecting variable A	ADVANCED	D0: DISABLE	978
P379	MPL4: Selecting variable B	ADVANCED	D0: DISABLE	979
P380	MPL4: Testing variable A	ADVANCED	0: >	980
P381	MPL4: Testing variable B	ADVANCED	0: >	981
P382	MPL4: Comparing value for Test A	ADVANCED	0	982
P383	MPL4: Comparing value for Test B	ADVANCED	0	983
P384	MPL4: Function applied to the result of the 2 tests	ADVANCED	0: (A) OR (B)	984
P384a	MPL4: Selecting variable C	ADVANCED	0: Disable	938
P384b	MPL4: Function applied to the result of f(A,B) C	ADVANCED	0: f(A,B) OR C	939
P385	MPL4: Output logic level	ADVANCED	1: TRUE	985

P350 MPL1: Digital Output Mode

P350	Range	0 ÷ 8	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT
	Default	1	1: DIGITAL
	Level	ADVANCED	
	Address	950	
	Function	This parameter defines the operating mode of **virtual digital output 1**. The different operating modes are described at the beginning of this chapter.	

NOTE

MPL1 Digital output can be programmed only if the frequency output is not set up: **P200** = Disable (see ANALOG AND FREQUENCY OUTPUTS MENU).

P351 MPL1: Selecting Variable A

P351	Range	0 ÷ 119	See Table 39
	Default	21	D21: MDI Enable
	Level	ADVANCED	
	Address	951	
	Function	This parameter selects the digital signal used to calculate the value of **MPL1** digital output. It selects an analog variable used to calculate the value of **MPL1** digital output if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P352 MPL1: Selecting Variable B

P352	Range	0 ÷ 119	See Table 39
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	952	
	Function	This parameter selects the second digital signal used to calculate the value of **MPL1** digital output. It selects an analog variable used to calculate the value of **MPL1** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P353 MPL1: Testing Variable A

P353	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	953	
	Function	This parameter defines the test to be performed for the variable detected by **P351** using **P355** as a comparing value.	

P354 MPL1: Testing Variable B

P354	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	954	
	Function	This parameter defines the test to be performed for the variable detected by **P352** using **P356** as a comparing value.	

P355 MPL1: Comparing Value for Test A

P355	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A*, see Table 39
	Default	0	0
	Level	ADVANCED	
	Address	955	
	Function	This parameter defines the comparing value with the selected variable for test A.	

P356 MPL1: Comparing Value for Test B

P356	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B*, see Table 39
	Default	0	0
	Level	ADVANCED	
	Address	956	
	Function	This parameter defines the comparing value with the selected variable for test B.	

P357 MPL1: Function Applied to the Result of the 2 Tests

P357	Range	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	0	0: (A) OR (B)
	Level	ADVANCED	
	Address	957	
	Function	This parameter determines the logic function applied to the result of the tests allowing calculating the output value.	

P357a MPL1: Selecting Variable C

P357a	Range	0 ÷ 59	See Table 39
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	932	
	Function	This parameter selects the digital signal used to calculate the value of **MPL1** digital output. The digital signals that can be selected are given in Table 39.	

P357b MPL1: Function Applied to the Result of f(A,B) C

P357b	Range	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: f(A,B)\ OR (C) 7: f(A,B) OR (C\) 8: f(A,B)\ AND (C) 9: f(A,B) AND (C\) 10: f(A,B) RESET (C) SET RISING EDGE 11: f(A,B) SET (C) RESET FALLING EDGE 12: f(A,B) RESET (C) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	933	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P358 MPL1: Output Logic Level

P358	Range	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ADVANCED	
	Address	958	
	Function	MPL1 digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P359 MPL2: Digital Output Mode

P359	Range	0 ÷ 8	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT
	Default	1	1: DIGITAL
	Level	ADVANCED	
	Address	959	
	Function	This parameter defines the operating mode of **virtual digital output 2.** The different operating modes are described at the beginning of this chapter.	

P360 MPL2: Selecting Variable A

P360	Range	0 ÷ 119	See Table 39
	Default	33	D33: Fan Fault
	Level	ADVANCED	
	Address	960	
	Function	This parameter selects the digital signal used to calculate the value of **MPL2** digital output. It selects an analog variable used to calculate the value of **MPL2** digital input if one of the "analog" operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P361 MPL2: Selecting Variable B

P361	Range	0 ÷ 119	See Table 39
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	961	
	Function	This parameter selects the second digital signal used to calculate the value of **MPL2** digital output. It selects an analog variable used to calculate the value of **MPL2** digital input if one of the "analog" operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P362 MPL2: Testing Variable A

P362	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	362	
	Function	This parameter defines the test to be performed for the variable detected by **P360** using **P364** as a comparing value.	

P363 MPL2: Testing Variable B

P363	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	963	
	Function	This parameter defines the test to be performed for the variable detected by **P361** using **P365** as a comparing value.	

P364 MPL2: Comparing Value for Test A

P364	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A,* see Table 39
	Default	0	0
	Level	ADVANCED	
	Address	964	
	Function	This parameter defines the comparing value with the selected variable for test A.	

P365 MPL2: Comparing Value for Test B

P365	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B,* see Table 39
	Default	0	0
	Level	ADVANCED	
	Address	965	
	Function	This parameter defines the comparing value with the selected variable for test B.	

P366 MPL2: Function Applied to the Result of the 2 Tests

P366	Range	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	966	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P366a MPL2: Selecting Variable C

P366a	Range	0 ÷ 59	See Table 39
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	934	
	Function	This parameter selects the digital signal used to calculate the value of **MPL2** digital output. The digital signals that can be selected are given in Table 39.	

P366b MPL2: Function Applied to the Result of f(A,B) C

P366b	Range	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	935	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P367 MPL2: Output Logic Level

P367	Range	0–1	0: FALSE 1: TRUE
	Default	1	1: TRUE
	Level	ADVANCED	
	Address	967	
	Function	MPL2 digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P368 MPL3: Digital Output Mode

P368	Range	0 ÷ 8	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT
	Default	1	1: DIGITAL
	Level	ADVANCED	
	Address	968	
	Function	This parameter defines the operating mode of **virtual digital output 3**. The different operating modes are described at the beginning of this chapter.	

P369 MPL3: Selecting Variable A

P369	Range	0 ÷ 119	See Table 39
	Default	38	D38: Fire Mode
	Level	ADVANCED	
	Address	969	
	Function	This parameter selects the digital signal used to calculate the value of **MPL3** digital output. It selects an analog variable used to calculate the value of **MPL3** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P370 MPL3: Selecting Variable B

P370	Range	0 ÷ 119	See Table 39
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	970	
	Function	This parameter selects the second digital signal used to calculate the value of **MPL3** digital output. It selects an analog variable used to calculate the value of digital input **MPL3** if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P371 MPL3: Testing Variable A

P371	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	971	
	Function	This parameter defines the test to be performed for the variable detected by **P369** using **P373** as a comparing value.	

P372 MPL3: Testing Variable B

P372	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	972	
	Function	This parameter defines the test to be performed for the variable detected by **P370** using **P374** as a comparing value.	

P373 MPL3: Comparing Value for Test A

P293	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A*, see Table 39
	Default	0	0
	Level	ADVANCED	
	Address	973	
	Function	This parameter defines the comparing value with the variable selected for test A.	

P374 MPL3: Comparing Value for Test B

P374	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B*, see Table 39
	Default	0	0
	Level	ADVANCED	
	Address	974	
	Function	This parameter defines the comparing value with the variable selected for test B.	

P375 MPL3: Function Applied to the Result of the 2 Tests

P375	Range	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	0	0: (A) OR (B)
	Level	ADVANCED	
	Address	975	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P375a MPL3: Selecting Variable C

P375a	Range	0 ÷ 59	See Table 39
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	936	
	Function	This parameter selects the digital signal used to calculate the value of **MPL3** digital output. The digital signals that can be selected are given in see Table 39.	

P375b MPL3: Function Applied to the Result of f(A,B) C

P375b	Range	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: f(A,B)\ OR (C) 7: f(A,B) OR (C\) 8: f(A,B)\ AND (C) 9: f(A,B) AND (C\) 10: f(A,B) RESET (C) SET RISING EDGE 11: f(A,B) SET (C) RESET FALLING EDGE 12: f(A,B) RESET (C) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	937	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P376 MPL3: Output Logic Level

P376	Range	0–1	0: TRUE 1: FALSE
	Default	1	1: TRUE
	Level	ADVANCED	
	Address	976	
	Function	MPL3 digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

P377 MPL4: Digital Output Mode

P377	Range	0 ÷ 8	0: DISABLE 1: DIGITAL 2: DOUBLE DIGITAL 3: ANALOG 4: DOUBLE ANALOG 5: DOUBLE FULL 6: BRAKE 7: ABS BRAKE 8: ABS LIFT
	Default	1	1: DIGITAL
	Level	ADVANCED	
	Address	977	
	Function	This parameter defines the operating mode of **virtual digital output 4**. The different operating modes are described at the beginning of this chapter.	

P378 MPL4: Selecting Variable A

P378	Range	0 ÷ 119	See Table 39
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	978	
	Function	This parameter selects the digital signal used to calculate the value of **MPL4** digital output. It selects an analog variable used to calculate the value of **MPL4** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P379 MPL4: Selecting Variable B

P379	Range	0 ÷ 119	See Table 39
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	979	
	Function	This parameter selects the second digital signal used to calculate the value of **MPL4** digital output. It selects an analog variable used to calculate the value of **MPL4** digital input if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 39.	

P380 MPL4: Testing Variable A

P380	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	980	
	Function	This parameter defines the test to be performed for the variable detected by **P378** using **P382** as a comparing value.	

P381 MPL4: Testing Variable B

P381	Range	0 ÷ 7	0: > 1: ≥ 2: < 3: ≤ 4: ABS(x) > 5: ABS(x) ≥ 6: ABS(x) < 7: ABS(x) ≤
	Default	0	0: >
	Level	ADVANCED	
	Address	981	
	Function	This parameter defines the test to be performed for the variable detected by **P379** using **P383** as a comparing value.	

P382 MPL4: Comparing Value for Test A

P382	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable A*, see Table 39
	Default	0	0
	Level	ADVANCED	
	Address	982	
	Function	This parameter defines the comparing value with the selected variable for test A.	

P383 MPL4: Comparing Value for Test B

P383	Range	–32000 ÷ 32000	–320.00 % ÷ 320.00 % *% of the full-scale value of selected variable B*, see Table 39
	Default	0	0
	Level	ADVANCED	
	Address	983	
	Function	This parameter defines the comparing value with the selected variable for test B.	

P384 MPL4: Function Applied to the Result of the 2 Tests

P384	Range	0 ÷ 12	0: (A) OR (B) 1: (A) SET (B) RESET 2: (A) AND (B) 3: (A) XOR (B) 4: (A) NOR (B) 5: (A) NAND (B) 6: (A\) OR (B) 7: (A) OR (B\) 8: (A\) AND (B) 9: (A) AND (B\) 10: (A) RESET (B) SET RISING EDGE 11: (A) SET (B) RESET FALLING EDGE 12: (A) RESET (B) SET FALLING EDGE
	Default	0	0: (A) OR (B)
	Level	ADVANCED	
	Address	984	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P384a MPL4: Selecting Variable C

P384a	Range	0 ÷ 59	See Table 39
	Default	0	D0: Disable
	Level	ADVANCED	
	Address	938	
	Function	This parameter selects the digital signal used to calculate the value of **MPL4** digital output. The digital signals that can be selected are given in Table 39.	

P384b MPL4: Function Applied to the Result of f(A,B) C

P384b	Range	0 ÷ 12	0: f(A,B) OR (C) 1: f(A,B) SET (C) RESET RISING EDGE 2: f(A,B) AND (C) 3: f(A,B) XOR (C) 4: f(A,B) NOR (C) 5: f(A,B) NAND (C) 6: f(A,B)\ OR (C) 7: f(A,B) OR (C\) 8: f(A,B)\ AND (C) 9: f(A,B) AND (C\) 10: f(A,B) RESET (C) SET RISING EDGE 11: f(A,B) SET (C) RESET FALLING EDGE 12: f(A,B) RESET (C) SET FALLING EDGE
	Default	1	1: (A) SET (B) RESET
	Level	ADVANCED	
	Address	939	
	Function	This parameter determines the logic function applied to the result of the two tests allowing calculating the output value.	

P385 MPL4: Output Logic Level

P385	Range	0–1	0: TRUE 1: FALSE
	Default	1	1: TRUE
	Level	ADVANCED	
	Address	985	
	Function	MPL4 digital output logic function to apply a logic reversal (negation) to the calculated output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

29. INPUTS FOR REFERENCES FROM OPTIONAL BOARD

This menu relates to ES847 I/O expansion board. It can be viewed only if **R023** (I/O board setting) = XAIN (see the EXPANSION BOARD CONFIGURATION MENU).
In addition to the analog inputs located on ES821 control board, a current analog input and a voltage analog input can be acquired if ES847 is fitted.

29.1. Scaling Analog Inputs XAIN4, XAIN5

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

Two analog inputs (XAIN4, XAIN5) are located on ES847 control board.
XAIN4 is a current input and XAIN5 is a voltage input. They are both bipolar analog inputs (–10V ÷ +10V or –20mA ÷ +20mA).
For both analog inputs, parameters **P390** to **P399** allow setting the type of signal to be acquired, offset compensation (if any), scaling to obtain a speed reference or a torque reference, the signal filtering time constant.
Parameter **P393** sets the offset of the input analog signal (if **P393**=0 offset is zero), while parameter **P394** defines the filtering time constant (factory setting: **P394** = 100ms).
The voltage signal can be bipolar (**–10V ÷ +10V**) or unipolar (**0V ÷ +10V**).
The current signal can be bipolar (**–20mA ÷ +20mA**), unipolar (**0mA ÷ +20mA**) or can have a minimum offset (**4mA ÷ 20mA**).
The user will set each analog input mode in parameters **P390, P395.**

Table 57: Analog input hardware mode.

Type / Terminals	Name	Type	Parameter
Differential input / Pin 11,12	XAIN4	±10V Input	P390
Differential input / Pin 13,14	XAIN5	±20mA Input	P395

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

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

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

The ordinates of the two points are the following:
the value of **Speed_Min** (or **Trq_Min** for the torque reference) multiplied by the percentage set with **P391a/P396a** for the **first point**; the value of **Speed_Max** (or **Trq_Max** for the torque reference) multiplied by the percentage set with **P392a/P397a** for the **second point**.

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

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

The X-axis values of the two points depend on the analog input:

XAIN4 Input:
Parameter **P391** is the X-axis of the **first point**; parameter **P392** is the X-axis of the **second point.**

XAIN5 Input:
Parameter **P396** is the X-axis of the **first point**; parameter **P397** is the X-axis of the **second point.**

(see also Scaling Analog Inputs REF, AIN1, AIN2).

29.2. List of parameters P390 to P399

Table 58: List of parameters P390 to P399.

Parameter	FUNCTION	User Level	DEFAULT VALUE	MODBUS Address
P390	Type of signal over **XAIN4** input	ADVANCED	1:0÷10V	990
P391	Value of **XAIN4** input producing min. reference (X-axis)	ADVANCED	0.0V	991
P391a	Percentage of Speed_Min/Trq_Min producing min. reference (Y-axis related to **P391**)	ADVANCED	100.0%	704
P392	Value of **XAIN4** input producing max. reference (X-axis)	ADVANCED	10.0V	992
P392a	Percentage of Speed_Max/Trq_Max producing max. reference (Y-axis related to **P392**)	ADVANCED	100.0%	710
P393	Offset over **XAIN4** input	ADVANCED	0V	993
P394	Filtering time over **XAIN4** input	ADVANCED	100ms	994
P395	Type of signal over **XAIN5** input	ADVANCED	3: 4÷20mA	995
P396	Value of **XAIN5** input producing min. reference (X-axis)	ADVANCED	4.0mA	996
P396a	Percentage of Speed_Min/Trq_Min producing min. reference (Y-axis related to **P396**)	ADVANCED	100.0%	711
P397	Value of **XAIN5** input producing max. reference (X-axis)	ADVANCED	20.0mA	997
P397a	Percentage of Speed_Min/Trq_Min producing min. reference (Y-axis related to **P397**)	ADVANCED	100.0%	712
P398	Offset over **XAIN5** input	ADVANCED	0mA	998
P399	Filtering time over **XAIN5** input	ADVANCED	100 ms	999

<u>P390 Type of Signal over XAIN4 Input</u>

P390			
	Range	0 ÷ 1	0: ± 10 V 1: 0 ÷ 10 V
	Default	1	1:0÷10V
	Level	ADVANCED	
	Address	990	
	Function	This parameter selects the type of single–ended, analog signal over XAIN4 terminal in the terminal board. The signal can be a voltage signal, a unipolar signal, or a bipolar signal. **0:** ± 10 V Bipolar voltage input between –10V and +10V. The detected signal is saturated between these two values. 1: 0 ÷ 10 V Unipolar voltage input between 0V and +10V. The detected signal is saturated between these two values.	

P391 Value of XAIN4 Input Producing Min. Reference

P391	Range	–100 ÷ 100, if **P390** = 0 0 ÷ 100, if **P390** = 1	–10.0 V ÷ 10.0 V, if **P390** = 0: ± 10 V 0.0 V ÷ 10.0V, if **P390** = 1: 0 ÷ 10 V
	Default	0	0.0V
	Level	ADVANCED	
	Address	991	
	Function	This parameter selects the value for XAIN4 input signal for minimum reference, or better the reference set in **C028 xP391a** (Master mode) or in **C047xP391a** (Slave mode). If motor 2 is active, **C071** and **C090** will be used instead of **C028** and **C047**; if motor 3 is active, the values set in **C114** and **C133** will be used.	

P391a Percentage of Speed_Min/Trq_Min. Producing Min. Reference (Y-axis related to P391)

P391a	Range	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	704	
	Function	This parameter represents the min. speed percentage (or the min. torque percentage for a torque reference) to be used for the minimum reference set with **P391**.	

P392 Value of XAIN4 Input Producing Max. Reference (X-axis)

P392	Range	–100 ÷ 100, if **P390** = 0 0 ÷ 100, if **P390** = 3	–10.0 V ÷ 10.0 V, if **P390** = 0: ± 10 V 0.0 V ÷ 10.0V, if **P390** = 1: 0 ÷ 10 V
	Default	100	+10.0V
	Level	ADVANCED	
	Address	992	
	Function	This parameter selects the value for XAIN4 input signal for maximum reference, or better the reference set in **C029xP392a** (Master mode) or in **C048xP392a** (Slave mode). If motor 2 is active, **C072** and **C091** will be used instead of **C029** and **C048**; if motor 3 is active, the values set in **C115** and **C134** will be used.	

P392a Percentage of Speed_Max/Trq_Max Producing Max. Reference (Y-axis related to P392)

P392a	Range	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	710	
	Function	This parameter represents the max. speed percentage (or the max. torque percentage for a torque reference) to be used for the maximum reference set with **P392**.	

P393 Offset over XAIN4 Input

P393	Range	–1000 ÷ 1000	–10.00 V ÷ +10.00 V
	Default	0	0.00 V
	Level	ADVANCED	
	Address	993	
	Function	This parameter selects the offset correction value of the XAIN4 analog signal that has been measured. The value set is added to the signal measured before saturation or conversion; its unit of measure is the same as the one of the signal selected for XAIN4 analog input.	

P394 Filtering Time over XAIN4 Input

P394	Range	0 ÷ +65000	0 ÷ +65000ms
	Default	100	100 ms
	Level	ADVANCED	
	Address	994	
	Function	This parameter selects the value of the filter time constant of the first command applied to the XAIN4 input signal when the signal saturation and conversion is over.	

P395 Type of Signal over XAIN5 Input

P395	Range	2 ÷ 4	2: ± 20 mA 3: 4 ÷ 20 mA 4: 0 ÷ 20 mA
	Default	3	3: 4 ÷ 20 mA
	Level	ADVANCED	
	Address	995	
	Function	This parameter selects the type of differential analog signal over terminals **XAIN5+** and **XAIN5–** in the terminal board. The signal can be a current signal, a unipolar signal, or a bipolar signal. **2:** ±20 mA Bipolar current input between –20mA and +20mA. The detected signal is saturated between these two values. **3:** 4 ÷ 20 mA Unipolar current input with min. threshold, between +4 mA and +20mA. The detected signal is saturated between these two values. Before being saturated, if the detected signal is lower than 4 mA or greater than 20 mA, alarms **A069** or **A086** trip. **4:** 0 ÷ 20 mA Unipolar current input between +0 mA and +20mA. The detected signal is saturated between these two values.	

P396 Value of XAIN5 Producing Min. Reference (X-axis

P396	Range	–200 ÷ 200, if **P055** = 2 +40 ÷ 200, if **P055** = 3 0 ÷ 200, if **P055**= 4	–20.0 mA ÷ 20.0 mA, if **P395** = 2: ± 20 mA +4.0mA ÷ 20.0 mA, if **P395** = 3: 4 ÷ 20 mA 0.0 mA ÷ 20.0 mA, if **P395** = 4: 0 ÷ 20 mA
	Default	40	+4.0mA
	Level	ADVANCED	
	Address	996	
	Function	This parameter selects the value for XAIN5 input signal for minimum reference, or better the reference set in **C028xP396a** (Master mode) or in **C047xP396a** (Slave mode). If motor 2 is active, **C071** and **C090** will be used instead of **C028** and **C047**; if motor 3 is active, the values set in **C114** and **C133** will be used.	

P396a Percentage of Speed_Min/Trq_Min Producing Min. Reference (Y-axis related to P396)

P396a	Range	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	711	
	Function	This parameter represents the min. speed percentage (or the min. torque percentage for a torque reference) to be used for the minimum reference set with P396.	

P397 Value of XAIN5 Input Producing Max. Reference (X-axis)

P397			
	Range	–200 ÷ 200, if **P055** = 2 +40 ÷ 200, if **P055** = 3 0 ÷ 200, if **P055** = 4	–20.0 mA ÷ 20.0 mA, if **P055** = 2: ± 20 mA +4.0mA ÷ 20.0 mA, if **P055** = 3: 4 ÷ 20 mA 0.0 mA ÷ 20.0 mA, if **P055** = 4: 0 ÷ 20 mA
	Default	200	+20.0mA
	Level	ADVANCED	
	Address	997	
	Function	This parameter selects the value for XAIN5 input signal for maximum reference, or better the reference set in **C029xP397a** (Master mode) or in **C048xP397a** (Slave mode). If motor 2 is active, **C072** and **C091** will be used instead of **C029** and **C048**; if motor 3 is active, the values set in **C115** and **C134** will be used.	

P397a Percentage of Speed_Min/Trq_Min Producing Min. Reference (Y-axis related to P397)

P397a			
	Range	0 ÷ 1000	100.0%
	Default	1000	100.0%
	Level	ADVANCED	
	Address	712	
	Function	This parameter represents the min. speed percentage (or the max. torque percentage for a torque reference) to be used for the maximum reference set with **P397**.	

P398 Offset over XAIN5 Input

P398			
	Range	–2000 ÷ 2000	– 20.00 mA ÷ +20.00 mA
	Default	0	0 mA
	Level	ADVANCED	
	Address	998	
	Function	This parameter selects the offset correction value of XAIN5 analog signal that has been measured. The value set is added to the signal measured before saturation or conversion; its unit of measure is the same as the one of the signal selected for XAIN5 analog input.	

P399 Filtering Time over XAIN5 Input

P399			
	Range	0 ÷ +65000	0 ÷ +65000ms
	Default	100	100 ms
	Level	ADVANCED	
	Address	999	
	Function	This parameter selects the value of the filter time constant of the first command applied to XAIN5 input signal when the signal saturation and conversion is over.	

30. AUTOTUNE MENU

30.1. Overview

NOTE See the FIRST STARTUP section for tuning based on the control algorithm to be used.

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

NOTE Autotune must be performed only after entering the motor ratings or the ratings of the encoder used as a speed feedback. Please refer to the MOTOR CONTROL MENU and the ENCODER/FREQUENCY INPUTS MENU.

The selected motor may be tuned in order to obtain the machine ratings or the parameterization required for the correct functioning of the control algorithms. The user can also check the proper operation/wiring of the encoder used as a speed feedback.

The Autotune menu includes two programming inputs, I073 and I074. Input I073 allows enabling and selecting the type of autotune. Input I074—which can be programmed only if I073 = Motor Tune— describes the type of autotune which is performed. Because the values set in I073 or I074 cannot be changed once for all and are automatically reset after autotuning, the ENABLE signal must be disabled and the ESC key must be used to accept the new value.

30.1.1. Motor Autotune and Adjusting Loops

Set I073 as Motor Tune to enable autotune functions that can be selected with I074.

NOTE For the correct operation of the tuning algorithms, enter the motor ratings and the ratings of the encoder used as a speed feedback. Please refer to the MOTOR CONTROL MENU and the ENCODER/FREQUENCY INPUTS MENU.

Table 59: Programmable "Motor Tune" functions.

I074 Setting	Motor Rotation	Type of Tune
0: all Ctrl no rotation	No	**Automatic** estimation of the stator resistance and the leakage inductance. If no-load current (C018) is zero, no-load current values are computed based on the rated power of the connected motor. Tuning mode required for the correct operation of the control algorithms.
1: FOC Auto no rotation	No	**Automatic** autotune of the current loop. Tuning mode required for the correct operation of FOC algorithm. If autotune of the current loop fails (Alarm **A065** Autotune KO trips), the current loop may be manually tuned (see 4: FOC Man rotation (current)). While autotuning, the system can monitor the reference current and the current obtained in analog outputs AO2 and AO1 respectively.
2: FOC. Auto + rotation	Yes	**Automatic** estimation of the rotor time constant. Tuning mode required for the correct operation of FOC algorithm. After entering the correct no-load current value (parameters **C021**, **C064**, **C107** for motors M1, M2 and M3 respectively) and tuning the current loop, the system can measure the rotor time constant for no-load rotation of the connected motor up to 90% of its constant speed.
3: VTC/FOC Man rotation (speed)	Yes	**Manual** tune of the current loop. Analog outputs AO1 and AO2 are displayed, showing the speed reference and the speed value obtained with the preset parameters of the speed regulator (see the SPEED LOOP AND CURRENT BALANCING MENU). Set the current regulator's parameters in order to reduce to a minimum the difference between the two waveforms.
4: FOC Man no rotation (current)	No	**Manual** tune of the current loop. If automatic tuning 1: FOC Auto no rotation fails, the current loop may be manually tuned. Display analog outputs AO1 and AO2, showing the current reference value and the current value measured. Set the current regulator's parameters (see the FOC REGULATORS MENU) in order to reduce to a minimum the difference between the two waveforms.
5: FOC Man no rotation (flux)	No	**Manual** tune of the flux loop. The correct parameters of the flux regulator are calculated whenever the rotor time constant value changes (see 2: FOC Auto rotation). However, you can manually tune the flux loop. Display analog outputs AO1 and AO2, showing the flux reference value and the flux value obtained. Set the current regulator's parameters in order to reduce to a minimum the difference between the two waveforms. See the FOC REGULATORS MENU.

NOTE

If **Manual tune** is selected, do the following to quit the function: disable the **ENABLE** command and set **I073** = [0: Disable].

NOTE

After tuning the rotor time constant, whenever the time constant value is manually changed, parameters **P158** and **P159** are adjusted based on the time constant value that has been set up.

30.1.2. 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.**
Please refer to the MOTOR CONTROL MENU and the 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 that the encoder is properly set up (see the ENCODER/FREQUENCY INPUTS MENU) and wired; if the Encoder B input is used, check the Configuration of the dip–switches located on ES836 option board (see the Sinus Penta's **Installation Instructions manual**).
If **W31 Encoder OK** appears: the speed feedback from encoder is correct.

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

30.2. List of Inputs I073 - I074

Table 60: List of inputs I073 - I074.

Input	FUNCTION	User Level	MODBUS Address
I073	Type of autotune	BASIC	1460
I074	Type of motor tune	BASIC	1461

I073 Type of Autotune

I073	Range	0 ÷ 2	0: Disable 1: Motor Tune 2: Encoder Tune
	Default	This is not a programming parameter: the input is set to zero whenever the drive is powered on and whenever the command is executed.	
	Level	BASIC	
	Address	1460	
	Function	**I073** selects the type of tune to perform. If you select [1: Motor Tune]: **I074** sets different types of tune for current loops, flux loops and speed loops and for the estimation of the motor ratings (see Motor Autotune and Adjusting Loops). If you select [2: Encoder Tune]: you can check the correct operation of the encoder used as a speed feedback (see Checking the Encoder Operation).	

I074 Type of Motor Tune

I074	Range	0 ÷ 5	0: All Auto no rotation 1: FOC Auto no rotation 2: FOC Auto + rotation 3: VTC/FOC Man rotation (speed) 4: FOC Man rotation (current) 5: FOC Man rotation (flux)
	Default	This is not a programming parameter: the input is set to zero whenever the drive is powered on and whenever the command is executed.	
	Level	BASIC	
	Address	1461	
	Function	**I074** selects the type of autotune to perform if **I073** = [1: Motor Tune] (see section Motor Autotune and Adjusting Loops).	

NOTE

No changes can be made to **I073** and **I074** when the **ENABLE** signal is present. If you attempt to change these values when **ENABLE** is active, **"W34 ILLEGAL DATA"** warning appears. Remove the **ENABLE** signal to set these values and activate the **ENABLE** signal to begin the selected autotune process.

NOTE

If **SAVE/ENTER** is pressed to store the changes made to **I073** and **I074**, **"W17 SAVE IMPOSSIBLE"** warning appears. Use the **ESC** key instead.

31. CARRIER FREQUENCY MENU

31.1. Overview

The Carrier Frequency Menu sets some of the PWM modulation characteristics based on the preset type of control.

31.1.1. IFD Control and VTC Control

The IFD and VTC control algorithms allow gaining access to all the parameters included in the Carrier Frequency menu. The user can set the minimum value and the maximum value of the switching carrier frequency and the number of pulses per period used to produce the output frequency when switching from min. carrier frequency to max. carrier frequency (synchronous modulation).

The silent modulation function can also be enabled (**C004**).

31.1.2. Example (IFD and VTC)

Setting two levels of carrier frequency and the number of pulses used for synchronous modulation.
A lower value for carrier frequency ensures a better performance of the motor but implies higher noise levels. Suppose that the connected motor has a rated speed equal to 1500rpm at 50Hz and that you need the best performance up to 200rpm and a "noiseless" carrier frequency at max. speed (3000rpm).
In this case, the max. speed of the drive will produce an output voltage with a frequency value equal to 100Hz; in proximity to this speed the carrier frequency should be at its maximum level. Suppose that a model implementing max. 16kHz carrier frequency is used.
Assign the following:
C001 = 1600Hz
C002 = 16000Hz
C003 ≥ (**C002**/100Hz) = (160 pulses per period)

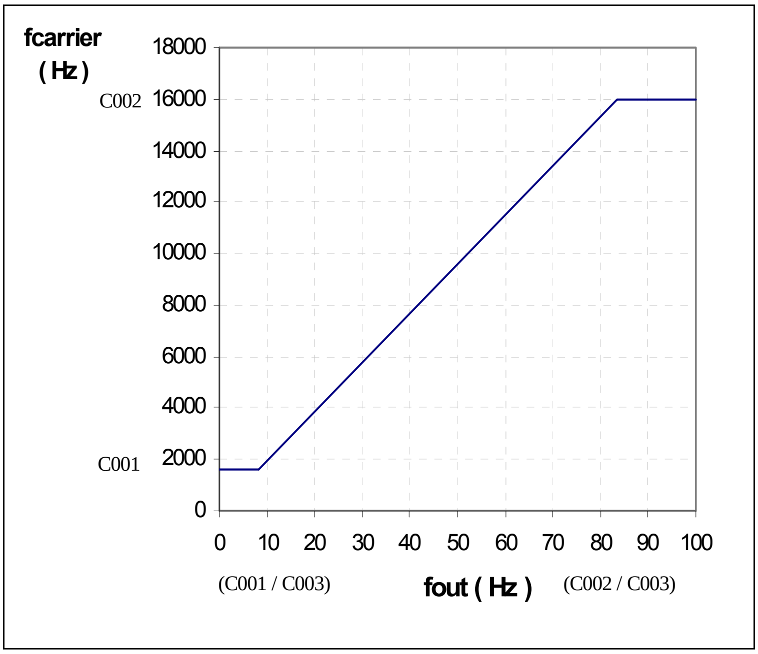


Figure 40: Carrier frequency (example).

Suppose that **C003** = 192np, so that **C002/C003** = 16000/192 = 83.33Hz. The max. carrier frequency is obtained with this output frequency. The min. frequency is kept constant until frequency **C001/C003** = 8.33 Hz is attained, corresponding to 250 rpm of the motor speed. In the output frequency range, ranging from 8.33 to 83.33Hz, synchronous modulation is obtained and the carrier frequency applied results from: f carrier = fout * **C003** [Hz].

31.1.3. FOC CONTROL

The FOC control algorithm selects the silent modulation mode (**C004**) and allows increasing the carrier frequency with parameter **C002**. The FOC algorithm uses a carrier frequency corresponding to:

- max. carrier freq. allowed for the Penta size concerned if freq. is < 8kHz (see Table 71);
- the greatest between **C002** and 8 kHz if the max. carrier freq. allowed is > 8kHz; this means that the value set in **C002** is applied only when exceeding 8kHz.

The carrier frequency is not affected by the value set in **C001**.

31.1.4. ANY CONTROL ALGORITHM

The maximum preset carrier frequency value also limits the maximum speed value to be programmed:

Max. programmable speed → rated speed * (maximum output frequency/rated frequency)
where the maximum output frequency results from the following:

C002 > 5000Hz fout_max = **C002** / 16
C002 ≤ 5000Hz fout_max = **C002** / 10

C002 is the maximum carrier frequency and the divisor is the min. allowable number of pulses per period.

Table 61: Maximum value of the output frequency depending on the Penta size.

Size	Max. output frequency (Hz) (*)
	2T/4T
Smaller than 0015	1000
0015 to 0129 (**)	625
0150 to 0162	500
Greater than 0162	400

(**) From 0023 to 0030 (437.5Hz), 0040 (1000Hz) and 0049 (800Hz)

Size	Max. Output Frequency (Hz) (*)
	5T/5T
Any PD size	400

(*) NOTE The maximum output frequency is limited to the speed level programmed in parameters **C028, C029 [–32000 ÷ 32000]rpm**. This results in **$Fout_{max}$= (RPM_{max}*NPole)/120;**

EXAMPLE:
When using a 4-pole motor and 30,000rpm are required, F_{out} will be 1000Hz, so the performance requirements are fulfilled.
On the other hand, if the same performance requirements are needed with an 8-pole system, 30,000rpm cannot be obtained, as F_{out} is 2000Hz. As a result, when using an 8-pole motor, the maximum allowable programmable speed is 15,000rpm[RPM_{outmax}=(F_{outmax}*120)/(number of motor poles)].

31.2. List of Parameters C001 to C004

Table 62: List of parameters C001 to C004.

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
C001	Minimum carrier frequency	ENGINEERING	1001	See Table 71
C002	Maximum carrier frequency	ENGINEERING	1002	See Table 71
C003	Number of pulses	ENGINEERING	1003	1:[24]
C004	Silent modulation	ENGINEERING	1004	See Table 71

The default value and the max. value of carrier frequency (**C001** and **C002**) depend on the drive size.
To check those values, see Table 71.

C001 Minimum Carrier Frequency

C001	Range	1600 ÷ 16000 *Depending on the drive model*	1600 ÷ 16000 Hz *Depending on the drive model* – see Table 71
	Default	See Table 71	
	Level	ENGINEERING	
	Address	1001	
	Control	IFD and VTC	
	Function	It represents the min. value of the modulation frequency being used.	

NOTE The min. value set in **C001** cannot exceed the max. value set in **C002**. Increase the max. value in **C002** if you need to increase the min. value and if **C001** equals **C002**.

C002 Maximum Carrier Frequency

C002	Range	1600 ÷ 16000 *Depending on the drive size*	1600 ÷ 16000 Hz *Depending on the drive model* – see Table 71
	Default	See Table 71	
	Level	ENGINEERING	
	Address	1002	
	Function	It represents the max. value of the modulation frequency being used. As per FOC control, the modulation frequency set in **C002** is used only if exceeding 8 kHz (when the max. allowable carrier frequency is > 8kHz). Otherwise, the max. carrier frequency allowed is used for the models implementing a carrier frequency <8 kHz, independently of **C002**.	

NOTE The max. value set in **C002** cannot be lower than the min. value set in **C001**. Decrease the min. value in **C001** if you need to decrease the max. value and if **C001** equals **C002**.

NOTE The max. value in **C002** also determines the max. allowable speed value for the selected motor, in order to ensure a minimum number of pulses per period of frequency produced. This value is 16 for maximum carrier frequency (max. **C002** value) greater than 5kHz and 10 for lower maximum carrier frequency (see Table 71).

C003 Pulse Number

C003	Range	0-5	0: [12] 1: [24] 2: [48] 3: [96] 4: [192] 5: [384]
	Default	1	1: [24]
	Level	ENGINEERING	
	Address	1003	
	Control	IFD and VTC	
	Function	This parameter has effect only if C001≠C002. It represents the min. value of pulses per period obtained when modulation frequency changes (synchronous modulation).	

C004 Silent Modulation

C004	Range	0-1	0: [No]; 1: [Yes]
	Default	See Table 71	
	Level	ENGINEERING	
	Address	1004	
	Function	This parameter enables silent modulation. The electric noise due to the switching frequency is dampened.	

32. MOTOR CONTROL MENU

32.1. Overview

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

The three types of control algorithms are identified with the acronyms
- ✓ IFD (Voltage/Frequency Control);
- ✓ VTC (Vector Torque Control);
- ✓ FOC (Field Oriented Control).

The Voltage/Frequency control allows controlling the motor by producing voltage depending on frequency.
The Vector Torque Control (sensorless) processes the machine equations depending on the equivalent parameters of the asynchronous machine. It also allows separating torque control from flux control with no need to use a transducer.
The Field Oriented Control is a closed-chain control requiring a speed transducer to detect the position of the motor shaft instant by instant.

The parameter set for the selected motor is included in the Motor Control menu:
- ✓ Motor Control 1 Menu concerns motor 1;
- ✓ Motor Control 2 Menu concerns motor 2;
- ✓ Motor Control 3 Menu concerns motor 3.

Factory setting allows configuring only one motor. To access the Configuration menus of the other connected motors, simply enter the number of the selected motor in C009 (Number of Configured Motors) in the Motor Control 1 Menu.
To select the connected motor, use digital inputs programmed with parameters C173 and C174, Digital Input for Motor 2 Activation and Digital Input for Motor 3 Activation respectively (see also the DIGITAL INPUTS MENU).
The parameters included in the Motor Control Menus are detailed in the table below.

Table 63: Description of the parameters classified by motor.

Parameter Contents	Motor Control 1	Motor Control 2	Motor Control 3
Mains rated voltage	C008	————	————
Control algorithm being used	C010	C053	C096
Type of reference being used (speed/torque)	C011	C054	C097
Availability of the speed feedback from encoder	C012	C055	C098
Electric ratings of the motor	C015 ÷ C025	C058 ÷ C068	C101 ÷ C111
Max. speed and min. speed required, speed at the beginning of flux weakening, max. speed alarm threshold and enabling	C028 ÷ C031	C071 ÷ C074	C114 ÷ C117
V/f pattern parameters	C013/C032 ÷ C038	C056/C075 ÷ C081	C099/C118 ÷ C124
Slip compensation activation	C039	C082	C125
Drop in rated current voltage	C040	C083	C126
Fluxing ramp time	C041	C084	C127

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

32.1.1. Electrical Specifications of the Connected Motor

This group of parameters can be divided into two subunits: the first subunit includes the motor ratings, the second subunit includes the parameters of the equivalent circuit of the asynchronous machine being used.

32.1.2. Motor Ratings

Table 64: Motor ratings.

Motor Ratings	Motor 1	Motor 2	Motor 3
Rated frequency	C015	C058	C101
Rated rpm	C016	C059	C102
Rated power	C017	C060	C103
Rated current	C018	C061	C104
Rated voltage	C019	C062	C105
No-load power	C020	C063	C106
No-load current	C021	C064	C107

32.1.3. PARAMETERS OF THE EQUIVALENT CIRCUIT OF THE ASYNCHRONOUS MACHINE

Table 65: Parameters of the equivalent circuit of the asynchronous machine.

Description	Motor 1	Motor 2	Motor 3
Stator resistance	C022	C065	C108
Leakage inductance	C023	C066	C109
Mutual inductance	C024	C067	C110
Rotor time constant	C025	C068	C111

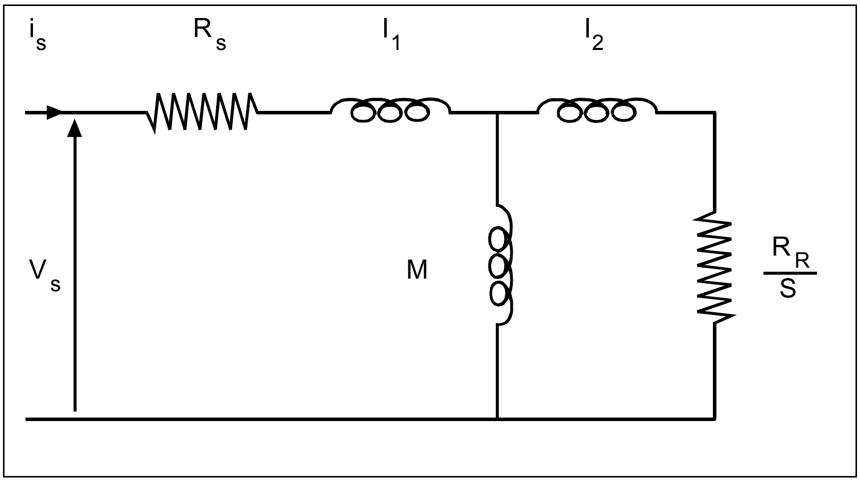


Figure 41: Equivalent circuit of the asynchronous machine.

Where:
Rs: Stator resistance (wires included)
Rr: Rotor resistance
l_1+l_2: Full leakage inductance
M: Mutual inductance (not required for control implementation)
S: Slip
τ rot. $\cong$ M / Rr rotor time constant.

Because the motor characteristics are generally unknown, the Sinus Penta is capable of automatically determining the motor characteristics (see the FIRST STARTUP section and the AUTOTUNE MENU).
However, some parameters may be manually adjusted to meet the requirements needed for special applications.

The parameters used for the different control algorithms are stated in the table below.

Table 66: Motor parameters used by control algorithms.

Parameter	IFD	VTC	FOC
Stator resistance	v	v	v
Leakage inductance	—	v	—
Mutual inductance	—	—	v
Rotor time constant	—	—	v

v Used ; — Not used

NOTE

Because the value of the stator resistance is used for any type of control, always perform the autotune procedure with I073= Motor Tune and I074= 0: All no rotation.

32.1.4. V/f Pattern (IFD Only)

This group of parameters which is included in the **Motor Control Menu** defines the V/f pattern trend of the drive when it is used as an IFD control algorithm. When setting the type of V/f pattern (e.g. **C013** for motor 1), the following curves can be used:

- Constant torque
- Quadratic
- Free setting

The diagram below illustrates three types of programmable curves compared to the theoretical V/f curve.
If **C013 = Constant Torque,** Preboost parameter **C034** allows altering the starting voltage value if compared to the theoretical V/f curve (this allows torque compensation for losses caused by the stator impedance and a greater torque at lower revs).
If **C013 = Quadratic,** the drive will follow a V/f pattern with a parabolic trend. You can set the starting voltage value (**C034**), the desired voltage drop if compared to the relevant constant torque (use **C032**) and the frequency allowing implementing this torque reduction (use **C033**).
If **C013 = Free Setting,** you can program the starting voltage (**C034 Preboost**), the increase in voltage to 1/20 of the rated frequency (**C035 Boost0**), and the increase in voltage (**C036 Boost1**) to the programmable frequency (**C037 Frequency for Boost1**).

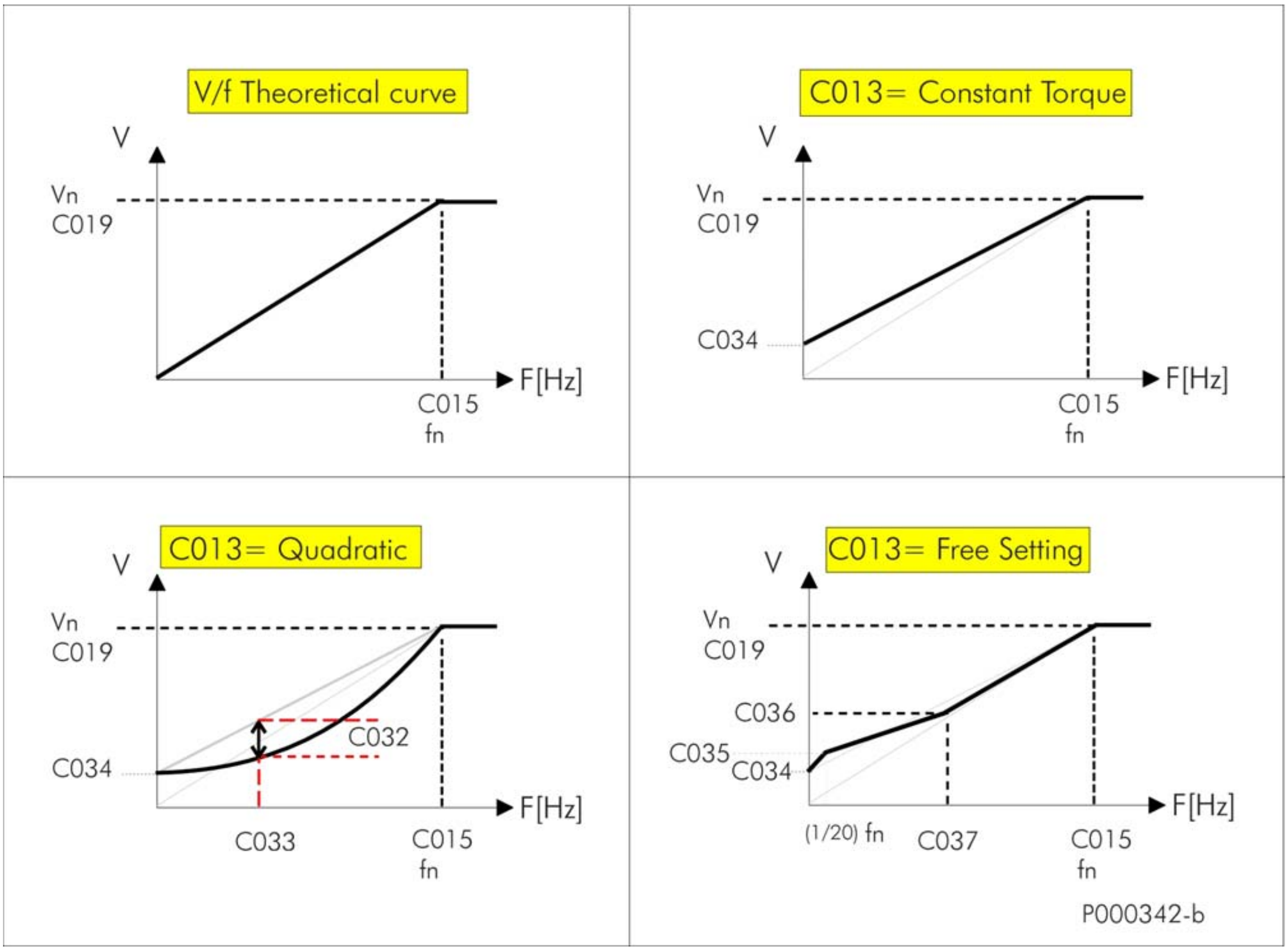


Figure 42: Types of programmable V/f curves.

The voltage produced by the drive may be altered also by setting the **Automatic increase in torque curve** parameter (**C038 for motor 1**).

For the description of the parameters used in the figure above, see the table below.

Table 67: IFD control parameters for the connected motors.

Parameter	Motor 1	Motor 2	Motor 3
Rated frequency: Rated frequency of the connected motor (current rating).	C015	C058	C101
Rated voltage: rated voltage of the connected motor (voltage rating).	C019	C062	C105
V/f curve type: Type of V/f curve applied.	C013	C056	C099
Torque reduction with quadratic curve: Torque reduction using V/f quadratic curve.	C032	C075	C118
Rated speed referring to torque reduction with quadratic curve: Speed that implements the torque reduction using a quadratic curve.	C033	C076	C119
Voltage preboost: Determines the voltage produced by the drive at min. output frequency fomin.	C034	C077	C120
Voltage boost 0 of torque curve: Determines the variation of the output rated voltage at fnom/20; Boost >0 increases the starting torque.	C035	C078	C121
Voltage boost 1 of torque curve: Determines the voltage variation with respect to rated voltage at preset frequency.	C036	C079	C122
Frequency for the application of Boost 1: Determines the frequency for the application of the boost at preset frequency.	C037	C080	C123
Torque curve automatic increase: Variable torque compensation expressed as a percentage of the rated motor voltage. The preset value expresses the voltage increase when the motor is running at rated torque.	C038	C081	C124

32.1.5. Example 1 - V/f Pattern Parameterization

Motor 1: the voltage/frequency pattern is to be programmed for an asynchronous motor (400V/50Hz) with a rated speed of 1500rpm up to 2000rpm.

Type of V/f curve	C013	=	Constant Torque
Rated frequency	C015	=	50 Hz
Rated voltage	C019	=	400 V
Preboost	C034	=	depending on the starting torque
Max. speed	C115	=	2000rpm

32.1.6. EXAMPLE 2 - V/F PATTERN PARAMETERIZATION

The voltage/frequency pattern is to be programmed for an asynchronous motor (400V/50Hz) having a rated power of 7.5 kW and a rated speed of 1420 rpm with a voltage compensation depending on the motor torque. Voltage compensation (AutoBoost) is calculated as follows:

Type of V/f curve	C013	=	Constant Torque
Rated frequency	C015	=	50 Hz
Motor rpm	C016	=	1420rpm
Rated power	C017	=	7.5kW
Rated voltage	C019	=	400 V
Preboost	C034	=	depending on the starting torque
Autoboost	C038	=	4%

Voltage compensation (AutoBoost) results from the formula below:
ΔV = C019 x (C038/100) x (T/Tn)
Where T is the estimated motor torque and Tn is the rated motor torque.
Tn is calculated as follows:
Tn = (Pn x pole pairs/$2\pi f$ = (C017 x pole pairs)/(2π x C015)
"Pole pairs" is the integer number obtained by rounding down (60* C015/C016).

The programmable parameters relating to the AutoBoost functions are the following:
C038 (AutoBoost): variable torque compensation expressed as a percentage of the motor rated voltage (C019). The value set in C038 is the voltage increase when the motor is running at its rated torque.
C017 (Pn): rated power of the connected motor.

32.1.7. SLIP COMPENSATION (IFD ONLY)

This function allows compensating the speed decrease of the asynchronous motor when the mechanical load increases (slip compensation). This is available for IFD control only.
The parameters relating to this function are included in the Motor Control Menu (Configuration Menu).

Table 68: Parameters setting Slip Compensation (IFD Control).

Parameter	Motor 1	Motor 2	Motor 3
Rated voltage: Rated voltage of the connected motor (voltage rating).	C019	C062	C105
No-load power: Power absorbed by the motor when no load is connected to the motor; it is expressed as a percentage of the motor rated power.	C020	C063	C106
Stator resistance: Determines the resistance of the stator phases used to compute the power consumption due to Joule effect.	C022	C065	C108
Activation of slip compensation: If other than zero, this parameter enables slip compensation and defines its relevant value.	C039	C082	C125

Once the drive output power has been estimated and the power losses due to the Joule effect and to the mechanical parts (depending on output voltage and no-load power) have been subtracted, mechanical power is obtained. Starting from mechanical power and the value set for slip compensation (C039 for motor 1), you can obtain the increase of the output frequency limiting the error between the desired speed value and the actual speed value of the connected motor.

32.1.8. TORQUE CONTROL (VTC AND FOC ONLY)

VTC and FOC controls allow controlling the drive with a torque reference instead of a speed reference. To do so, set [1: Torque or 2: Torque with Speed Limit [FOC only] in the relevant parameter (C011 for motor 1, C054 for motor 2, C097 for motor 3).
In this way, the main reference corresponds to the motor torque demand and may range from C047 to C048 (Limits Menu) for motor 1 (minimum and maximum torque expressed as a percentage of the motor rated torque). For motors 2 and 3, the parameters relating to min. and max. torque (C090, C091 and C133, C134) are included in the Limits Menu 2 and Limits Menu 3.
Using a 0020 drive connected to a 15kW motor, C048 is factory-set to 120% of the motor rated torque. If the max. reference is applied (C143 = REF), the torque reference will be 120%.
If a 7.5kW motor is connected, C048 may exceed 200%; torque values exceeding 200% may be obtained based on the value set in C048.
The motor rated torque results from the following formula:
$C=P/\omega$
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

32.2. List of Parameters C008 to C128

Table 69: List of parameters C008 to C128.

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C008	Rated mains voltage	BASIC	1008	2:[380÷480V]
C009	N. of configured motors	ENGINEERING	1009	1

Parameter		FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C010	M1	Type of control algorithm	BASIC	1010	0: IFD
C053	M2			1053	
C096	M3			1096	
C011	M1	Type of reference	ADVANCED	1011	0: Speed (MASTER mode)
C054	M2			1054	
C097	M3			1097	
C012	M1	Speed feedback from encoder	BASIC	1012	0: No
C055	M2			1055	
C098	M3			1098	
C013	M1	Type of V/f curve	BASIC	1013	See Table 73
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	
C016	M1	Rated motor rpm	BASIC	1016	1420 rpm
C059	M2			1059	
C102	M3			1102	
C017	M1	Rated motor power	BASIC	1017	See Table 74
C060	M2			1060	
C103	M3			1103	
C018	M1	Rated motor current	BASIC	1018	See Table 71
C061	M2			1061	
C104	M3			1104	
C019	M1	Rated motor voltage	BASIC	1019	Depending on the drive voltage class
C062	M2			1062	
C105	M3			1105	
C020	M1	Motor no-load power	ADVANCED	1020	0.0%
C063	M2			1063	
C106	M3			1106	
C021	M1	Motor no-load current	ADVANCED	1021	0%
C064	M2			1064	
C107	M3			1107	
C022	M1	Motor stator resistance	ENGINEERING	1022	See Table 74
C065	M2			1065	
C108	M3			1108	
C023	M1	Leakage inductance	ENGINEERING	1023	See Table 74
C066	M2			1066	
C109	M3			1109	

C024	M1	Mutual inductance	ADVANCED	1024	250.00mH
C067	M2			1067	
C110	M3			1110	
C025	M1	Rotor time constant	ADVANCED	1025	0 ms
C068	M2			1068	
C111	M3			1111	
C026	M1	Time constant of bus voltage low-pass filter	ENGINEERING	1026	0 ms
C069	M2			1069	
C112	M3			1112	
C028	M1	Min. motor speed	BASIC	1028	0 rpm
C071	M2			1071	
C114	M3			1114	
C029	M1	Max. motor speed	BASIC	1029	1500 rpm
C072	M2			1072	
C115	M3			1115	
C030	M1	Flux weakening speed	ENGINEERING	1030	90%
C073	M2			1073	
C116	M3			1116	
C031	M1	Max. speed alarm	ADVANCED	1031	0: Disabled
C074	M2			1074	
C117	M3			1117	
C032	M1	Reduction in quadratic torque curve	ADVANCED	1032	30%
C075	M2			1075	
C118	M3			1118	
C033	M1	Rated revs referring to reduction in quadratic torque curve	ADVANCED	1033	20%
C076	M2			1076	
C119	M3			1119	
C034	M1	Voltage Preboost for IFD	BASIC	1034	See Table 73
C077	M2			1077	
C120	M3			1120	
C034a	M1	VTC Boost for positive reference	ENGINEERING	1204	0%
C077a	M2			1206	
C120a	M3			1208	
C034b	M1	VTC Boost for negative reference	ENGINEERING	1205	0%
C077b	M2			1207	
C120b	M3			1209	
C035	M1	Voltage Boost at 5% of the motor rated frequency	ADVANCED	1035	See Table 73
C078	M2			1078	
C121	M3			1121	
C036	M1	Voltage Boost at programmable frequency	ADVANCED	1036	See Table 73
C079	M2			1079	
C122	M3			1122	
C037	M1	Frequency for application of voltage Boost at programmable frequency	ADVANCED	1037	See Table 73
C080	M2			1080	
C123	M3			1123	
C038	M1	Autoboost	ADVANCED	1038	See Table 73
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	

C041	M1	Fluxing ramp time	ENGINEERING	1041	See Table 72
C084	M2			1084	
C127	M3			1127	
C042	M1	Vout saturation percentage	ENGINEERING	1042	100%
C085	M2			1085	
C128	M3			1128	

C008 Rated Mains Voltage

C008	Range	0 ÷ 8	0: [200 ÷ 240] V 1: 2T Regen. 2: [380 ÷ 480] V 3: [481 ÷ 500] V 4: 4T Regen. 5: [500 ÷ 600] V 6: 5T Regen. 7: [600 ÷ 690] V 8: 6T Regen.
	Default	2	2: [380 ÷ 480] V
	Level	BASIC	
	Address	1008	
	Function	This parameter defines the rated voltage of the mains powering the drive, thus allowing obtaining voltage ranges to be used for the drive operation. The value set in this parameter depends on the **Drive voltage class.** To supply the drive via a non-stabilized DC source, the corresponding AC voltage range must be used (see Table 70). DO NOT USE xT Regen settings in this case.	

Table 70: Equivalence between AC mains range and DC range.

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

NOTE

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

C009 N. of Configured Motors

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

C010 (C053,C096) Type of Control Algorithm

C010 (Motor 1) C053 (Motor 2) C096 (Motor 3)	Range	0 ÷ 2	0: IFD 1: VTC 2: FOC
	Default	0	0: IFD
	Level	BASIC	
	Address	1010 1053 1096	
	Function	This parameter sets the type of control algorithm to be used. Type of controls: 0: IFD V/f control 1: VTC Sensorless Vector Torque control 2: FOC Field Oriented Control 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 (IFD Only)). Sensorless vector control processes the machine equations depending on the equivalent parameters of the asynchronous machine, such as stator resistance and leakage inductance (**C022**, **C023** for motor 1; **C065**, **C066** for motor 2; **C108**, **C109** for motor 3 respectively) and allows separating torque control from flux control with no need to use a transducer. The drive can be then controlled with a torque reference instead of a speed reference. Field oriented control is a closed-loop control requiring a speed transducer to detect the position of the motor shaft instant by instant. The machine equations depend on the following: **magnetizing current**, obtained from no-load current **C021** (**C064** for motor 2 and **C107** for motor 3); **mutual inductance C024** (**C067** for motor 2 and **C110** for motor 3); **rotor time constant C025** (**C068** for motor 2 and **C111** for motor 3). The machine equations allow separating torque control from flux control with no need to use a transducer; the drive can be controlled with a torque reference instead of a speed reference.	

NOTE FOC control requires a speed transducer, such as an encoder feedback.

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

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

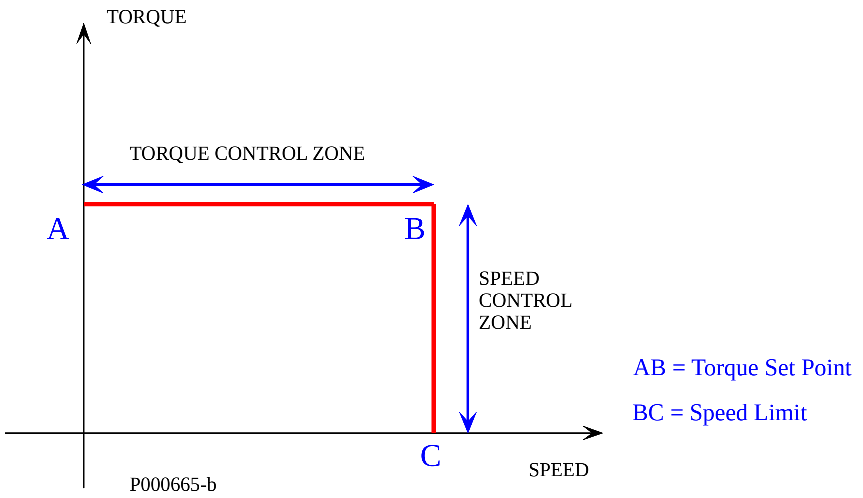


Figure 43: Torque control with speed limit.

NOTE Mode 2 can be selected only if a FOC control is implemented.

C012 (C055,C098) Speed Feedback from Encoder

C012 (Motor 1) C055 (Motor 2) C098 (Motor 3)	Range	0 ÷ 1	0: No 1: Yes
	Default	0	0 ÷ 1
	Level	BASIC	
	Address	1012, 1055, 1098	
	Control	VTC and FOC	
	Function	This parameter enables the encoder as a speed feedback. It defines the encoder characteristics and whether Encoder A (MDI6 and MDI7 in the terminal board) or Encoder B (with option board) is used as a speed feedback (see the ENCODER/FREQUENCY INPUTS MENU).	

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

C013 (Motor 1) C056 (Motor 2) C099 (Motor 3)	Range	0 ÷ 2	0: Constant Torque 1: Quadratic 2: Free Setting
	Default	See Table 73	
	Level	BASIC	
	Address	1013, 1056, 1099	
	Control	IFD	
	Function	Allows selecting different types of V/f pattern. If **C013** (**C056,C099**) = **Constant torque**, voltage at zero frequency can be selected (Preboost **C034** (**C077,C120**)). If **C013** (**C056,C099**) = **Quadratic**, you can select voltage at zero frequency (preboost, **C034** (**C077,C120**)), max. voltage drop with respect to the theoretical V/f pattern, **C032** (**C075 C118**), and the frequency allowing implementing max. voltage drop, **C033** (**C076 C119**). If **C013** (**C056,C099**) = **Free Setting**, you can set voltage at zero frequency (preboost, **C034**(**C077,C120**)); voltage increase to 20% of the rated frequency (Boost0, **C035** (**C078,C121**)); and voltage increase to a programmed frequency (Boost1, **C036** (**C079,C122**); frequency for Boost1, **C037** (**C080,C123**)).	

C014 (C057, C100) Phase Rotation

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

DANGER!!! When activating **C014** (**C057, C100**), the mechanical rotation of the connected motor and its load is reversed accordingly.

C015 (C058, C101) Rated Motor Frequency

C015 (Motor 1) C058 (Motor 2) C101 (Motor 3)	Range	10 ÷ 10000	1.0 Hz ÷ 1000.0 Hz
		See upper limits in Table 62	
	Default	500	50.0 Hz
	Level	BASIC	
	Address	1015, 1058, 1101	
	Control	All	
	Function	This parameter defines the rated motor frequency (nameplate rating).	

C016 (C059,C102) Rated Motor Rpm

C016 (Motor 1) C059 (Motor 2) C102 (Motor 3)	Range	1 ÷ 32000	1 ÷ 32000 rpm
	Default	1420	1420 rpm
	Level	BASIC	
	Address	1016 , 1059, 1102	
	Function	This parameter defines the rated motor rpm (nameplate rating).	

C017 (C060,C103) Rated Motor Power

C017 (Motor 1) C060 (Motor 2) C103 (Motor 3)	Range	1 ÷ 32000	0.1 ÷ 3200.0 kW
		See twice the upper values in **Pnom** column in Table 74.	
	Default	See Table 74	
	Level	BASIC	
	Address	1017, 1060, 1103	
	Function	This parameter defines the rated motor power (nameplate rating).	

C018 (C061,C104) Rated Motor Current

C018 (Motor 1) C061 (Motor 2) C104 (Motor 3)	Range	1 ÷ 32000	0.1 ÷ 3200.0 A
		See twice the upper values in **Inom** column in Table 71	
	Default	See Table 71	
	Level	BASIC	
	Address	1018 , 1061, 1104	
	Function	This parameter defines the rated motor current (nameplate rating).	

C019 (C062,C105) Rated Motor Voltage

C019 (Motor 1) C062 (Motor 2) C105 (Motor 3)	Range	50 ÷ 12000	5.0 ÷ 1200.0 V
	Default	2300 for 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) Motor No-Load Power

C020 (Motor 1) C063 (Motor 2) C106 (Motor 3)	Range	0 ÷ 1000	0.0 ÷ 100.0%
	Default	0	0.0%
	Level	ADVANCED	
	Address	1020 , 1063, 1106	
	Function	This parameter defines the power absorbed by the motor at rated voltage and rated rpm when no load is connected to the motor.	

C021 (C064,C107) Motor No-Load Current

C021 (Motor 1) C064 (Motor 2) C107 (Motor 3)	Range	1 ÷ 100	1 ÷ 100%
	Default	0	0%
	Level	BASIC	
	Address	1021, 1064, 1107	
	Function	This parameter defines the current absorbed by the motor at rated voltage and rated rpm when no load is connected to the motor. It is expressed as a percentage of the motor rated current **C018** (**C061**, **C104**). For a proper tuning of the current loops required for FOC control, enter a value other than zero. If the stator resistance is tuned (**I073** = [1: Motor Tune]); **I074** = (0: All no rotation)) and the no load current parameter is zero, a value for a first attempt is assigned to this parameter, depending on power and pole pairs of the connected motor.	

C022 (C065,C108) Motor Stator Resistance

C022 (Motor 1) C065 (Motor 2) C108 (Motor 3)	Range	0 ÷ 32000	0.000 ÷ 32.000Ω
	Default	See Table 74	
	Level	ADVANCED	
	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.	

C023 (C066,C109) Motor Leakage Inductance

C023 (Motor 1) C066 (Motor 2) C109 (Motor 3)	Range	0 ÷ 32000	0.00 ÷ 320.00mH
	Default	See Table 74	
	Level	ADVANCED	
	Address	1023, 1066, 1109	
	Function	This parameter defines the global leakage inductance of the connected motor. If a star connection is used, it matches with the value of the inductance of one phase; if a delta connection is used, it matches with 1/3 of the inductance of one phase. Autotune is always recommended.	

NOTE With the 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 (Motor 1) C067 (Motor 2) C110 (Motor 3)	Range	0 ÷ 65000	0.00 ÷ 650.00mH
	Default	25000	250.00mH
	Level	ADVANCED	
	Address	1024, 1067, 1110	
	Function	This parameter defines the mutual inductance of the connected motor. The approximate value of the mutual inductance results from no-load current according to the formula below: M ≅ (Vnom – Rstat*Io) / (2πfnom* 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.

C025 (C068,C111) Rotor Time Constant

C025 (Motor 1) C068 (Motor 2) C111 (Motor 3)	Range	0 ÷ 5000	0 ÷ 5000msec
	Default	0	
	Level	ADVANCED	
	Address	1025, 1068, 1111	
	Control	FOC	
	Function	This parameter defines the rotor time constant of the connected motor. If the rotor time constant is not stated by the motor manufacturer, it can be obtained through the autotune function (see the FIRST STARTUP section and the AUTOTUNE MENU).	

NOTE

Whenever one of these parameters is written, the drive automatically computes and saves the parameters of PI flux regulator and FOC control: proportional constant for motor 1 **P158** (**P165** for motor 2, **P172** for motor 3) and integral time **P159** (**P166** for motor 2, **P173** for motor 3).

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

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

C028 (C071,C114) Min. Motor Speed

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

(*) NOTE

The maximum allowable value (as an absolute value) for **C028** and **C029** (min. and max. motor speed) also depends on the preset **max. carrier frequency** (see Table 61). It can be max. 4 times the rated speed of the connected motor.

NOTE

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

NOTE

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

C029 (C072,C115) Max. Motor Speed

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

NOTE

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

C030 (C073,C116) Flux Weakening Speed

C030 (Motor 1) C073 (Motor 2) C116 (Motor 3)	Range	0 ÷ 200	0% ÷ 200%
	Default	90	90%
	Level	ENGINEERING	
	Address	1030, 1073, 1116	
	Control	FOC	
	Function	This parameter defines the speed value determining the motor flux weakening. It is expressed as a percentage of the motor rated speed: **C016** (**C059**,**C102**)	

C031 (C074,C117) Max. Speed Alarm

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

C032 (C075, C118) Reduction in Quadratic Torque Curve

C032 (Motor 1) C075 (Motor 2) C118 (Motor 3)	Range	0 ÷ 1000	0 ÷ 100.0%
	Default	300	30.0%
	Level	ADVANCED	
	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) Rated Revs Referring to Reduction in Quadratic Torque Curve

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

C034 (C077,C120) Voltage Preboost

C034 (Motor 1) C077 (Motor 2) C120 (Motor 3)	Range	0 ÷ 50	0.0 ÷ 5.0 %
	Default	See Table 73	
	Level	BASIC	
	Address	1034, 1077, 1120	
	Control	IFD	
	Function	Torque compensation at minimum frequency produced by the drive. IFD control: determines the increase of the output voltage at 0Hz.	

C034a (C077a, C120a) VTC Torque Reference for Positive Reference

C034a (mot. n.1) C077a (mot. n.2) C120a (mot. n.3)	Range	–500 ÷ 500	–50.0 ÷ 50.0 %
	Default	0%	
	Level	ENGINEERING	
	Address	1204, 1206, 1208	
	Control	VTC	
	Function	VTC control: determines the increase of the torque at low rpm with a positive speed/torque reference.	

C034b (C077b, C120b) VTC Torque Boost for Negative Reference

C034b (mot. n.1) C077b (mot. n.2) C120b (mot. n.3)	Range	–500 ÷ 500	–50.0 ÷ 50.0 %
	Default	0%	
	Level	ENGINEERING	
	Address	1205, 1207, 1209	
	Control	VTC	
	Function	VTC control: determines the increase of the torque at low rpm with a negative speed/torque reference.	

C035 (C078,C121) Torque Curve Increment Boost 0

C035 (Motor 1) C078 (Motor 2) C121 (Motor 3)	Range	–100 ÷ +100	–100 ÷ +100 %
	Default	See Table 73.	
	Level	ADVANCED	
	Address	1035, 1078, 1121	
	Control	IFD	
	Function	Torque compensation at low rpm. Determines how output voltage varies at 5% of the motor rated 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 (Motor 1) C079 (Motor 2) C122 (Motor 3)	Range	–100 ÷ +400	–100 ÷ +400 %
	Default	See Table 73	
	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 (Motor 1) C080 (Motor 2) C123 (Motor 3)	Range	6 ÷ 99	6 ÷ 99 %
	Default	See Table 73	
	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 motor rated frequency.	

C038 (C081,C124) Torque Curve Automatic Increment

C038 (Motor 1) C081 (Motor 2) C124 (Motor 3)	Range	0 ÷ 10	0 ÷ 10 %
	Default	See Table 73	
	Level	ADVANCED	
	Address	1038, 1081, 1124	
	Control	IFD	
	Function	Variable torque compensation expressed as a percentage of the motor rated voltage. The preset value expresses the voltage increase when the motor is running at its rated torque.	

C039 (C082,C125) Slip Compensation

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

C040 (C083, C126) Voltage Drop at Rated Current

C040 (Motor 1) C083 (Motor 2) C126 (Motor 3)	Range	0÷500	0÷50.0%
	Default	0	0:Disabled
	Level	ADVANCED	
	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.	

C041 (C084,C127) Fluxing Ramp Time

C041 (Motor 1) C084 (Motor 2) C127 (Motor 3)	Range	40 ÷ 4000	40 ÷ 4000 msec
	Default	See Table 71	
	Level	ENGINEERING	
	Address	1041, 1084, 1127	
	Control	VTC and FOC	
	Function	This parameter indicates the time spent for motor fluxing.	

C042 (C085, C0128) Vout Saturation Percentage

<table>
<tr><td>C042 (Motor 1)
C085 (Motor 2)
C128 (Motor 3)</td><td>Range</td><td>10 ÷ 120</td><td>10 ÷ 120 %</td></tr>
<tr><td rowspan="4"></td><td>Default</td><td>100</td><td>100%</td></tr>
<tr><td>Level</td><td colspan="2">ENGINEERING</td></tr>
<tr><td>Address</td><td colspan="2">1042, 1085, 1128</td></tr>
<tr><td>Function</td><td colspan="2">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 flux weakening.</td></tr>
</table>

32.3. Tables Including the Parameters Depending on the Drive Size

Table 71: Parameters depending on the Drive Size and Model / 1.

SIZE	MODEL	DEF IMOT [A]	DRIVE INOM [A]	DRIVE IMAX [A]	DRIVE IPEAK [A]	DEF CARRIER [kHz]	MAX CARRIER [kHz]	Silent Modulation DEF
	M1	C018				C001 C002	C001 C002	C004
	M2	C061						
	M3	C104						
S05	0005	6.4	10.5	11.5	14	5	16	YES
	0007	8.4	12.5	13.5	16	5	16	YES
	0008	8.5	15	16	19	5	16	YES
	0009	9	16.5	17.5	19	5	16	YES
	0010	11	17	19	23	5	16	YES
	0011	11.2	16.5	21	25	5	16	YES
	0013	13.2	19	21	25	5	16	YES
	0014	14.8	16.5	25	30	5	16	YES
	0015	15	23	25	30	5	16	YES
S05/S12	0016	17.9	27	30	36	3/5	16	YES
	0020	17.9	30	36	43	3/5	16	YES
S12	0017	21	30	32	37	3	16	YES
	0023	25.7	38	42	51	3	16	YES
	0025	29	41	48	58	3	16	YES
	0030	35	41	56	67	3	16	YES
	0033	36	51	56	68	3	16	YES
	0034	41	57	63	76	3	16	YES
	0036	46	60	72	86	3	16	YES
	0037	50	65	72	83	3	16	YES
S15	0038	46	67	75	88	3	16	YES
	0040	46	72	80	88	3	16	YES
	0049	55	80	96	115	3	12.8	YES
S20	0060	67	88	112	134	3	12.8	YES
	0067	80	103	118	142	3	12.8	YES
	0074	87	120	144	173	3	12.8	YES
	0086	98	135	155	186	3	12.8	YES
S30	0113	133	180	200	240	2	10	YES
	0129	144	195	215	258	2	10	YES
	0150	159	215	270	324	2	5	YES
	0162	191	240	290	324	2	5	YES
S40	0179	212	300	340	408	2	4	NO
	0200	228	345	365	438	2	4	NO
	0216	264	375	430	516	2	4	NO
S40/S65	0250	321	390	480	576	2	4	NO
S41	0180	228	300	340	408	2	5	NO
	0202	264	345	420	438	2	5	NO
	0217	273	375	430	516	2	5	NO
	0260	341	421	560	576	2	5	NO
S42	0062	67	85	110	132	2	4	NO
	0069	80	100	130	156	2	4	NO
	0076	95	125	165	198	2	4	NO
	0088	115	150	200	240	2	4	NO
	0131	140	190	250	300	2	4	NO
	0164	165	230	300	360	2	4	NO
	0181	205	305	380	455	2	4	NO
	0201	250	330	420	504	2	4	NO
	0218	310	360	465	558	2	4	NO
	0259	350	400	560	672	2	4	NO
S50/S65	0312	375	480	600	720	2	4	NO
	0366	421	550	660	792	2	4	NO
	0399	480	630	720	864	2	4	NO

S51	0313	375	480	600	720	2	5	NO
	0367	421	550	660	792	2	5	NO
	0402	528	680	850	1020	2	5	NO
S52	0259	350	400	560	672	2	4	NO
	0260	341	450	600	720	2	4	NO
	0314	440	500	665	798	2	4	NO
	0368	480	560	720	864	2	4	NO
	0401	544	640	850	1020	2	4	NO
S60/S65	0457	528	720	880	1056	2	4	NO
	0524	589	800	960	1152	2	4	NO
S65	0598	680	900	1100	1260	2	4	NO
	0748	841	1000	1300	1560	2	4	NO
S65/S70	0831	939	1200	1440	1728	2	4	NO
S75	0964	1200	1480	1780	2136	2	4	NO
S75/S80	1130	1334	1700	2040	2448	2	4 [*]	NO
	1296	1650	2100	2520	3024	2	4 [*]	NO
	1800	2050	2600	3100	3720	2	4 [*]	NO
	2076	2400	3000	3600	4000	2	4 [*]	NO
2xS41	0523	589	765	1000	1200	2	5	NO
2xS42	0459	626	720	1000	1200	2	4	NO
2xS51	0599	680	900	1100	1320	2	5	NO
	0749	841	1000	1300	1560	2	5	NO
	0800	841	1100	1350	1620	2	5	NO
	0832	939	1200	1440	1728	2	5	NO
3xS51	0850	1080	1340	1600	1920	2	5	NO
	0965	1200	1480	1780	2136	2	5	NO
	1129	1334	1650	2000	2400	2	5	NO
2xS52	0526	696	800	1050	1260	2	4	NO
	0600	773	900	1100	1320	2	4	NO
	0750	858	1000	1300	1560	2	4	NO
	0828	954	1150	1440	1728	2	4	NO
3xS52	0960	1150	1400	1800	2160	2	4	NO
	1128	1360	1600	2000	2400	2	4	NO

[*] 2kHz for 5T and 6T Class.

Table 72: Parameters depending on the Drive Size and Model / 2.

SIZE	MODEL	DEF. TFLUX [ms]	DEF. ILIM DEC [%Inom]	DEF DCB RAMP [ms]	DEF Acc. Time [sec]	DEF Dec. Time [sec]	S – Ramps	DEF Fire Mode Ramps [sec]	DEF u.of m. Acc. / Dec. [sec]	DEF. Dec. Ramp Extension
	M1	C041	C045	C222	P009 P012 P015 P018	P010 P013 P016 P019	P021	P032 P033	P014 P020	C210
	M2	C084	C088	C223						
	M3	C127	C131	C224						
S05	0005	300	150	50	10	10	On	10	0.1	0.2
	0007	300	150	50	10	10	On	10	0.1	0.2
	0008	300	150	50	10	10	On	10	0.1	0.2
	0009	300	150	50	10	10	On	10	0.1	0.2
	0010	300	150	50	10	10	On	10	0.1	0.2
	0011	300	150	50	10	10	On	10	0.1	0.2
	0013	300	150	50	10	10	On	10	0.1	0.2
	0014	300	150	50	10	10	On	10	0.1	0.2
	0015	300	150	50	10	10	On	10	0.1	0.2
S05/S12	0016	300	150	50	10	10	On	10	0.1	0.2
	0020	300	150	50	10	10	On	10	0.1	0.2
S12	0017	300	150	50	10	10	On	10	0.1	0.2
	0023	300	150	50	10	10	On	10	0.1	0.2
	0025	300	150	50	10	10	On	10	0.1	0.2
	0030	300	150	50	10	10	On	10	0.1	0.2
	0033	300	150	50	10	10	On	10	0.1	0.2
	0034	300	150	70	10	10	On	10	0.1	0.2
	0036	300	150	70	10	10	On	10	0.1	0.2
	0037	300	150	70	10	10	On	10	0.1	0.2
S15	0038	300	150	70	10	10	On	10	0.1	0.2
	0040	300	150	70	10	10	On	10	0.1	0.2
	0049	300	150	80	10	10	On	10	0.1	0.2
S20	0060	300	150	80	10	10	On	10	0.1	0.2
	0067	300	150	100	10	10	On	10	0.1	0.2
	0074	300	150	100	10	10	On	10	0.1	0.2
	0086	300	150	150	10	10	On	10	0.1	0.2
S30	0113	300	150	150	10	10	On	10	0.1	0.2
	0129	300	150	150	10	10	On	10	0.1	0.2
	0150	300	150	200	10	10	On	10	0.1	0.2
	0162	300	150	200	10	10	On	10	0.1	0.2
S40	0179	450	100	200	100	100	Off	100	1	2
	0200	450	100	220	100	100	Off	100	1	2
	0216	450	100	250	100	100	Off	100	1	2
S40/S65	0250	450	100	250	100	100	Off	100	1	2
S41	0180	450	100	250	100	100	Off	100	1	2
	0202	450	100	250	100	100	Off	100	1	2
	0217	450	100	250	100	100	Off	100	1	2
	0260	450	100	250	100	100	Off	100	1	2
S42	0062	450	100	250	100	100	Off	100	1	2
	0069	450	100	250	100	100	Off	100	1	2
	0076	450	100	250	100	100	Off	100	1	2
	0088	450	100	250	100	100	Off	100	1	2
	0131	450	100	250	100	100	Off	100	1	2
	0164	450	100	250	100	100	Off	100	1	2
	0181	450	100	250	100	100	Off	100	1	2
	0201	450	100	250	100	100	Off	100	1	2
	0218	450	100	250	100	100	Off	100	1	2
	0259	450	100	250	100	100	Off	100	1	2
S50/S65	0312	450	100	250	100	100	Off	100	1	2
	0366	450	100	250	100	100	Off	100	1	2
	0399	450	100	250	100	100	Off	100	1	2

S51	0313	450	100	250	100	100	Off	100	1	2
	0367	450	100	250	100	100	Off	100	1	2
	0402	450	100	250	100	100	Off	100	1	2
S52	0290	450	100	250	100	100	Off	100	1	2
	0314	450	100	250	100	100	Off	100	1	2
	0368	450	100	250	100	100	Off	100	1	2
	0401	450	100	250	100	100	Off	100	1	2
S60/S65	0457	450	100	250	100	100	Off	100	1	2
	0524	450	100	250	100	100	Off	100	1	2
S65	0598	450	100	250	100	100	Off	100	1	2
	0748	450	100	250	100	100	Off	100	1	2
S65/S70	0831	450	100	250	100	100	Off	100	1	2
S75	0964	450	100	250	100	100	Off	100	1	2
S75/S80	1130	450	100	250	100	100	Off	100	1	2
	1296	450	100	250	100	100	Off	100	1	2
	1800	450	100	250	100	100	Off	100	1	2
	2076	450	100	250	100	100	Off	100	1	2
2xS41	0523	450	100	250	100	100	Off	100	1	2
2xS42	0459	450	100	250	100	100	Off	100	1	2
2xS51	0599	450	100	250	100	100	Off	100	1	2
	0749	450	100	250	100	100	Off	100	1	2
	0800	450	100	250	100	100	Off	100	1	2
	0832	450	100	250	100	100	Off	100	1	2
3xS51	0850	450	100	250	100	100	Off	100	1	2
	0965	450	100	250	100	100	Off	100	1	2
	1129	450	100	250	100	100	Off	100	1	2
2xS52	0526	450	100	250	100	100	Off	100	1	2
	0600	450	100	250	100	100	Off	100	1	2
	0750	450	100	250	100	100	Off	100	1	2
	0828	450	100	250	100	100	Off	100	1	2
3xS52	0960	450	100	250	100	100	Off	100	1	2
	1128	450	100	250	100	100	Off	100	1	2

Table 73: Parameters depending on the Drive Size and Model / 3.

SIZE	MODEL	DEF V/f Pattern	DEF PREBOOST [%Vnom]	BOOST @ 5% fnom and DEF BOOST [%Vnom]	Frequency for DEF BOOST [%fnom]	DEF Auto BOOST [%Vnom]
	M1	C013	C034	C035/C036	C037	C038
	M2	C056	C077	C078/C079	C080	C081
	M3	C099	C120	C121/C122	C123	C124
S05	0005	0:CONST	1.0	0	50	1
	0007	0:CONST	1.0	0	50	1
	0008	0:CONST	1.0	0	50	1
	0009	0:CONST	1.0	0	50	1
	0010	0:CONST	1.0	0	50	1
	0011	0:CONST	1.0	0	50	1
	0013	0:CONST	1.0	0	50	1
	0014	0:CONST	1.0	0	50	1
	0015	0:CONST	1.0	0	50	1
S05/S12	0016	0:CONST	1.0	0	50	1
	0020	0:CONST	1.0	0	50	1
S12	0017	0:CONST	1.0	0	50	1
	0023	0:CONST	1.0	0	50	1
	0025	0:CONST	1.0	0	50	1
	0030	0:CONST	1.0	0	50	1
	0033	0:CONST	1.0	0	50	1
	0034	0:CONST	1.0	0	50	1
	0036	0:CONST	1.0	0	50	1
	0037	0:CONST	1.0	0	50	1
S15	0038	0:CONST	1.0	0	50	1
	0040	0:CONST	1.0	0	50	1
	0049	0:CONST	1.0	0	50	1
S20	0060	0:CONST	1.0	0	50	1
	0067	0:CONST	1.0	0	50	1
	0074	0:CONST	1.0	0	50	1
	0086	0:CONST	1.0	0	50	1
S30	0113	0:CONST	0.5	0	50	1
	0129	0:CONST	0.5	0	50	1
	0150	0:CONST	0.5	0	50	1
	0162	0:CONST	0.5	0	50	1
S40	0179	2:FREE	0.2	–20	20	0
	0200	2:FREE	0.2	–20	20	0
	0216	2:FREE	0.2	–20	20	0
S40/S65	0250	2:FREE	0.2	–20	20	0
S41	0180	2:FREE	0.2	–20	20	0
	0202	2:FREE	0.2	–20	20	0
	0217	2:FREE	0.2	–20	20	0
	0260	2:FREE	0.2	–20	20	0
S42	0062	2:FREE	0.2	–20	20	0
	0069	2:FREE	0.2	–20	20	0
	0076	2:FREE	0.2	–20	20	0
	0088	2:FREE	0.2	–20	20	0
	0131	2:FREE	0.2	–20	20	0
	0164	2:FREE	0.2	–20	20	0
	0181	2:FREE	0.2	–20	20	0
	0201	2:FREE	0.2	–20	20	0
	0218	2:FREE	0.2	–20	20	0
	0259	2:FREE	0.2	–20	20	0
S50/S65	0312	2:FREE	0.2	–20	20	0
	0366	2:FREE	0.2	–20	20	0
	0399	2:FREE	0.2	–20	20	0

S51	0313	2:FREE	0.2	–20	20	0
	0367	2:FREE	0.2	–20	20	0
	0402	2:FREE	0.2	–20	20	0
S52	0290	2:FREE	0.2	–20	20	0
	0314	2:FREE	0.2	–20	20	0
	0368	2:FREE	0.2	–20	20	0
	0401	2:FREE	0.2	–20	20	0
S60/S65	0457	2:FREE	0.2	–20	20	0
	0524	2:FREE	0.2	–20	20	0
S65	0598	2:FREE	0.2	–20	20	0
	0748	2:FREE	0.2	–20	20	0
S65/S70	0831	2:FREE	0.2	–20	20	0
S75	0964	2:FREE	0.2	–20	20	0
S75/S80	1130	2:FREE	0.2	–20	20	0
	1296	2:FREE	0.2	–20	20	0
	1800	2:FREE	0.2	–20	20	0
	2076	2:FREE	0.2	–20	20	0
2xS41	0523	2:FREE	0.2	–20	20	0
2xS42	0459	2:FREE	0.2	–20	20	0
2xS51	0599	2:FREE	0.2	–20	20	0
	0749	2:FREE	0.2	–20	20	0
	0800	2:FREE	0.2	–20	20	0
	0832	2:FREE	0.2	–20	20	0
3xS51	0850	2:FREE	0.2	–20	20	0
	0965	2:FREE	0.2	–20	20	0
	1129	2:FREE	0.2	–20	20	0
2xS52	0526	2:FREE	0.2	–20	20	0
	0600	2:FREE	0.2	–20	20	0
	0750	2:FREE	0.2	–20	20	0
	0828	2:FREE	0.2	–20	20	0
3xS52	0960	2:FREE	0.2	–20	20	0
	1128	2:FREE	0.2	–20	20	0

Table 74: Parameters depending on the Drive Size, Model and Voltage Class.

SIZE	MODEL	2T			4T			5T			6T		
		Pnom [kW]	Rstat [Ω]	Lleak [mH]	Pnom [kW]	Rstat [Ω]	Lleak [mH]	Pnom [kW]	Rstat [Ω]	Lleak [mH]	Pnom [kW]	Rstat [Ω]	Lleak [mH]
	M1	C017	C022	C023	C017	C022	C023	C017	C022	C023	C017	C022	C023
	M2	C060	C065	C066	C060	C065	C066	C060	C065	C066	C060	C065	C066
	M3	C103	C108	C109	C103	C108	C109	C103	C108	C109	C103	C108	C109
S05	0005	---	---	---	3	2.500	30.00	---	---	---	---	---	---
	0007	1.8	1.155	14.43	4	2.000	25.00	---	---	---	---	---	---
	0008	2.2	1.000	12.00	---	---	---	---	---	---	---	---	---
	0009	---		---	4.5	1.600	16.00	---	---	---	---	---	---
	0010	3	0.800	7.50	---	---	---	---	---	---	---	---	---
	0011	---	---	---	5.5	1.300	12.00	---	---	---	---	---	---
	0013	3.7	0.650	6.00	---	---	---	---	---	---	---	---	---
	0014	---	---	---	7.5	1.000	8.00	---	---	---	---	---	---
	0015	4	0.600	5.00	---	---	---	---	---	---	---	---	---
S05/S12	0016	4.5	0.462	3.46	9.2	0.800	6.00	---	---	---	---	---	---
	0020	5.5	0.346	2.89	11	0.600	5.00	---	---	---	---	---	---
S12	0017	---	---	---	9.2	0.800	6.00	---	---	---	---	---	---
	0023	7.5	0.300	2.50	---	---	---	---	---	---	---	---	---
	0025	---	---	---	15	0.400	3.00	---	---	---	---	---	---
	0030	---	---	---	18.5	0.300	2.50	---	---	---	---	---	---
	0033	11	0.200	1.50	---	---	---	---	---	---	---	---	---
	0034	---	---	---	22	0.250	2.00	---	---	---	---	---	---
	0036	---	---	---	25	0.250	2.00	---	---	---	---	---	---
	0037	15	0.100	1.15	---	---	---	---	---	---	---	---	---
S15	0038	15	0.115	1.15	25	0.200	2.00	---	---	---	---	---	---
	0040	15	0.115	1.15	25	0.200	2.00	---	---	---	---	---	---
	0049	18.5	0.087	1.15	30	0.150	2.00	---	---	---	---	---	---
S20	0060	22	0.069	1.15	37	0.120	2.00	---	---	---	---	---	---
	0067	25	0.058	0.69	45	0.100	1.20	---	---	---	---	---	---
	0074	30	0.046	0.69	50	0.080	1.20	---	---	---	---	---	---
	0086	32	0.035	0.58	55	0.060	1.00	---	---	---	---	---	---
S30	0113	45	0.023	0.58	75	0.040	1.00	---	---	---	---	---	---
	0129	50	0.023	0.58	80	0.040	1.00	---	---	---	---	---	---
	0150	55	0.017	0.58	90	0.030	1.00	---	---	---	---	---	---
	0162	65	0.012	0.58	110	0.020	1.00	---	---	---	---	---	---
S40	0179	75	0.010	0.58	120	0.018	1.00	---	---	---	---	---	---
	0200	80	0.010	0.52	132	0.018	0.90	---	---	---	---	---	---
	0216	90	0.009	0.46	150	0.015	0.80	---	---	---	---	---	---
S40/S65	0250	100	0.007	0.35	185	0.012	0.60	280	0.017	0.87	330	0.021	1.04
S41	0180	75	0.010	0.52	132	0.018	0.9	---	---	---	---	---	---
	0202	90	0.010	0.52	160	0.018	0.9	---	---	---	---	---	---
	0217	110	0.009	0.46	185	0.015	0.8	---	---	---	---	---	---
	0260	132	0.007	0.35	220	0.012	0.6	---	---	---	---	---	---
S42	0062	---	---	---	---	---	---	55	0.173	2.89	75	0.208	3.46
	0069	---	---	---	---	---	---	75	0.144	1.73	90	0.173	2.08
	0076	---	---	---	---	---	---	90	0.115	1.73	110	0.139	2.08
	0088	---	---	---	---	---	---	110	0.087	1.44	132	0.104	1.73
	0131	---	---	---	---	---	---	132	0.058	1.44	160	0.069	1.73
	0164	---	---	---	---	---	---	160	0.029	1.44	200	0.035	1.73
	0181	---	---	---	---	---	---	200	0.026	1.44	250	0.031	1.73
	0201	---	---	---	---	---	---	250	0.026	1.30	280	0.031	1.56
	0218	---	---	---	---	---	---	280	0.022	1.15	315	0.026	1.39
	0259	---	---	---	---	---	---	315	0.017	0.87	355	0.021	1.04
S50/S65	0312	132	0.007	0.32	220	0.012	0.50	340	0.017	0.81	410	0.021	0.97
	0366	150	0.006	0.23	250	0.010	0.40	370	0.014	0.58	450	0.017	0.69
	0399	160	0.006	0.17	280	0.010	0.30	410	0.014	0.43	490	0.017	0.52

S51	0313	132	0.006	0.28	250	0.012	0.50	---	---	---	---	---	---
	0367	160	0.005	0.23	280	0.010	0.40	---	---	---	---	---	---
	0402	185	0.005	0.17	355	0.010	0.30	---	---	---	---	---	---
S52	0290	---	---	---	---	---	---	355	0.017	0.72	480	0.020	0.86
	0314	---	---	---	---	---	---	400	0.017	0.72	550	0.020	0.86
	0368	---	---	---	---	---	---	450	0.014	0.57	610	0.017	0.69
	0401	---	---	---	---	---	---	500	0.014	0.43	680	0.017	0.51
S60/S65	0457	200	0.005	0.14	315	0.008	0.25	500	0.012	0.36	590	0.014	0.43
	0524	220	0.004	0.12	355	0.007	0.20	540	0.010	0.29	650	0.012	0.35
S65	0598	250	0.003	0.12	400	0.006	0.20	620	0.009	0.29	740	0.010	0.35
	0748	280	0.002	0.09	500	0.003	0.15	730	0.004	0.22	870	0.005	0.26
S65/S70	0831	330	0.001	0.06	560	0.002	0.10	810	0.003	0.14	970	0.003	0.17
S75	0964	400	0.001	0.05	710	0.002	0.09	1000	0.003	0.13	1220	0.003	0.16
S75/S80	1130	450	0.001	0.05	800	0.001	0.09	1170	0.001	0.13	1400	0.001	0.16
	1296	560	0.001	0.05	1000	0.001	0.09	1340	0.001	0.13	1610	0.001	0.16
	1800	710	0.001	0.03	1200	0.001	0.06	1750	0.001	0.08	2100	0.001	0.10
	2076	800	0.001	0.03	1400	0.001	0.05	2000	0.001	0.07	2400	0.001	0.08
2xS41	0523	220	0.004	0.12	355	0.007	0.20	---	---	---	---	---	---
2xS42	0459	---	---	---	---	---	---	500	0.012	0.36	630	0.014	0.43
2xS51	0599	250	0.003	0.12	400	0.006	0.20	---	---	---	---	---	---
	0749	280	0.002	0.09	500	0.003	0.15	---	---	---	---	---	---
	0800	280	0.002	0.09	500	0.003	0.15	---	---	---	---	---	---
	0832	330	0.001	0.06	650	0.002	0.10	---	---	---	---	---	---
3xS51	0850	355	0.001	0.05	630	0.002	0.09	---	---	---	---	---	---
	0965	400	0.001	0.05	710	0.002	0.09	---	---	---	---	---	---
	1129	450	0.001	0.05	800	0.001	0.09	---	---	---	---	---	---
2xS52	0526	---	---	---	---	---	---	500	0.010	0.29	710	0.012	0.35
	0600	---	---	---	---	---	---	630	0.009	0.29	800	0.010	0.35
	0750	---	---	---	---	---	---	710	0.004	0.22	900	0.005	0.26
	0828	---	---	---	---	---	---	710	0.003	0.14	1000	0.003	0.17
3xS52	0960	---	---	---	---	---	---	1000	0.003	0.13	1200	0.003	0.16
	1128	---	---	---	---	---	---	1000	0.001	0.13	1400	0.002	0.16

33. LIMITS MENU

33.1. Overview

The Limits Menu defines the current/torque limits applied to the control functions (IFD, VTC or FOC controls) selected for the three connected motors.
For IFD control, current limits are used. Three limit current levels are available, which are expressed as a percentage of the motor rated current:

1) Current limit while accelerating;
2) Current limit at constant rpm;
3) Current limit while decelerating.

Two special parameters are also available; one sets the decrease of the limit current value when the motor runs at constant power (flux weakening), while the other parameter disables the frequency decrease in case of acceleration current limit (this is useful for inertial loads).
If a VTC control or a FOC control is used, limits are expressed as a percentage of the rated motor torque.
Values set in the two parameters relating to min. torque and max. torque represent the limits for saturation of the control torque demand. If an external torque limit is set (C147 in the CONTROL METHOD MENU), the values set in the parameters above represent the range of the source used for limitation; the torque ramp times set in the RAMPS MENU will be applied to the preset limit torque reference.
Also, ramp time for torque limit can be selected (C049 for motor 1, C092 for motor 2 and C135 for motor 3) for VTC and FOC controls only.

The Ipeak current load is available (see Table 71) for a maximum time of 3 seconds and only if the preset carrier frequency is lower than/equal to the default frequency value (see Table 71). When operating with synchronous modulation, the current peak value dynamically decreases when the output frequency increases.
Manually enabling/disabling that function can be done only when using the IFD control with current limit parameters C043/C044/C045. When using the VTC or FOC control, the system will automatically handle the maximum current value that can be used also based on the torque limit configured with C047/C048.

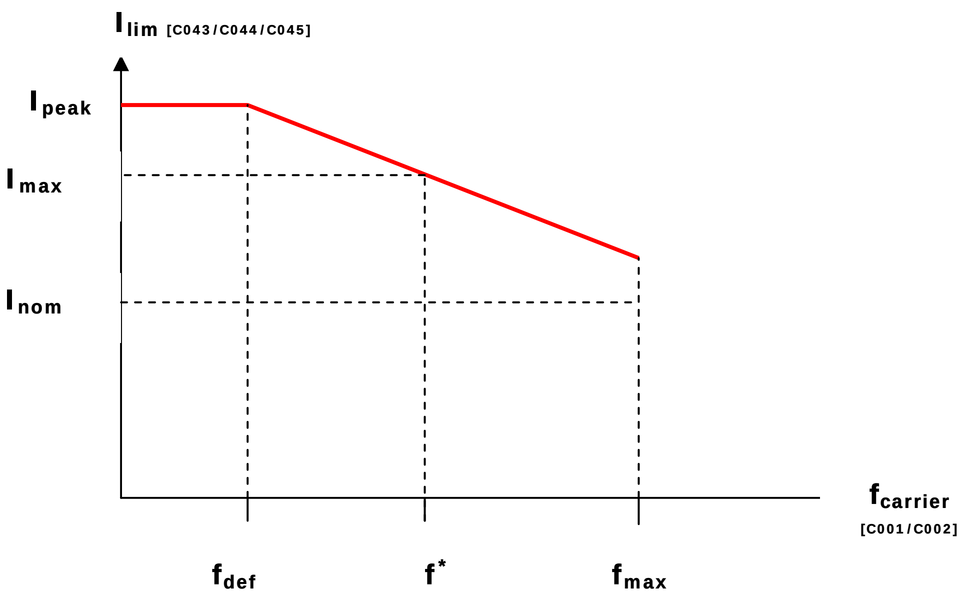


Figure 44: Current limit decreased based on the carrier frequency.

f*: Max. frequency for which Imax can be obtained.

33.2. List of Parameters C043 to C135

Table 75: List of parameters C043 to C135.

Parameter		FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C043	M1	Current limit while accelerating	BASIC	1043	150%
C086	M2		ADVANCED	1086	
C129	M3			1129	
C044	M1	Current limit at constant rpm	BASIC	1044	150%
C087	M2		ADVANCED	1087	
C130	M3			1130	
C045	M1	Current limit while decelerating	BASIC	1045	See Table 72
C088	M2		ADVANCED	1088	
C131	M3			1131	
C046	M1	Current limit decrease in flux weakening	ADVANCED	1046	0: Disabled
C089	M2			1089	
C132	M3			1132	
C047	M1	Minimum torque	ADVANCED	1047	0.0%
C090	M2			1090	
C133	M3			1133	
C048	M1	Maximum torque	BASIC	1048	120.0%
C091	M2		ADVANCED	1091	
C134	M3			1134	
C049	M1	Ramp time for torque limit	ADVANCED	1049	200.0%/sec
C092	M2			1092	
C135	M3			1135	
C050	M1	Frequency decrease during acceleration limit	ADVANCED	1050	0: Enabled
C093	M2			1093	
C136	M3			1136	

C043 (C086, C129) Current Limit While accelerating

C043 (Motor 1) C086 (Motor 2) C129 (Motor 3)	Range	0 ÷ 400 (*)	0: Disabled 1.0% ÷ Min[*Imax inverter/Inom mot, 400.0%*]
	Default	150%	
	Level	BASIC (C043); ADVANCED (C086, C129)	
	Address	1043, 1086, 1129	
	Control	IFD	
	Function	This parameter defines the current limit while accelerating; it is expressed as a percentage of the rated current of the selected motor.	

(*) *The maximum allowable value depends on the drive size.*

C044 (C087, C130) Current Limit at Constant Rpm

C044 (Motor 1) C087 (Motor 2) C130 (Motor 3)	Range	0 ÷ 400 (*)	0: Disabled 1.0% ÷ Min[*Imax inverter/Inom mot, 400.0%*]
	Default	150%	
	Level	BASIC (C044); ADVANCED (C087, C130)	
	Address	1044, 1087, 1130	
	Control	IFD	
	Function	This parameter defines the current limit at constant rpm; it is expressed as a percentage of the rated current of the selected motor.	

(*) *The maximum allowable value depends on the drive size.*

C045 (C088, C131) Current Limit while Decelerating

C045 (Motor 1) C088 (Motor 2) C131 (Motor 3)	Range	0 ÷ 400 (*)	0: Disabled 1.0% ÷ Min[*Imax inverter/Inom mot, 400.0%*]
	Default	See Table 72	
	Level	BASIC (C045); ADVANCED (C088, C131)	
	Address	1045, 1088, 1131	
	Control	IFD	
	Function	This parameter defines the current limit while decelerating; it is expressed as a percentage of the rated current of the selected motor.	

(*) *The maximum allowable value depends on the drive size.*

C046 (C089, C132) Current Limit Decrease in Flux Weakening

C046 (Motor 1) C089 (Motor 2) C132 (Motor 3)	Range	0 ÷ 1	0: Disabled 1: Enabled
	Default	*0*	0: Disabled
	Level	ADVANCED	
	Address	1046, 1089, 1132	
	Control	IFD	
	Function	This parameter enables the current limit decrease function in flux weakening. The current limit is multiplied by the ratio between the motor rated torque and the frequency forced to the drive: limit = current limit being used * (Fnom/ Fout).	

C047 (C090, C133) Minimum Torque

C047 (Motor 1) C090 (Motor 2) C133 (Motor 3)	Range	–5000 ÷ 5000 (*)	–500.0% ÷ +500.0%
	Default	0	0.0%
	Level	ADVANCED	
	Address	1047, 1090, 1133	
	Control	VTC and FOC	
	Function	This parameter sets the min. limit of the torque demanded by the control being used. Torque is expressed as a percentage of the rated torque of the selected motor.	

NOTE

If an external torque limit is set (**C147** in the CONTROL METHOD MENU), the values set in the parameters above represent the range of the source used for limitation; they can be reduced by adjusting the external source; the torque ramp times set in the RAMPS MENU will be applied to the preset limit torque reference (**P026–P027**).

C048 (C091, C134) Maximum Torque

C048 (Motor 1) C091 (Motor 2) C134 (Motor 3)	Range	–5000(*) ÷ 5000 (*)	–500.0% ÷ +500.0%
	Default	1200	120.0%
	Level	BASIC (C048); ADVANCED (C091;C134)	
	Address	1048, 1091, 1134	
	Control	VTC and FOC	
	Function	This parameter sets the max. limit of the torque demanded by the control being used. Torque is expressed as a percentage of the rated torque of the selected motor.	

NOTE

If an external torque limit is set (**C147** in the CONTROL METHOD MENU), the values set in the parameters above represent the range of the source used for limitation; the torque ramp times set in the RAMPS MENU will be applied to the preset limit torque reference (**P026–P027**).

C049 (C092, C135) Ramp Time for Torque Limit

C049 (Motor 1) C092 (Motor 2) C135 (Motor 3)	Range	10 ÷ 30000	10 ÷ 30000ms
	Default	50	50ms
	Level	ADVANCED	
	Address	1049, 1092, 1135	
	Control	VTC and FOC	
	Function	This parameter sets the time taken by the torque limit of the selected motor to go to zero from max. value.	

C050 (C093, C136) Frequency Decrease during Acceleration Limit

C050 (Motor 1) C093 (Motor 2) C136 (Motor 3)	Range	0 ÷ 1	0: Enabled 1: Disabled
	Default	0	0: Enabled
	Level	ADVANCED	
	Address	1050, 1093, 1136	
	Control	IFD	
	Function	This parameter enables output frequency decrease during acceleration limit.	

NOTE

Setting "1:Disabled" is recommended for high inertia loads. When high inertia loads are connected to the drive, the frequency decrease can lead to strong regeneration and DC-bus voltage oscillations.

34. CONTROL METHOD MENU

34.1. Overview

NOTE Please refer to the Sinus Penta's **Installation Instructions Manual** for the hardware description of digital inputs (COMMANDS) and analog inputs (REFERENCES).
See also the INPUTS FOR REFERENCES MENU and the DIGITAL INPUTS MENU.

The drive is factory set to receive digital commands via the terminal board; the main speed reference is sent from the REF analog input, and no external limit for torque limitation is enabled.

The parameters in this menu allow selecting the following:

- The source of the **drive commands** (digital inputs) from **three signal sources** (through parameters **C140, C141, C142**) which are logically matched so as to obtain an active **M031** command set. For each of these 3 **parameters** you can select the source of the command signals from **4 different sources;**
- The source of the **speed reference** (or torque reference) from **4 different sources** (that can be selected with parameters **C143, C144, C145, C146**) that **can be summed up together.**

For each of these **4 parameters**, you can select the source of the reference signals from **9 different sources**;

- The source of the **torque limit** reference (through parameter **C147**, allowing selecting the reference source from **9 different sources**).

Therefore, you can select and enable different **command sources** (hardware or virtual sources), different speed (or torque) **references** (hardware or virtual sources) and enable an external torque **limit**.
The drive **commands** may be sent from:

- The hardware terminal board (terminal board on ES821), which is logically separated into terminal board A and terminal board B;
- The keypad;
- The virtual remote terminal board: through serial link with MODBUS communications protocol;
- The virtual remote terminal board: through Fieldbus (option board).

Multiple terminal boards may also be enabled (up to 3 terminal boards with parameters **C140, C141, C142**); in this case, the drive will apply logic functions **OR** or **AND** to the different terminals to obtain the activated terminal board (see Command Sources).

The following **references** and torque limit signals may be sent:

- Three analog inputs acquired to the hardware terminal board (REF, AIN1, AIN2), plus two analog inputs (XAIN4, XAIN5) acquired to the hardware terminal board located on ES847 option board ;
- FIN frequency input;
- Encoder input;
- Keypad;
- Serial link with MODBUS communications protocol;
- Fieldbus (option board);
- Up/Down from MDI (Up and Down digital inputs)

Multiple reference sources may be enabled at the same time (up to 4 reference sources with parameters **C143, C144, C145, C146**); in this case, the drive will consider the sum of all active reference as the main reference.

Finally, a dynamic selection between two command sources and two reference sources is allowed when using the digital input configured as Source Selection (see **C179**).

34.1.1. Command Sources

The drive commands may be sent from the following sources:

0: Disabled
1: Terminal board A
2: Serial link (with MODBUS protocol)
3: Fieldbus (fieldbus on option board)
4: Terminal board B
5: Keypad (remotable display/keypad)

The factory-setting enables only Terminal Board A (C140=1 and C141=1) as a command source (see also the DIGITAL INPUTS MENU). Both Terminal board A and B refer to the same terminal board located on ES821, but allow switching between one set of START, STOP, REVERSE commands sent to three terminals to a different set of commands sent to three different terminals.

Most commands may be delayed (when enabled or disabled): refer to the TIMERS MENU.

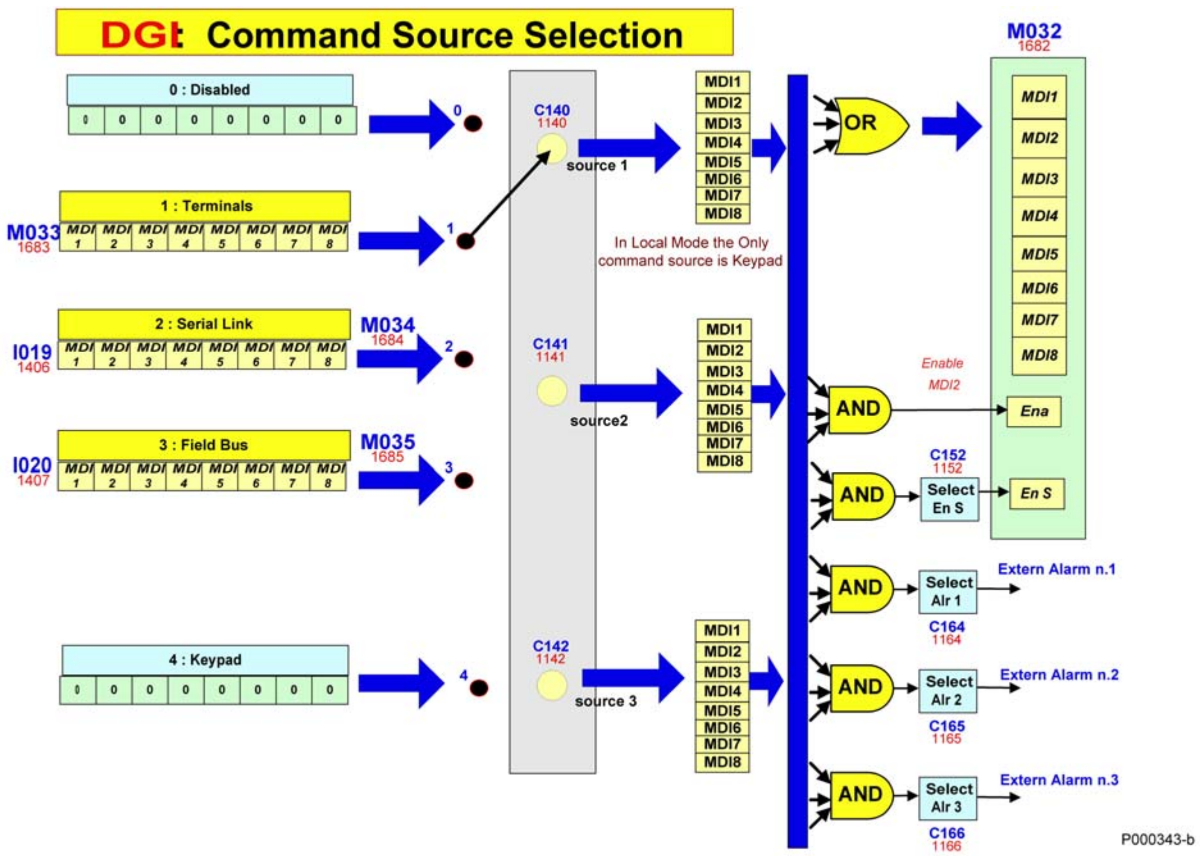


Figure 45: Selecting the command sources.

If the keypad is not selected as a command source or if the STOP input function is enabled (C150≠0), more than one command source may be enabled at a time. In this case, the logic function implemented by the drive for the terminals of all active command sources is the following:

- AND for the terminals allocated to the ENABLE, ENABLE–S, External Alarms n.1, n.2, n.3 functions;
- OR for all other terminals.

NOTE If the keypad is enabled as a command source, the **START**, **STOP**, **RESET**, **FWD/REV**, **LOC/REM** functions are enabled (to disable **FWD/REV LOC/REM** see parameter **P269**). The keypad is ignored for the processing of logic functions (AND/OR) of the other command sources that are enabled at that moment.

NOTE As the **ENABLE** command of the hardware terminal board is a hardware safety device (it enables the drive) it is always active, even when none of parameters **C140, C141** or **C142** selects the terminal board (=1).

NOTE The commands for the **External Alarm n.1, n.2, n.3** functions are always considered for the drive terminal board only.

NOTE The ***LOCAL mode,*** that can be enabled with the **LOC/REM** key on the keypad or with the **LOCAL** command function from the terminal board (see **C180**), forces the keypad as the only command source, thus ignoring the values set in parameters **C140, C141, C142**.
The following functions are therefore enabled for the hardware terminal board: **External Alarm n.,1 n.2, n.3, Motor Sel. n.2, Motor Sel. n.3, SLAVE, PID Disable, LOCAL** and the **ENABLE** and **RESET** functions are always enabled for terminals **MDI2** and **MDI3**.

Table 76: Remote command inputs from serial link.

MODBUS Address	Input Code	User Level	Description	Range
1406	I019	BASIC	Remote, virtual terminal board from serial link	Bit input: 0÷1 for 8 bits corresponding to MDI1÷ MDI8
1407	I020	BASIC	Auxiliary, virtual terminal board from serial link	Bit input: 0÷1 for 8 bits corresponding to XMDI1÷ XMDI8

NOTE **I020** is enabled only if **R023** is set other than 0.

Example:

If **C140** = 3 (Fieldbus) and **C141** = 2 (Serial link), the **ENABLE** command is sent by closing terminal **MDI2** on the terminal board and (AND) by forcing bit **MDI2** from the serial link on input **I019** (MODBUS address: 1406) **and** bit **MDI2** from Fieldbus (see the FIELDBUS CONFIGURATION MENU).
The **START** command may also be sent (OR) by forcing bit **MDI1** from serial link on input **I019** **or** by forcing bit **MDI1** from Fieldbus for the relevant variable.

34.1.2. SPEED/TORQUE REFERENCE SOURCES

The "**main reference**" is the value at constant speed to be attained by the controlled variable (speed or torque) (**M000**, **M007**) "required" from the drive.
This reference is acquired by the drive only if the **START** command and the **ENABLE** commands are active; otherwise, it is ignored.
When the main reference is acquired by the drive (**START** and **ENABLE** are active), it becomes the input signal controlled by the "time ramp" functions that generate the speed/torque reference setpoint for the connected motor.

The speed or torque references may come from the following command sources:

0. **Source disabled;**
1. **REF** (*single–ended analog input from terminal board*);
2. **AIN1** (*differential analog input from terminal board*);
3. **AIN2** (*differential analog input from terminal board*);
4. **FIN** (*frequency input from terminal board; see also the ENCODER/FREQUENCY INPUTS MENU);*
5. **Serial link** (*with MODBUS protocol*);
6. **Fieldbus** (*fieldbus in option board*);
7. **Keypad** (*remotable display/keypad*);
8. **Encoder** (*in terminal board MDI6–ECHA, MDI7–ECHB or option board*);
9. **Up Down from MDI** (*Up/down from digital inputs, see* **C161** and **C162**)
10. **XAIN4** (*auxiliary, differential voltage analog input from ES847 terminal board)*
11. **XAIN5** (*auxiliary, differential current analog input from ES847 terminal board)*

NOTE If multiple reference sources are selected, the processed reference is the algebraic sum of all enabled references.

REF, AIN1 and AIN2

The sources called REF, AIN1 and AIN2 come from the analog inputs in the terminal board and generate a reference resulting from the setting of the relevant parameters (from **P050** to **P064**). See the INPUTS FOR REFERENCES MENU for the scaling, offset compensation and filtering of the reference obtained. The inputs may be used as voltage or current inputs depending on the setting and the position of the relevant dip-switches (see the Sinus Penta's Installation Instructions manual).

FIN

The *FIN* source is a frequency input on terminal **MDI6 (FINA)** or **MD18 (FINB)** and it generates a reference determined by the setting of the relevant parameters (from **P071** to **P072**), allowing proper scaling (see the INPUTS FOR REFERENCES MENU and the ENCODER/FREQUENCY INPUTS MENU).

SERIAL LINK

The *Serial Link* source is an input located on the MODBUS link: the reference value must be written by the user to the addresses below:

Table 77: Reference inputs from serial link.

MODBUS Address	Input Code	User Level	Reference	Description	Range	Unit of measure
1412	I025	BASIC	Speed	Speed reference/limit (integer portion)	Min. speed ÷ Max. speed	RPM
1413	I026	BASIC	Speed	Speed reference/limit (decimal portion)	–99 ÷ 99	RPM/100
1416	I029	BASIC	Torque	Torque reference/limit	Min. torque ÷ Max. torque	Tenths %

NOTE

I025 is the speed reference if at least one among parameters **C143..146** is set to 5:Serial Link and the type of reference of the active motor (parameters **C011** / **C054** / **C097**) is set to 0:Speed; I025 is the speed limit if **C147**=5:Serial Link and the type of reference of the active motor is set to 2:Torque with Speed Limit. The range of this reference depends on the active Minimum Speed value and Maximum Speed value as set in parameters **C028** and **C029** (for motor 1, and relevant parameters for motor 2 and motor 3).
If **C029** ≤ **C028**, then **Min. speed** = **C029**, **Max. speed** = **C028**.
If **C029** ≥ **C028**, then **Min. speed** = **C028**, **Max. speed** = **C029**.

NOTE

I026 is the decimal portion of the speed reference in RPM and has effect in **FOC** motor control mode only.

NOTE

I029 is used as a torque reference if at least one among parameters **C143..146** is set to 5:Serial Link and the type of reference of the active motor (parameters **C011** / **C054** / **C097**) is set to 1:Torque or 2:Torque with Speed Limit. **I029** is used as a torque limit if **C147**=5:Serial Link.
I029 is expressed as a percentage of the max. absolute torque set with the parameters **C047** and **C048** (motor 1, and relevant parameters for motor 2 and motor 3). The max. absolute torque is the max. value between absolute values of parameters **C047** and **C048**.
Max. absolute torque = Max(| **C047** | , | **C048** |)
The unit of measure is tenths of %:
Torque reference % = (I029*0.1) %
Reference range:
If **C047** ≤ **C028**, then **Min. speed** = **C029**, **Max. speed** = **C028**.
If **C029** ≥ **C028**, then **Min. speed** = **C028**, **Max. speed** = **C029**.
Example: 1200 = 120.0%

FIELDBUS

For a description of the **Fieldbus** source, see the FIELDBUS CONFIGURATION MENU.

KEYPAD

NOTE

The keypad is a special reference source. The keypad reference may be altered with the ▲ and ▼ keys only if this reference is on a Keypad page displaying a reference in line 4.
If the keypad is enabled, a **variation** to the active reference may be added through an algebraic sum (calculated by processing the other reference sources that are activated at that moment).
The reference variation method can be selected with parameters **P067**, **P068**, **P069**, and **C163**.
This function is the same as the **UP** and **DOWN** functions from the terminal board (see the DIGITAL INPUTS MENU: **C161** and **C162 and P068÷P069** in the INPUTS FOR REFERENCES MENU).

NOTE

The *LOCAL mode,* that can be enabled with the *LOC/REM key* on the keypad or with the **LOCAL** command function from terminal board (see **C180**), forces the keypad to become the only command and reference source, thus ignoring the values set in parameters **C143, C144, C145, C146**.

ENCODER

The *Encoder* source is an encoder input: it can come from the terminal board (terminals **MDI6, MDI7**) in Encoder A, or from the optional Encoder B board (see the ENCODER/FREQUENCY INPUTS MENU). It generates a reference resulting from the correct setting of the relevant parameters (**P073, P074**), allowing the relevant scaling (see the INPUTS FOR REFERENCES MENU).

UP/DOWN from digital inputs

To enable the **UP/DOWN from digital inputs** also set the relevant Up and Down inputs (see the DIGITAL INPUTS MENU).

XAIN4 and XAIN5

XAIN4 and XAIN5 come from the analog inputs in the terminal board of ES847 and generate a reference determined by the settings of the relevant parameters (**P390** to **P399**), allowing proper scaling, offset compensation and filtering (see the INPUTS FOR REFERENCES FROM OPTIONAL BOARD).

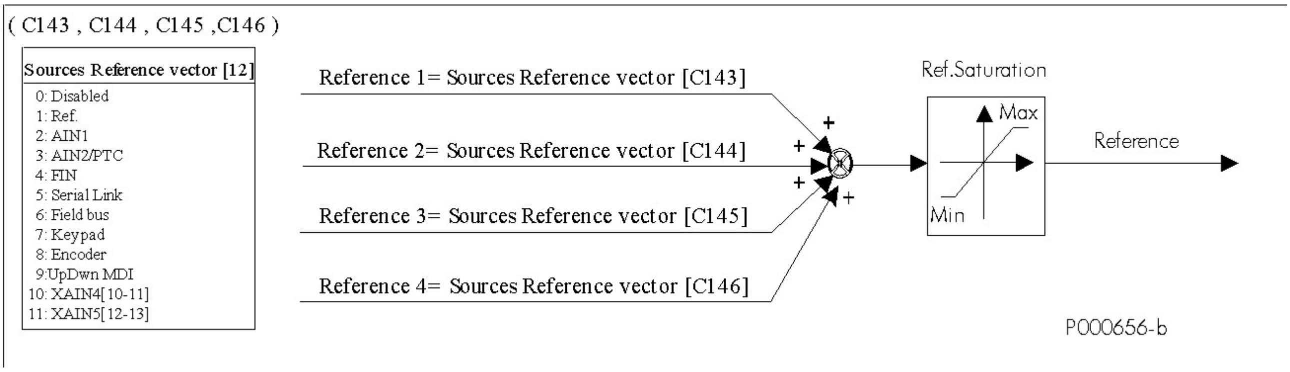


Figure 46: Selecting the source references.

34.1.3. ALTERNATIVE COMMAND AND REFERENCE SOURCES

A digital input can be set as a selector between 2 alternative command and reference sources.

Example:

C179 MDI To select sources = **MDI6**
C140 To select command source number 1 = **Keypad**
C141 To select command source number 2 = **Fieldbus**
C143 To select reference source number 1 = **AIN1**
C144 To select reference source number 2 = **Fieldbus**

If MD16 (in the drive terminal board) set as a selector is open, the drive will consider number 1 as reference and command sources (that is **C140** = **Keypad** and **C143** = **AIN1**); if it is closed, number 2 will be considered (**C141** = **Fieldbus** and **C144** = **Fieldbus**).
If references sources 3 and 4 (**C145 and C146**) are not set to Disable, the reference sent for these sources shall be a sum of the source selected by MD16 vector.

See **C179** in the DIGITAL INPUTS MENU.

34.1.4. Torque Limit Source

The source of the Torque Limit can be selected with parameter **C147**.
The Torque limit function is a limit of the absolute value of the torque required from the drive.
(– Torque limit) <= torque <= (+ Torque limit)

The torque limit references may be selected from the following:

0. **Source disabled**
1. **REF** (*single–ended analog input from terminal board*);
2. **AIN1** (*differential analog input from terminal board*);
3. **AIN2** (*differential analog input from terminal board; see also the ENCODER/FREQUENCY INPUTS MENU);*
4. **FIN** (*frequency input from terminal board*);
5. **Serial link** (*with MODBUS protocol*);
6. **Fieldbus** (*fieldbus on option board*);
7. **Keypad** (*remotable display/keypad*);
8. **Encoder** (*in terminal board MDI6–ECHA , MDI7–ECHB or option board*);
9. **Up Down from MDI** (*Up/down from digital inputs, see* ***C161*** *and* ***C162***)
10. **XAIN4** (*auxiliary, differential voltage analog input from ES847 terminal board)*
11. **XAIN5** (*auxiliary, differential current analog input from ES847 terminal board)*

NOTE

If the reference source is disabled, the torque limit results from the max. absolute torque determined by the drive size and the motor size.
The max. absolute torque is the max. value ranging between the absolute values of **C047** and **C048** (motor 1, and relevant parameters for motor 2 and motor 3).
Max. absolute torque = Max(| **C047** | , | **C048** |)

Factory setting is **C147**=0: the reference source is disabled and the torque limit is given by the max. absolute torque.

34.1.5. Remote/Local Mode

According to factory-setting, switching over from the **Remote** mode to the **Local** mode can only be made when the drive is disabled. The reference and command sources for the **Remote** mode depend on the settings of parameters **C140** to **C147** in the CONTROL METHOD MENU and on the settings of parameters **C285** to **C287** in the PID CONFIGURATION MENU. When switching over from the Remote mode to the Local mode, the command and reference can be sent via keypad only. This is true for the switch over from the **Local** to the **Remote** mode as well.
Parameter **C148** allows customizing the Loc/Rem function so that it can be performed even when the drive is running. Parameter **C148** also allows setting whether the same running condition and the same reference must be maintained when switching over from the Remote to the Local mode.

NOTE

For more details on the Loc/Rem function, see LOC/REM Key (Keypad Pages) and DIGITAL INPUTS MENU.

34.2. List of Parameters C140 to C148

Table 78: List of parameters C140 to C148.

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
C140	Command digital input 1	ADVANCED	1140	1:Terminal Board
C141	Command digital input 2	ADVANCED	1141	1:Terminal Board
C142	Command digital input 3	ENGINEERING	1142	0
C143	Input reference 1	ADVANCED	1143	1: REF
C144	Input reference 2	ADVANCED	1144	2: AIN1
C145	Input reference 3	ENGINEERING	1145	0
C146	Input reference 4	ENGINEERING	1146	0
C147	Torque Limit input	ENGINEERING	1147	0
C148	Switch over from Remote to Local command	ENGINEERING	1148	0: StandBy or Fluxing

NOTE The programming range of parameters **C140**, **C141**, **C142** depends on the setting of parameter **C150** and vice versa (see the detailed description of the parameters above).

<u>C140 (C141, C142) Command Source Selection 1 (2, 3)</u>

C140 (C141, C142)			
	Range	0 ÷ 5	0: Disabled, 1: Terminal Board, 2: Serial Link, 3: Fieldbus, 4: Terminal Board B, 5: Keypad
	Default	C140 ÷ C141= 1 C142 = 0	C140 ÷ C141= 1: Terminal Board C142 = 0: Disabled
	Level	C140 ÷ C141 ADVANCED; C142 ENGINEERING	
	Address	1140 (1141,1142)	
	Function	Selection of the drive command source.	

NOTE If the command source is set as Keypad, different command sources can be set up only if the STOP or STOP B digital inputs are programmed (see **C150** and **C150a**) to enable pushbutton operation or to make sure that the Source Selection function is activated (see **C179**).

NOTE If the first command source is already set and it is not a Keypad source, you can set the Keypad as a second or third source, only if the STOP or STOP B inputs are programmed (**C150** ≠ 0 or **C150a** ≠ 0) to enable pushbutton operation or to make sure that the Source Selection function is activated (see **C179**).

C143 (C144, C145, C146) Reference 1 (2, 3, 4) Selection

C143 (C144, C145, C146)	Range	0 ÷ 9 0 ÷ 11 if ES847 is in	0: Disabled 1: REF 2: AIN1 3: AIN2 4: Frequency input 5: Serial Link 6: Fieldbus 7: Keypad 8: Encoder 9: UpDown from MDI 10: XAIN4 11: XAIN5
	Default	C143 = 1, C144 = 2 C145 ÷ C146 = 0	C143 = 1: REF, C144 = 2: AIN1 C145 ÷ C146 = 0 : Disabled
	Level	C143 ÷ C144 ADVANCED; C145 ÷ C146 ENGINEERING	
	Address	1143 (1144, 1145, 1146)	
	Function	This parameter selects the sources for the speed (or torque) reference. The reference resulting from the sum of the selected sources represents the drive speed or torque reference. If the PID action has been set as reference **C294 = Reference**, the drive speed or torque references shall only be given by the PID output and not by the sources set in **C143 ÷ C146**. Reference sources 10 and 11 can be selected only after setting XAIN in parameter R023.	

C147 Torque Limit Input

C147	Range	0 ÷ 9	0: Disabled 1: REF 2: AIN1 3: AIN2 4: Frequency input 5: Serial Link 6: Fieldbus 7: Keypad 8: Encoder 9: UpDown from MDI 10: XAIN4 11: XAIN5
	Default	0	0: Disabled
	Level	ENGINEERING	
	Address	1147	
	Control	VTC and FOC	
	Function	If a speed control with FOC or VTC control algorithms is used, an external torque limit can be used. Parameter **C147** selects the Torque Limit source. The torque ramp times set in **P026–P027** will be applied to the torque limit reference source that has been selected. The external torque limit may be disabled by closing the digital input set with **C187**. Limiting sources 10 and 11 can be selected only after setting XAIN in parameter **R023**.	

NOTE

If the reference source is disabled, the torque limit results from the max. absolute torque determined by the drive size and the motor size.
The max. absolute torque is the max. value ranging between the absolute values of **C047** and **C048** (motor 1, and relevant parameters for motor 2 and motor 3).
Max. absolute torque = Max(| **C047** | , | **C048** |)

Factory-setting : the reference source is disabled (C147=0), so the torque limit depends on the max. absolute torque (see also the INPUTS FOR REFERENCES MENU).

<u>C148 Switch over from Remote to Local Command</u>

C148	Range	0 ÷ 3	0: StandBy + Fluxing 1: Drive Running / No Bumpless 2: Drive Running / Commands Bumpless 3: Drive Running / All Bumpless
	Default	0	0: StandBy or Fluxing
	Level	ENGINEERING	
	Address	1148	
	Function	The drive factory-setting (0: StandBy or Fluxing) allows switching over from Remote to Local mode (and vice versa) only when the drive is not running. Different settings allowed by parameter **C148** are detailed below; switching from Remote to Local mode (and vice versa) can be performed even when the drive is running: • **No Bumpless** → When switching from Remote to Local mode, a “zero” speed or torque reference is sent to the drive; the **START** button must be pressed to start the drive. • **Commands Bumpless** → When switching from Remote to Local mode, a “zero” speed or torque reference is sent to the drive, but the running conditions are the same as in Remote mode. For example, if the motor is running in Remote mode, the drive still runs even in Local mode and the reference can be changed with the **INC/DEC** key, starting from “zero”. • **All Bumpless** → When switching from Remote to Local mode, the drive maintains the same speed/torque reference and the same running condition as in Remote mode. For example, if the motor is running at 1000 rpm in Remote mode, the drive still runs even in Local mode with a reference of 1000 rpm that can be changed with the **INC/DEC** key, starting from “zero”.	

NOTE

Parameter **C148** affects parameters **C140** to **C147** and **C285** to **C287** (see PID CONFIGURATION MENU) when the PID controller is enabled.

35. DIGITAL INPUTS MENU

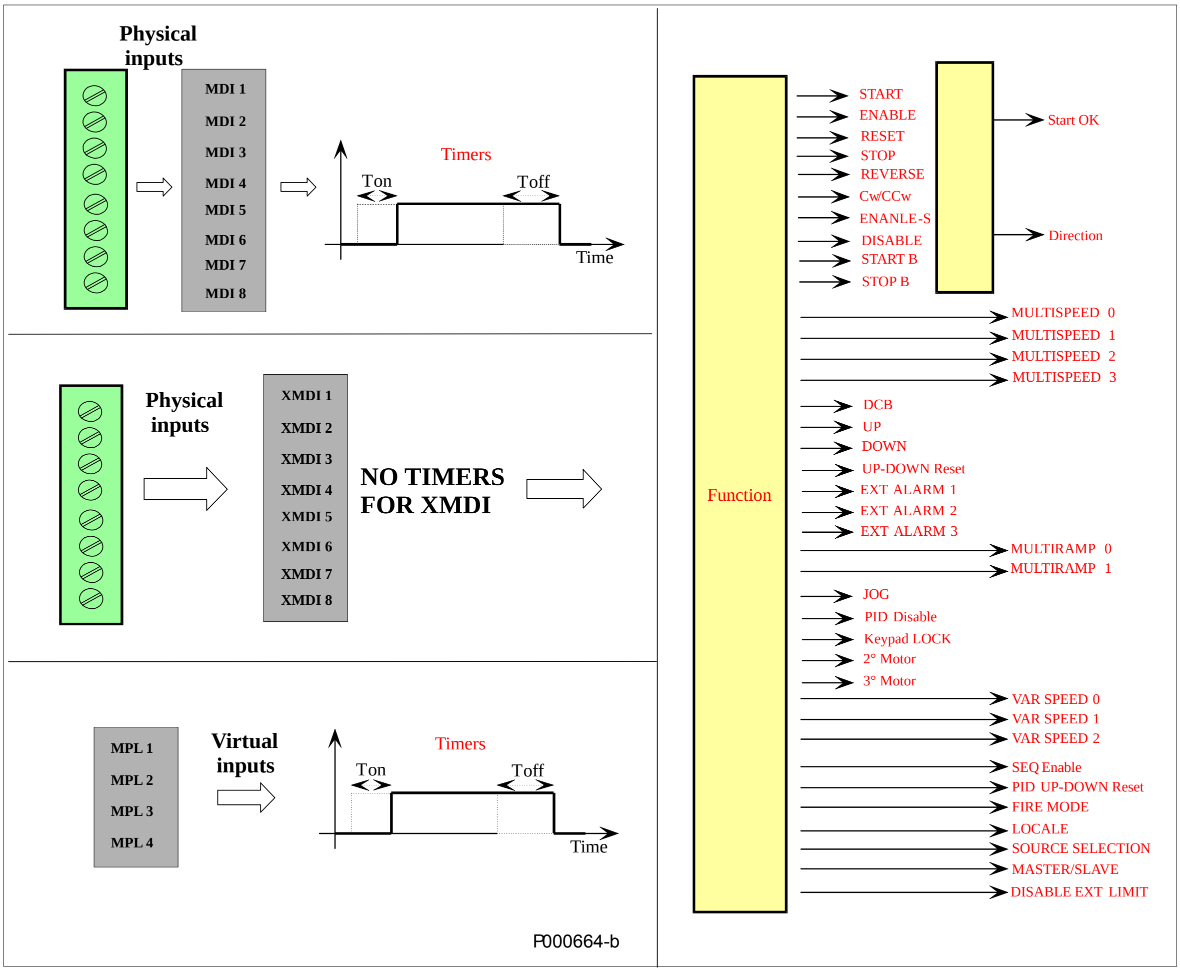
35.1. Overview

NOTE

Please refer to the Sinus Penta's Installation Instructions manual for the hardware description of the digital inputs.

The parameters contained in this menu assign particular digital control functions to each digital input in the terminal board. Each parameter has a particular function, which is assigned to a given terminal on the terminal board.

Figure 47: Inputs that can be selected to implement control functions.



The full processing of the digital inputs also includes the selection of other remote/virtual terminal boards (see the CONTROL METHOD MENU) and the possibility of delaying input digital signal enable/disable by means of software timers (see the TIMERS MENU).

As shown in the figure above, the digital input status is displayed in measures M031, M032, M033.
Measure M033 shows the current status of the 8 inputs in the local hardware terminals in the drive board.
The symbol ℜ displays the logic levels for terminals M033 for inactive inputs; the active inputs are marked with ⇐.

Measure M032 shows the current status of the virtual terminal board obtained by processing all active terminal boards. It includes 10 signals, with two additional signals with respect to the local hardware terminal board:

- Inputs MDI1 ~ MDI8 are obtained with the **logic OR** of the input signals for all active terminals;
- The ENABLE input is obtained with the logic **AND** of the input signals for terminal **MDI2** in all active terminal boards;
- The ENABLE–S input is obtained with the logic **AND** of the terminals selected for this function in all active terminal boards.

Measure M031 is similar to **M032**, but it displays the status of the terminal board obtained after delaying the input signals of M032 using special timers.
The drive uses this terminal board to acquire digital commands.
Some functions cannot be programmed, but they are assigned to special terminals:

Table 79: Unprogrammable functions.

Function	*Terminal*
START	MDI1
ENABLE	MDI2
RESET	MDI3 (can be disabled if **C154**=Yes)

Some terminals in the local hardware terminal board can also be used for different functions:

Table 80: Terminals used for other inputs.

Terminal	*Description*
MDI6	ECHA: channel A of **encoder A** in the terminal board
MDI7	ECHB: channel B of **encoder A** in the terminal board
MDI8	FIN: frequency input

35.1.1. START (TERMINAL 14:MDI1)

To enable the Start input, set the control modes via terminal board (factory setting). The **START** command can also be sent from the display/keypad.
The enabling/disabling of the **MDI1** input can be delayed using special timers.
The **START** input function is assigned to MDI1 terminal and cannot be set to other terminals, whereas the same terminal may be assigned to different functions.
The motor stop mode (**C185**) can be programmed. When sending a **START** command, the following motor stop modes can activate:
the motor stops following a deceleration ramp or starts idling; the motor is fluxed (VTC, FOC) only when the **START** command is shut down and the **ENABLE** is not closed (**C184**).
When **START** is **active** (and when **ENABLE** is active as well), the **RUN** command is enabled: the speed (or torque) *setpoint* increases proportionally to the preset ramp until it reaches the active *reference*. (IFD control: in order to enable the RUN command, the main speed reference must be other than zero).
When **START** is **inactive** (but **ENABLE** is active), the **RUN** command is disabled: the reference is set to zero and the speed (or torque) setpoint decreases down to zero depending on the preset deceleration ramp.

NOTE

The way the **START** enables or disables the **RUN** command also depends on the setup of other functions, in particular the **STOP**, **REVERSE** and **JOG** functions (see parameters **C150**, **C151**, **C169**).
If the **REVERSE** (C151≠0) function is enabled, it can enable/disable the **RUN** command. However, if the **START** and **REVERSE** commands are both active, the **RUN** command is disabled.
*In this case, **START** is interpreted as FORWARD and **REVERSE** as REVERSE. When both Start and Reverse are active, the system cannot interpret the query to be FORWARD or REVERSE.*
If the **JOG** function is enabled (C169≠0), it can enable/disable the **RUN** command, but only if the **RUN** command has not been previously enabled by other functions.
If the **STOP** function is enabled (C150≠0), the **RUN** command may be enabled/disabled only by pressing the relevant "key": see the description of the **STOP** function (**C150**).

NOTE

If only the keypad is enabled as the command source, press the **START** key located on the keypad to enable the drive **RUN** and press the **STOP** key to disable the drive **RUN**.

NOTE

If **C185** = Free Wheel when activating the start command, the drive will not carry out the deceleration ramp and will be put on stand-by.

35.1.2. ENABLE (TERMINAL 15:MDI2)

The ENABLE input function is assigned to terminal MDI2 and **enables the drive operation**. It cannot be set to other terminals, whereas the same terminal may be assigned to different functions.
The ENABLE input is always to be activated to enable the inverter operation irrespective of the control mode.
If the ENABLE input is disabled, the drive output voltage is always set to zero, so the connected motor starts idling (the motor idles and stops due to friction or the mechanical load).
In case of pulled loads (e.g. lifting applications), when the motor is idling, the mechanical load could cause the motor to run at uncontrolled speed!

If the ENABLE input is disabled when the drive is controlling the motor, it is closed with a delay time depending on the drive size. This ENABLE delay starts from the instant when the input is disabled irrespective of the enable delay (if any) set through a software timer in MDI2.

The operating mode and the logic used by the ENABLE input to enable/disable the drive also depends on the programming of the ENABLE–S and DISABLE functions.

If the IFD control is used, the drive enabling also depends on the START input and the current value of the active reference. If the START command is active but the reference is lower than the preset threshold, the drive operation is disabled. To enable this operating mode with other types of control, parameters P065 and P066 must be set accordingly.
The drive may also be disabled by the PID regulator (see parameter P255).

CAUTION: If the ENABLE input signal is disabled for one of the active terminals, the drive is instantly disabled and the motor starts idling! The motor could run at uncontrolled speed due to the activation of the mechanical load. If so, the mechanical load could cause uncontrolled acceleration/slowing down of the connected motor!

CAUTION: If a protection/alarm trips, the drive disables and the motor starts idling!

NOTE: If software timers are enabled for digital inputs, the timer for the ENABLE signal (timer active for MDI2) delays the signal enabling. The ENABLE signal is always instantly disabled (*for the ENABLE function, Toff in MDI2 is ignored*).

NOTE: The activation of the ENABLE command enables the alarms controlling the configuration consistency of certain parameters.

NOTE: When the ENABLE signal is shutdown, C parameters cannot be altered (factory-setting). If P003 Condition required for altering C parameters = Standby+Fluxing, the parameters may be altered even if the drive is enabled but the motor is not running.

NOTE: When the ENABLE signal is shutdown for VTC and FOC controls, the motor is fluxed by the drive. Motor fluxing is allowed only if the START contact is shutdown and C184 = Yes.

NOTE: If set accordingly, safety parameter C181 prevents the drive from starting if the ENABLE signal is already active when the drive is powered on.

35.1.3. RESET (TERMINAL 16:MDI3)

The **RESET** function is assigned to input terminal **MDI3**. It resets the alarms to unlock the drive operation. It cannot be set to other terminals, whereas the same terminal may be assigned to different functions. To allocate the reset function to a different terminal than MDI3, set **C154** = Yes.
If a protection trips, the drive locks, the motor starts idling (the motor idles and stops due to friction or the mechanical load) and an alarm message is displayed (see also the AUTORESET MENU and the ALARMS AND WARNINGS section).

Reset procedure
To unlock the drive, activate the **RESET** input for an instant, or press the **RESET** key on the keypad. When the drive unlocks and the cause responsible for the alarm has disappeared, "Inverter ok" comes up on the screen, otherwise, the alarm persists and cannot be reset.
If set up accordingly, safety parameter **C181** permits to deactivate and reactivate the **ENABLE** signal to restart the drive once the cause responsible for the alarm has disappeared.

NOTE — Factory setting does not reset alarms at power off. Alarms are stored and displayed at next power on and the drive is locked. A manual reset is then required to unlock the drive (see the AUTORESET MENU).

CAUTION — If an alarm trips, see the ALARMS AND WARNINGS section and reset the equipment after detecting the cause responsible for the alarm.

DANGER!!! — Electrical shock hazard exists on output terminals (U, V, W) and resistive braking module terminals (+, –, B) even when the drive is disabled.

NOTE — Set C154 = Yes to remove the reset function from MDI3. After that, only one different function can be allocated to MDI3 even when multiprogramming is active (see parameter C182).

35.2. Factory-setting of the Digital Inputs

Table 81: Terminal board: Factory-setting.

Function	Terminal	Description
START	14: MDI1	Enables the drive RUN
ENABLE	15: MDI2	Enables the drive
RESET	16: MDI3	Resets the alarms tripped
MULTISPEED 0	17: MDI4	Bit 0 for Multispeed selection
MULTISPEED 1	18: MDI5	Bit 1 for Multispeed selection
Source Sel	19: MDI6	Source Selection
Loc/Rem	20: MDI7	Local / Remote Control Selection
CwCCW	21: MDI8	Reference reversal

35.3. List of Parameters C149a to C188c and I006

The parameters ranging from C149a to C180 and from C186 to C187 (one for each command function) activate single functions and set the terminal for each enabling/disabling function.
Parameter C181 enables a safe START mode.
Parameter C182 enables multiple programming (if compatible) to the same terminal. Max. two functions can be programmed to the same input.

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
I006	Function selection for DGI control	ADVANCED	1393	inactive
C149a	START B Input	ADVANCED	1297	none
C150	STOP Input	ADVANCED	1150	none
C150a	STOP B Input	ADVANCED	1298	none
C151	REVERSE Input	ADVANCED	1151	none
C151a	REVERSE B Input	ADVANCED	1299	none
C152	ENABLE–S Input	ADVANCED	1152	none
C153	DISABLE Input	ADVANCED	1153	none
C154	Disable RESET alarms on MDI3	ADVANCED	1154	NO
C155	MULTISPEED 0 Input	ADVANCED	1155	MDI4
C156	MULTISPEED 1 Input	ADVANCED	1156	MDI5
C157	MULTISPEED 2 Input	ADVANCED	1157	none
C158	MULTISPEED 3 Input	ADVANCED	1158	none
C159	CW/CCW Input	ADVANCED	1159	MDI8
C160	DCB Input	ADVANCED	1160	none
C161	UP Input	ADVANCED	1161	none
C162	DOWN Input	ADVANCED	1162	none
C163	RESET UP/DOWN Input	ADVANCED	1163	none
C164	External alarm 1 Input	ADVANCED	1164	none
C164a	External alarm 1 trip delay	ADVANCED	1305	immediate
C165	External alarm 2 Input	ADVANCED	1165	none
C165a	External alarm 2 trip delay	ADVANCED	1306	immediate
C166	External alarm 3 Input	ADVANCED	1166	none
C166a	External alarm 3 trip delay	ADVANCED	1307	immediate
C167	MultiRamp 0 Input	ENGINEERING	1167	none
C168	MultiRamp 1 Input	ENGINEERING	1168	none
C169	JOG Input	ADVANCED	1169	none
C170	SLAVE Input	ADVANCED	1170	none
C171	PID DISABLE Input	ADVANCED	1171	none
C171a	Input for PID control selection	ENGINEERING	1188	none
C172	KEYPAD LOCK Input	ADVANCED	1172	none
C173	MOTOR 2 SEL. Input	ENGINEERING	1173	none
C174	MOTOR 3 SEL. Input	ENGINEERING	1174	none
C175	SPEED VAR. 0 Input	ENGINEERING	1175	none
C176	SPEED VAR. 1 Input	ENGINEERING	1176	none
C177	SPEED VAR. 2 Input	ENGINEERING	1177	none
C178	PID RESET UP/DOWN input	ADVANCED	1178	none
C179	SOURCE SELECTION Input	ADVANCED	1179	MDI6
C180	LOC/REM Input	ADVANCED	1180	MDI7
C180a	Type of LOC/REM contact	ADVANCED	1303	Pushbutton+Storage
C181	Safety Start enable	ADVANCED	1181	inactive
C182	Multiprogramming enable	ENGINEERING	1182	inactive
C183	Max. fluxing time before drive Disable	ADVANCED	1183	disabled
C184	Fluxing at activation only with START closed	ADVANCED	1184	no
C185	Stop Mode	ADVANCED	1185	deceleration ramp
C186	Fire Mode enabling Input	ENGINEERING	1186	none

Table 82: List of parameters C149a to C188c and I006.

C187	Torque Limit Source Ref. Disabling Input	ADVANCED	1187	none
C188a	PID Multireference 1 Input	ENGINEERING	1365	none
C188b	PID Multireference 2 Input	ENGINEERING	1366	none
C188c	PID Multireference 3 Input	ENGINEERING	1367	none

NOTE — If a parameter is set to zero, its function is disabled, otherwise the parameter value stands for the MDIx input assigned to the function.

NOTE — Auxiliary digital inputs XMDI (values from 13 to 20 in control function parameters) can be set up only after setting XMDI/O in parameter **R023**.

CAUTION — Set **C182=1** to allocate 2 functions to the same terminal.

I006 Function Selection for DGI Control

I006	Range	0 ÷ 2	0 → Inactive 1 → Clear all 2 → Set factory default
	Default	This is not a programming parameter: the input is set to zero whenever the drive is powered on and whenever the command is executed.	
	Level	ADVANCED	
	Address	1393	
	Function	0 → Inactive. 1 → Forces to "0 → Inactive" the settings of all the digital inputs. 2 → Forces to the default values the settings of all the digital inputs.	

C149a START B Input

C149a	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1297	
	Function	The **START B** Input operates as the **START** Input (see START (Terminal 14:MDI1)) when Terminal Board B is active.	

C150 STOP Input

C150	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1150	
	Function	This parameter disables the **RUN** function enabled by the **START** command. The setting of this function affects the enabling/disabling mode of the **RUN** command: it can be enabled/disabled using the START and STOP keys or the START, STOP and REVERSE keys instead of the **START** key as an ON/OFF switch (factory-setting). If the drive is enabled: Press **START** to enable the drive **RUN**; Press **STOP** to disable the drive **RUN**: reference is set to zero, so the speed (or torque) setpoint decreases to zero based on the preset deceleration ramp. In case of preset **STOP**, the keypad and one or more terminal boards may be enabled at a time. In this case, the ***START*** key and the ***STOP*** key in the display/keypad are active and can enable or disable the drive **RUN**. The **STOP** input is a normally closed input signal.	

NOTE According to factory setting, only the hardware terminal board selected with command source 1 (**C140**=1) is active as a switch-operated mode (**C150**=0).
To switch to the key-operated mode, set the **STOP** input (**C150** ≠0). The keypad and other terminal boards may be selected in key-operated mode only.
If the **STOP** input is not programmed, and the switch-operated mode is active, the keypad may be selected as the only command source (**C140**=5, **C141**=0, **C142** =0).

NOTE The **STOP** function has priority over the **START** function; if both inputs are active, the **STOP** input prevails. Therefore, the **STOP** input acts as a key and as a **switch**.

NOTE The START/STOP commands are ignored when the drive is disabled.

C150a STOP B Input

C150a	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1298	
	Function	The **STOP B** Input acts as the **STOP** Input (see **C150**) when Terminal Board B is active. The **STOP B** is a normally closed input signal.	

C151 REVERSE Input

C151	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1151	
	Function	The **REVERSE** function carries out a **START** command, but it reverses the motor direction of rotation. If both the **START** and **REVERSE** inputs are active at the same time, the drive is sent a STOP command. If the **STOP** input function is not programmed (**C150**=0), the **REVERSE** signal and the **START** input act as switches, otherwise they act as keys.	

NOTE

If the keypad is active, pressing the **FWD/REV** key on the display/keypad will also reverse the direction of rotation of the connected motor.
The reference direction of rotation can be reversed with **Cw/CCw** if this is set up (**C159** ≠ 0).
Both functions cause a signal reversal; if they are both active, they will cancel each other.

NOTE

The keypad and the terminal board can be simultaneously activated only if the **STOP** (**C150** ≠ 0) function is activated. Three sources for the signal reversal are then active: **REVERSE**, **Cw/CCw**, ***REV*** key; if two of them are active, they will cancel each other, while if all three sources are active, the reference sign will be reversed.

CAUTION

When the reference sign is reversed, <u>the direction of rotation of the connected motor is not immediately reversed</u>: the setpoint decreases to zero following the preset deceleration ramp, and it increases up to the reference value having the opposite sign following the preset acceleration ramp.

C151a REVERSE B Input

C151a	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1299	
	Function	The **REVERSE B** Input acts as the **REVERSE** Input (see **C151**) when Terminal Board B is active.	

The figure illustrates the processing logic diagram for the START, REV, Cw/CCw functions and the *START, STOP, REV* keys on the display/keypad if the STOP function is not programmed.

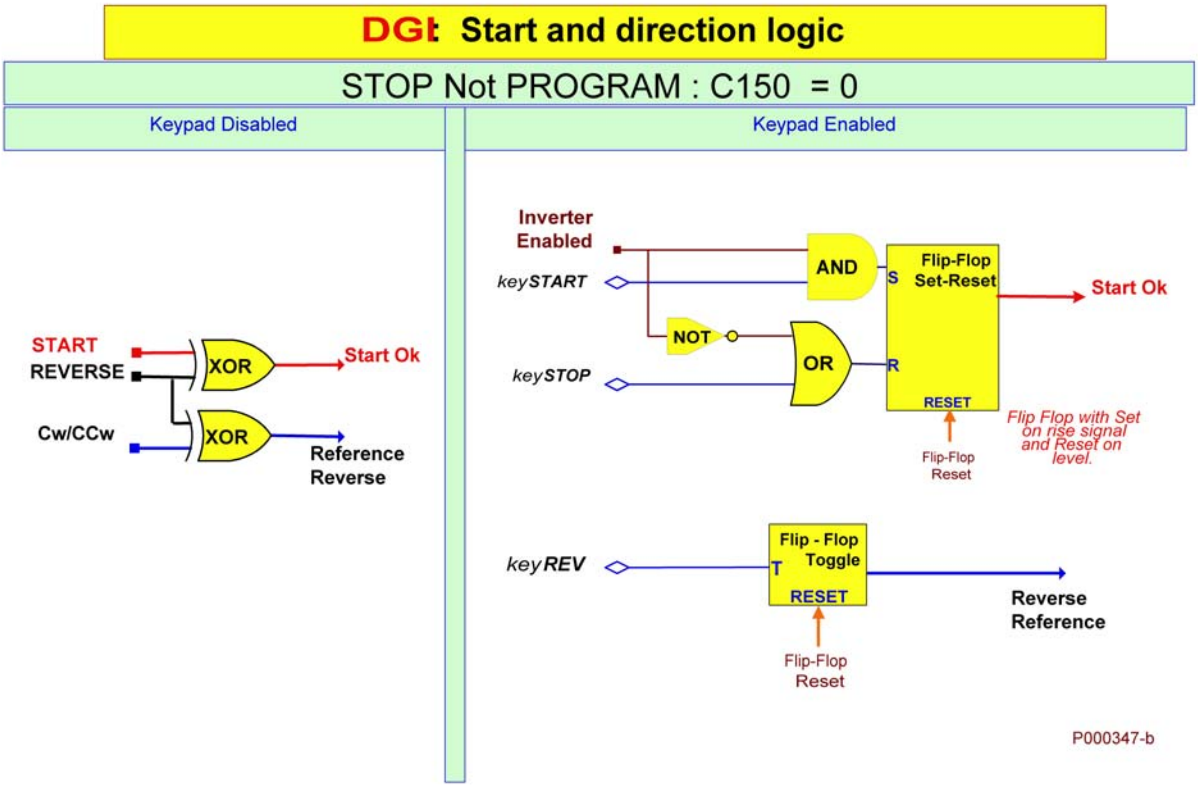


Figure 48: Controlling Run and Direction when the STOP Input is not programmed.

The figure illustrates the processing logic diagram for the **START**, **REV**, **Cw/CCw** functions and the ***START, STOP, REV keys*** on the display/keypad, if the **STOP** function is programmed.

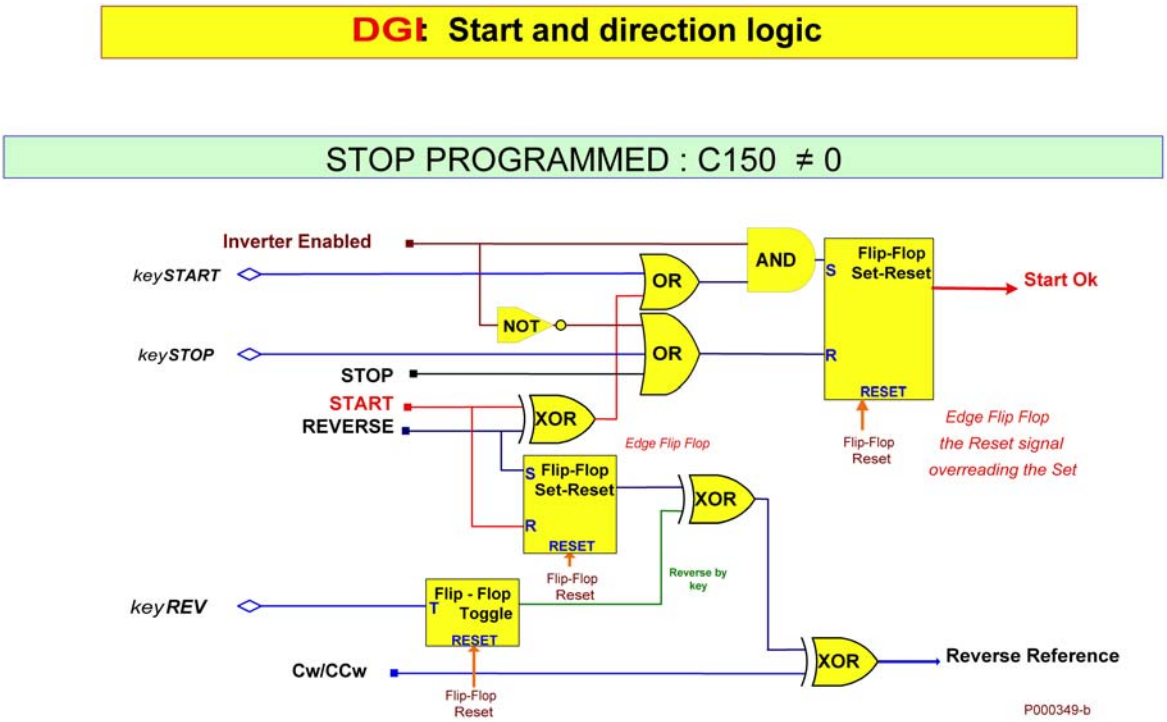


Figure 49: Controlling Run and Direction when the STOP Input is programmed.

C152 ENABLE–S Input

C152	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1152	
	Function	This is a safety ENABLE: if this function is enabled, the drive activates only if both **ENABLE** and **ENABLE–S** inputs are active.	

NOTE

The **ENABLE–S** signal cannot be delayed by software timers: if a timer is programmed for the terminal relating to **ENABLE–S**, it will have no effect on the **ENABLE–S** function, whereas it will normally delay other functions programmed for the same terminal.

C153 DISABLE Input

C153	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1153	
	Function	The **DISABLE** function disables the drive and overrides any **ENABLE** signals. The **DISABLE** command sets the drive output voltage to zero, so the motor starts idling (the motor idles and stops due to friction or the mechanical load). If the **DISABLE** function is set (**C153**≠0) to activate the drive, deactivate the input signal on the terminal selected with **C153** to enable the drive; then activate the **ENABLE** function (and the **ENABLE–S** function, if programmed).	

C154 Disable RESET Alarms on MDI3

C154	Range	0 ÷ 1	0: NO ; 1: Yes
	Default	0	0: NO
	Level	ADVANCED	
	Address	1154	
	Function	If **C154** =1 : Yes, the alarm reset function can be disabled from MDI3.	

C155, C156, C157, C158 MULTISPEED Inputs

C155 C156 C157 C158	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	**C155** = 4, **C156** = 5, **C157** = 0, **C158** = 0.	**C155** = MDI4, **C156** = MDI5, **C157** = **C158** = Inactive.
	Level	ADVANCED	
	Address	1155, 1156, 1157, 1158	
	Function	This function generates up to 15 speed references that can be programmed with parameters **P081**÷**P098** according to the programming mode set in **P080**. The 4 Multispeed functions determine which of the 15 active speed references are active: active value (**1**) or inactive value (**0**) of each preset input signal determines a bit-logic binary number: **MULTISPEED 0** is the less significant bit (bit 0) and **MULTISPEED 3** is the most significant bit (bit 3). If one of these functions is not set up, its relevant bit is "zero".	

Table 83: Multispeed selection.

Multispeed selected =	Bit 3	Bit 2	Bit 1	Bit 0
	MULTISPEED 3	MULTISPEED 2	MULTISPEED 1	MULTISPEED 0

Table 84: Selected Speed reference.

Function:	Status of the relevant input																
START	0	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
MULTISPEED 0	X	0	1	0	1	0	1	0	1	0	1	0	1	0	1	0	1
MULTISPEED 1	X	0	0	1	1	0	0	1	1	0	0	1	1	0	0	1	1
MULTISPEED 2	X	0	0	0	0	1	1	1	1	0	0	0	0	1	1	1	1
MULTISPEED 3	X	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1
Multispeed selected	*X*	*0*	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*	*14*	*15*
Resulting reference	0	(*)	P081	P083	P085	P087	P088	P089	P090	P091	P092	P093	P094	P095	P096	P097	P098

If one of these functions is not set up, its relevant bit is "zero".
For example, if C156 and C157 are Inactive (0), while C155 and C158 are programmed to two different terminals, only Multispeed 0, 1, 8, 9 can be selected, relating to the following references:

(*)	P081	P091	P092

(*) Factory-setting: (P080 = *Preset Speed*) if no Multispeed function is selected, the active reference **is** the reference set according to the parameters in the INPUTS FOR REFERENCES MENU.
If P080 = *Speed Sum*, the selected Multispeed function **adds up** to the active reference: the reference set according to the parameters in the INPUTS FOR REFERENCES MENU.
If P080 = *Preset Speed Esc*, the selected Multispeed **replaces** the active reference, which will be ignored. If no Multispeed function is selected, the resulting reference is equal to zero.
See also the INPUTS FOR REFERENCES MENU for the reference processing sequence: the **Speed Decrease** function and the **Reference Reversal** function become active downstream of the **Multispeed** function.

NOTE

In Table 84:
0 ⇒ Inactive input;
1 ⇒ Active input;
X ⇒ Input having no effect.

C159 CW/CCW Input

C159	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	8	MDI8
	Level	ADVANCED	
	Address	1159	
	Function	The Cw/CCw function reverses the **active reference signal**: the connected motor decelerates to zero following the preset deceleration ramp, then it accelerates following the preset acceleration ramp until it reaches the new reference value.	

C160 DCB Input

C160	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1160	
	Control	IFD and VTC	
	Function	For other types of control, this function has no effect even if **C160**≠0. The DCB command enables **DC braking** for a time period depending on the speed value determining the input activation. See the DC BRAKING MENU for more details.	

C161, C162 UP and DOWN Inputs

C161 C162	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1161, 1162	
	Function	This function increases (**UP**) or decreases (**DOWN**) the reference for which the **UpDown source from MDI has been selected** by adding a quantity to the reference itself. This also depends upon the following parameters: **C163** Up/Down Reset **P067** Up/Down Ramp Time **P068** Store Up/Down value at power off **P068a** Speed/Torque Up/Down Reset at stop **P068b** PID Up/Down Reset at stop **P068c** Speed/Torque Up/Down Reset at sources changeover **P068d** PID Up/Down Reset at sources changeover **P069** Up/Down Reference range	

C163 Reset Up/Down Input for Speed/Torque Reference

C163	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1163	
	Function	This function sets to zero the reference **variation** obtained via the **UP** or **DOWN** inputs or the ▲ and ▼ keys located on the display/keypad. The Up/Down reference (Speed/Torque only) may also be reset using different functions (see **P068a – P068c**).	

C164 , C165, C166 External Alarm Inputs

C164 C165 C166	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1164, 1165, 1166	
	Function	When allocating one of these 3 functions to a digital input, the status of this input will ALWAYS BE CHECKED ON THE DRIVE'S TERMINAL BOARD. When the command contact opens, the drive is locked due to an alarm tripped. Parameters **C164a, C165a, C166a** allow delaying external alarms. To restart the drive, the digital input set as an external alarm must be closed and a Reset procedure is required. Alarms tripped due to these 3 functions are **A083**, **A084**, **A085** respectively. This function is factory set as disabled.	

CAUTION

The terminal board for these 3 functions is the hardware terminal board of the drive. If different command sources are enabled (see the CONTROL METHOD MENU), the "External Alarm" signal command is obtained only for the hardware terminal board of the drive. Therefore, in order to avoid any external alarm, the input signal for the active terminal must be active in the terminal board.
Alarms trip when only one input signal for the terminal selected on one of the active command sources is disabled. A trip delay can be programmed with parameters **C164a, C165a, C166a.**

C164a (C165a, C166a) External Alarm Trip Delay

C164a C165a C166a	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Immediate
	Level	ADVANCED	
	Address	1305, 1306, 1307	
	Function	External alarm trip delay. To avoid untimely alarm trip, it may be necessary to set a check time for the opening of the input set as an external alarm before the alarm trips.	

C167, C168 MULTIRAMP Inputs

C167 C168			
	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ENGINEERING	
	Address	1167, 1168	
	Function	This function allows selecting up to **4 acceleration/deceleration ramps**. Each ramp has its own programming parameters; see **P009** ÷ **P025** (RAMPS MENU). These 2 functions determine which of the 4 ramps is to be selected: the active value (**1**) or inactive value (**0**) of each preset input signal determines a binary number with a bit-logic, where **Multiramp 0** is the less significant bit (bit 0) and **Multiramp 1** is the most significant bit (bit 1). **The ramps range from 1 to 4; for the selected ramp, add 1 to the binary figure obtained.** If one of these functions is not programmed, the relevant bit is "zero".	

Table 85: Multiramp selection.

		Bit 1	Bit 0	
Selected Ramp =	(	Multiramp 1	Multiramp 0	) + 1

Table 86: Selected ramp.

Function:	Input Status			
Multiramp 0	0	1	0	1
Multiramp 1	0	0	1	1
Selected Ramp	*1*	*2*	*3*	*4*
Active ramp times (parameters determining the ramp model)	P009 P010 P014 (*)	P012 P013 P014 (*)	P015 P016 P020 (*)	P018 P019 P020 (*)

If one of these functions is not programmed, its bit is "zero".
For example, if **C167** is Inactive (0) and **C168** is programmed for one terminal, only ramp **1** or ramp **4** can be selected.

NOTE (*) If the ramp rounding off function is enabled (**P021**≠0), the real ramp times also depend on the values set in parameters **P022**, **P023**, **P024**, **P025**, **P031**.

C169 JOG Input

C169	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1169	
	Function	When the JOG function is enabled, the motor rotates at low speed following slow ramps which are manually controlled by the user only by means of the keys in keypad. If the drive is enabled (**ENABLE** activated) but is not running, and if the JOG terminal is enabled, the drive will run: the connected motor will accelerate following a JOG ramp (**P029**) up to the JOG speed reference (**P070**). On the other hand, if the terminal is disabled, the drive will stop: the connected motor will decelerate to zero speed following the JOG ramp (**P029**). Reverse the direction of rotation of the active reference to reverse the JOG reference.	

CAUTION — The motor starts running as soon as this terminal is activated (only if the drive is enabled).

NOTE — The **RUN** function will override the **JOG** function.
Therefore, if the **RUN** function is active, the **JOG** function is ignored.

NOTE — If the motor is not running in ***SLAVE* mode** (torque reference instead of speed reference), it can rotate at JOG speed when the user activates the **JOG** function.
In **SLAVE mode**, the **JOG** function is ignored if the motor is still rotating due to an active reference torque.

C170 SLAVE Input

C170	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1170	
	Control	VTC and FOC	
	Function	When activating the terminal allocated to the Slave Input, the main reference becomes a torque reference and the speed loop is by-passed. This function enables the *SLAVE* operating mode (**torque reference**), instead of the *MASTER* operating mode (speed reference); the Torque References and the Ramp Torques are used (see the INPUTS FOR REFERENCES MENU and the RAMPS MENU).	

	NOTE	This function is ignored if the operating mode selected for the active motor is the *SLAVE* mode, i.e. **C011**=1 or 2 (motor 1), **C054**=1 or 2 (motor 2), **C097**=1 or 2 (motor 3). Commands are factory-set to *MASTER* mode and the speed reference is selected as factory setting (**C011**= 0 ; **C054** =0 ; **C097** = 0).
	CAUTION	Switching from *MASTER* to *SLAVE* mode (or vice versa) is allowed only when the drive is disabled.

C171 PID DISABLE Input

C171	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1171	
	Function	This function is used for managing the PID regulator (see the PID CONFIGURATION MENU). When the terminal allocated to this function is activated, the PID regulator can be disabled: its output and its external variable are set to zero. More precisely, if the PID regulator is in **External Out** mode (**C294**=0), when the **PID DISABLE** function is enabled, the PID output is set to zero and the external variable regulated by the PID regulator (feedback) is no longer regulated by the PID regulator itself. In Reference mode, the **PID DISABLE** function disables the PID regulator as described above and switches the reference, thus becoming the main active reference again.	

C171a Input for PID Control Selection

C171a	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ENGINEERING	
	Address	1188	
	Function	This parameter pertains to the activation of the two PIDs or the 2-zone mode (see the PID CONFIGURATION MENU). It allows using the PID regulator outputs in different ways and allows disabling the 2-zone mode.	

C172 KEYPAD LOCK Input

C172	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1172	
	Function	This function avoids accessing **parameter modification** through the removable display/keypad and avoids accessing the *LOCAL mode* by pressing the *LOC/REM key* or by enabling the LOCAL input function (C181).	

NOTE

If the *LOCAL* mode is already active, the LOCK command will have no effect on the *LOCAL* function: it only avoids altering the programming parameters, while it is still possible to send references and the *START/STOP/REV/JOG/RESET* commands via keypad.
If the LOCK command is active and the *LOCAL mode* is disabled, the LOCK function prevents the LOCAL mode from activating.

C173, C174 MOTOR SEL Input

C173 C174	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ENGINEERING	
	Address	1173	
	Function	This function **activates motor 2 and 3** and sets the relevant programming parameters (see Table 87). A different active motor can be selected only when the drive is disabled.	

Table 87: Motor selection.

Value of the terminal allocated to the **Sel. Motor n.2** (C173) function	Value of the terminal allocated to the **Sel. Motor n.3** (C174) function	Active motor
0	0	Motor n.1
1	0	Motor n.2
0	1	Motor n.3
1	1	Motor n.1

NOTE

When both inputs are enabled, Motor 1 is selected again.

C175, C176, C177 SPEED VAR. Inputs

C175 C176 C177	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ENGINEERING	
	Address	1175, 1176, 1177	
	Function	This function generates up to 7 values of variation % for the active reference ranging from –100% to 100% with parameters **P115÷P121**. The 3 functions determine which of the 7 values of the speed reference variation is active: the active value (**1**) or inactive value (**0**) of each preset input signal determines a bit-logic binary number where **SPEED VAR. 0** is the less significant bit (bit 0), while **SPEED VAR. 2** is the most significant bit (bit 3) as shown in Tables 77 and 78. If one of these functions is not set up, its bit is "zero".	

Table 88: Selection of the speed reference variation.

Variation of the Selected Speed Reference =	Bit 2	Bit 1	Bit 0
	SPEED VARIATION 2	SPEED VARIATION 1	SPEED VARIATION 0

Table 89: Variation of the selected speed reference.

Function:	Input Status							
MULTISPEED 0	0	1	0	1	0	1	0	1
MULTISPEED 1	0	0	1	1	0	0	1	1
MULTISPEED 2	0	0	0	0	1	1	1	1
Variation of the selected speed reference	*None*	*1*	*2*	*3*	*4*	*5*	*6*	*7*
Variation % selected	0	P115	P116	P117	P118	P119	P120	P121

If one of the functions above is not set up, its bit is "zero".
For example, if **C175** and **C177** are INACTIVE (0) and **C176** is programmed for one terminal, only variation 2 corresponding to parameter **P116** can be selected.
In any case, the output speed must never exceed the max. allowable speed, even when a higher speed is required.

NOTE

In Table 89 above:
0 ⇒ Inactive Input;
1 ⇒ Active Input.

C178 PID Up/Down Reset Input

C178	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1178	
	Function	This function <u>resets</u> **the variation of the PID reference** obtained with the ▲ and ▼ keys on the KEYPAD page of the user interface on the display/keypad in PID mode.	

C179 Source Selection Input

C179	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	6	MDI6
	Level	ADVANCED	
	Address	1179	
	Function	The digital input set as a source selector is **considered in the drive terminal board only.** When the digital input set as a source selector is <u>open</u>, only the first command sources and references programmed in the CONTROL METHOD MENU are considered (**C140** command source n.1 and **C143** reference source n.1 respectively) as well as the first reference and feedback sources programmed in the PID CONFIGURATION MENU (parameter **C285** for reference source n. 1 and **C288** for feedback source n.1). When the digital input set as a source selector is <u>closed</u>, only the second command source and the second reference source programmed in the CONTROL METHOD MENU are considered (**C141** for command source n. 2 and **C144** for reference source n.2), as well as the second reference sources and feedback sources set in the PID CONFIGURATION MENU (parameter **C286** for reference source n.2 and parameter C289 for feedback source n.2).	

CAUTION

If set different from 0:Disabled, reference sources n.3 (**C145** in the CONTROL METHOD MENU and **C287** and **C290** in the PID CONFIGURATION MENU) and reference sources n.4 (**C146** in the CONTROL METHOD MENU) are always considered as summed up to the reference source selected by the source selector.

C180 LOC/REM Input

C180	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	7	MDI7
	Level	ADVANCED	
	Address	1180	
	Function	The **LOCAL mode** can be enabled via the relevant digital input (it ignores any enabling/disable delay times set via software timers) or by pressing the *LOC/REM* located on the display/keypad. Factory setting allows enabling the Local mode only when the drive is not running. Settings may be changed through **C148 Changeover from Remote to Local Command** (see the CONTROL METHOD MENU); switching from Remote to Local command is allowed even when the drive is operating and when the running condition or reference must be maintained in Local mode. This function allows switching over to **LOCAL mode** and allows ignoring parameters **C140** to **C147** and **C285** to **C287** (see the PID CONFIGURATION MENU) when the PID controller is enabled, **thus allowing setting them via KEYPAD only**. The following functions are still active in the hardware terminal board of the control board being used: **ENABLE**, **External Alarm 1,2,3**, **Sel.Motor n.2**, **Sel.Motor n.3**, **SLAVE**, **PID Disable**, and <u>the LOCAL function itself</u>, that can be disabled at any time. If the input is deactivated when the drive is disabled, signals coming from different sources will activate again. If the main reference of the drive is the PID output, you can set **C180a Type of LOC/REM Contact** = **Pushbutton** and **P266 Type of Keypad page** in **Local Mode** = **Ref.Activated + Spd**. As a result, when the **Loc** key is pressed and released once, the drive enters the Local mode and the PID reference can be altered, whereas when the **Loc** command is pressed and released again (provided that the drive is not enabled) the PID is disabled and the RPM reference can be sent to the connected motor. See also the CONTROL METHOD MENU and the Keypad page and Local mode in the DISPLAY/KEYPAD menu.	

C180a Type of LOC/REM Contact

C180a	Range	0 ÷ 2	0:[Switch] 1:[Pushbutton] 2:[[Pushbutton+Storage]]
	Default	2	2:[Pushbutton+Storage]
	Level	ADVANCED	
	Address	1303	
	Function	Factory-setting: the digital contact set as LOC/REM (**C180**) is Pushbutton based. If the PID output is the main reference and **P266 Type of Keypad Page in Local Mode** = **Ref.Activated + Spd**, allowing entering the LOCAL mode when the LOC/REM command is first sent, thus controlling the PID reference, and allowing the LOCAL mode to be maintained when the LOC/REM command is sent for the second time, thus disabling the PID and allowing setting a speed reference, the LOC/REM digital input must be set as **C180a=Pushbutton**. If **C180a=2**, the logic status of **LOC/REM** will be saved at power off and will be used when the drive is next powered on.	

C181 Safety Start

C181			
	Range	0 ÷ 1	Inactive, Active
	Default	0	Inactive
	Level	ADVANCED	
	Address	1181	
	Function	This function <u>enables</u> the *Safety START mode*. When this function is enabled and the drive is to be restarted after resetting an alarm, <u>open and close</u> the **ENABLE** terminal. This prevents the drive from RUNNING when it is turned off and on again (for example after a mains loss) and the **START** and **ENABLE** inputs are on.	

NOTE

If multiple terminal boards are selected with parameters **C140**, **C141**, **C142**, open and close the **ENABLE** terminal (**MDI2**) in one of the active terminal boards to restart the drive.

C182 Multiprogramming Enabling

C182			
	Range	0 ÷ 1	Inactive, Active
	Default	1	Inactive
	Level	ENGINEERING	
	Address	1182	
	Function	This function allows allocating two different functions to the same terminal.	

NOTE

Only few preset combinations are allowed.
When invalid configurations are set up, "ILLEGAL DATA" appears on the display/keypad of the Penta drive.

C183 Max. Fluxing Time Before Drive disabling

C183			
	Range	0 ÷ 65000	0 ÷ 65000 ms
	Default	0	Disabled
	Level	ADVANCED	
	Address	1183	
	Control	VTC and FOC	
	Function	This function disables the drive if the fluxing time period is longer than the preset time (if the **ENABLE** command, not a RUN command, is sent). To restore motor fluxing, disable and enable the **ENABLE** command, or send a **START** command when **ENABLE** is closed.	

NOTE

The time set in C183 is added to the Fluxing Ramp Time set in **C041** / **C084** / **C127**.

C184 Fluxing at Activation only with START Closed

C184			
	Range	0 ÷1	0:No - 1:Yes
	Default	0	0:No
	Level	ADVANCED	
	Address	1184	
	Control	VTC and FOC	
	Function	Fluxing may be carried out only when the **START** command is closed.	

C185 STOP Mode

C185	Range	0 ÷ 1	0: [Deceleration Ramp] – 1:[Idling]
	Default	0	0: [Deceleration Ramp]
	Level	ADVANCED	
	Address	1185	
	Function	This function allows selecting whether the drive is to be deactivated with a controlled deceleration ramp or is left idling when the **START** command is open.	

C186 Fire Mode Enable Input

C186	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ENGINEERING	
	Address	1186	
	Function	This parameter allows programming a digital input to activate the Fire Mode (see the Fire Mode section).	

C187 Torque Limit Source Ref. Disable Input

C187	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1187	
	Function	This function sets a digital input allowing disabling the external torque limit. When the digital input set for **C187** is active, the torque limit will depend on the parameters contained in the LIMITS MENU of the active motor.	

C188a, C188b, C188c Inputs for PID MULTIREFERENCES

C188a C188b C188c	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is fitted	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	Inactive
	Level	ADVANCED	
	Address	1365, 1366, 1367	
	Function	This function allows generating up to <u>7 PID references</u> that can be programmed with parameters **P081a** to **P087a** according to the operating mode selected with **P080a**. The 3 functions determine which is the active reference among the 7 available PID references: the active value (**1**) or the inactive value (**0**) of each programmed input signal determines a bit-logic value, where **MULTIREF 0** is the least significant bit (bit 0) and **MULTIREF 2** is the most significant bit (bit 2). If one of the available functions is not programmed, the value of the relevant bit is "zero".	

Table 90: Selection of PID Multireferences.

Multireference selected =	Bit 2	Bit 1	Bit 0
	MULTIRFERENCE 2	MULTIRFERENCE 1	MULTIRFERENCE 0

36. ENCODER/FREQUENCY INPUTS MENU

36.1. 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 encoder reading (encoder A) or as frequency inputs. In addition, if ES836 option board is used (see the Sinus Penta's Installation Instructions manual), an additional encoder reading (encoder B) is allowed.

NOTE If MDI6 and MDI7 are used for encoder reading, only Push–Pull encoders can be used.

NOTE For the reversal of the encoder speed measure, properly set up parameter C199.

36.1.1. WHEN ES836 IS NOT USED

- Encoder reading:

Digital inputs MDI6 and MDI7 are used for reading the two channels of a 24V push–pull encoder powered directly by the encoder board (see the Sinus Penta's Installation Instructions Manual).
No function can be programmed for MDI6 and MDI7; if you attempt to program MDI6 and MDI7, alarm A082 Illegal Encoder Configuration will trip when 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 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 ES836 option board.

36.1.2. WHEN ES836 IS USED

• Reading 1 or 2 Encoders:
To read one Encoder, use ES836 option board or digital inputs MDI6 and MDI7 (if a push–pull encoder is used).
Both the option board and digital inputs MDI6 and MDI7 can be used to read two encoders at a time. Use parameter C189 to set the readout of the speed measure of the controlled motor or to read reference values.
You can use encoder A or encoder B as a speed feedback or a reference source (speed reference, torque reference or PID reference).

Example:
If you want to use encoder A as a speed reference source and encoder B as a speed feedback, set C189 as 6:[A Ref ; B Fbk]; use P073 and P074 (INPUTS FOR REFERENCES MENU) to define the min. speed and the max. speed read for scaling and saturation of encoder A selected as a reference source (in one of parameters C144 ÷ C147, CONTROL METHOD MENU); set parameter C012 (motor 1) to [Yes] to enable the Speed Feedback from Encoder function.
If encoder A is selected, no function can be programmed for MDI6 and MDI7; otherwise, alarm A082 Illegal Encoder Configuration will trip when ENABLE closes.
If encoder B is selected and ES836 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 Encoder:

MDI6 Digital input (FINA) is used as a frequency input and Encoder B is used (because ES836 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 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).

36.1.3. WHEN USING TWO ENCODERS

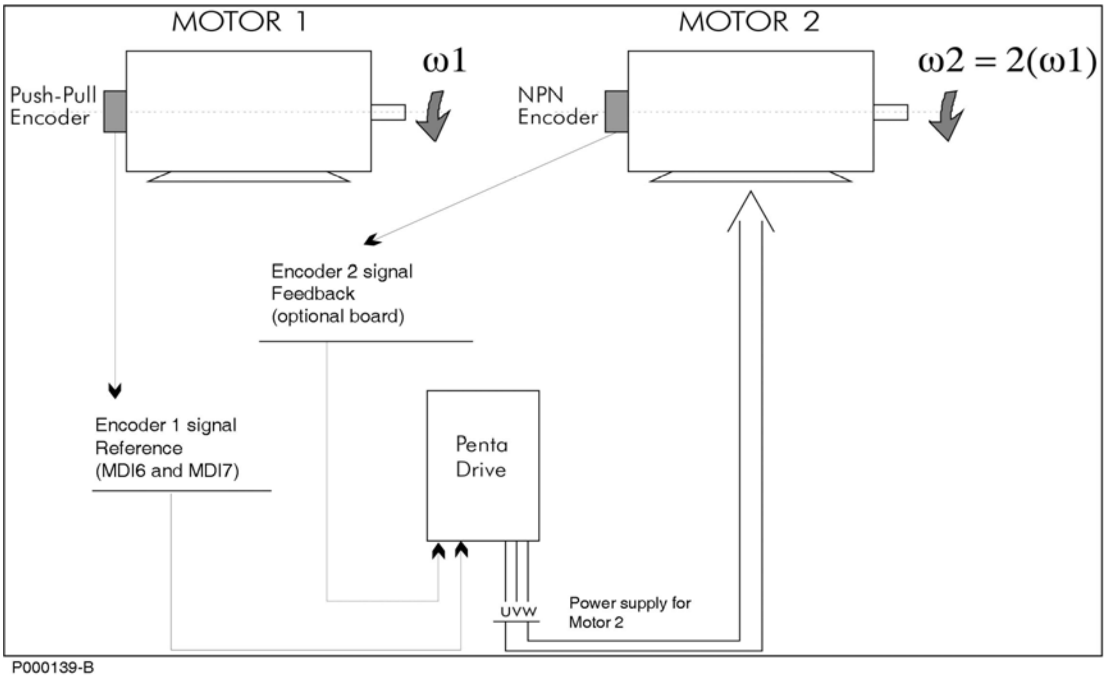


Figure 50: Using two encoders (example).

Suppose that motor 2 is to be controlled in closed chain and that its speed value is twice the speed value of motor 1.
To do so, use speed of motor 1, provided with an encoder, as the reference for the Penta Drive, and use the speed measure of encoder B, which is coaxial to the motor controlled by the drive, as a speed feedback.
Suppose that motor 1 speed ranges from 0 to 750rpm and that motor 1 is provided with a Push–Pull encoder with Single–Ended outputs and that its resolution is 2048 pls/rev.

Motor 2 is provided with an NPN encoder with Single–Ended outputs; its resolution is 1024 pls/rev.
Only one Push-Pull encoder can be connected to digital inputs MDI6-MDI7, so encoder NPN of motor 2, representing the speed feedback of the drive, must be connected to ES836 board (drive Encoder B), whereas the encoder of motor 1 (Push–Pull), used as a reference, shall be connected to terminals MDI6 and MDI7 (drive Encoder A).
Encoder Configuration is as follows:

Encoder/Frequency Inputs Menu

(operating modes and encoder feature setting)

C189 = [6: A–Reference B–Feedback]	(Encoder/Frequency input operating mode)
C190 = 2048 pls/rev	(Number of pls/rev for Encoder A)
C191 = 1024 pls/rev	(Number of pls/rev for Encoder B)
C197 = [0: 2Ch.Quad.]	(Number of channels of Encoder A)
C198 = [0: 2Ch.Quad.]	(Number of channels of Encoder B)
C199 = [0: Fdbk.No Ref.No]	(Encoder reading sign reversal)

Motor Control 1 Menu

(Setup of control mode with speed feedback from encoder and min. speed and max. speed of the controlled motor)

C012 =	[Yes]	(Speed feedback from M1 encoder)
C028 =	0 rpm	(Min. speed of motor M1)
C029 =	1500 rpm	(Max. speed of motor M1)

Control Method Menu

(Setup of the source of the speed feedback from encoder)

C143 =	[8: Encoder]	(Selection of reference 1 source)
C144 =	[0: Disable]	(Selection of reference 2 source)
C145 =	[0: Disable]	(Selection of reference 3 source)
C146 =	[0: Disable]	(Selection of reference 4 source)

References Menu

(Setup of the reading range for the encoder used as a speed reference)

P073 =	0 rpm	(Encoder input min. rpm)
P074 =	750 rpm	(Encoder input max. rpm)

Ramps Menu

(Ramps time applied to the reference are reset to maintain the desired speed variation without entering any delay value)

P009 =	0	(Acceleration time 1)
P010 =	0	(Deceleration time 1)

When motor 1 reaches its max. speed (750rpm), the speed reference is 100% (because the speed value read by the encoder used as a reference source is saturated and scaled with respect to the min. rpm and max. rpm set in P073, P074). Because the max. speed of the motor controlled by the drive is 1500 rpm (C029), the speed reference is 1500 rpm.

36.2. List of Parameters C189 to C199

Table 91: List of parameters C189 to C199.

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C189	Encoder/Frequency input operating mode	BASIC	1189	0 [Not used, Not used]
C190	Number of pls/rev for encoder A	BASIC	1190	1024
C191	Number of pls/rev for encoder B	BASIC	1191	1024
C192	Speed searching error timeout	ENGINEERING	1192	5.00 sec
C193	Error between reference and speed	ENGINEERING	1193	300 rpm
C194	Tracking error alarm enable	ENGINEERING	1194	1: Active
C195	Filter time constant over value of feedback from encoder	ENGINEERING	1195	5.0 ms
C196	Filter time constant over value of reference from encoder	ENGINEERING	1196	5.0 ms
C197	Number of channels of Encoder A	ENGINEERING	1197	0:2 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]

C189 Encoder/Frequency Input Operating Mode

C189	Range	0 ÷ 14	See Table 92
	Default	0	0 [Not used; Not used]
	Level	BASIC	
	Address	1189	
	Function	This parameter determines the operating mode of quick acquisition digital inputs. 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 PID reference source in the PID CONFIGURATION MENU) and the encoder to be used as a speed feedback. Configuration allowed for quick acquisition digital inputs is shown in Table 92. **If the encoder is used as a reference source, the detected speed value will be saturated and scaled based on values set in P073 and P074 respectively (minimum and maximum value for the encoder).** *Example*: **C189** [A Reference; B Unused], **P073** [–1500rpm], **P074** [1500rpm] if the encoder is used as a PID reference, the reference measure is expressed as a percentage of the max. value [|**P073**|; |**P074**|]. If a frequency input is selected, its readout is saturated and scaled based on parameters P071 and P072 respectively (minimum and maximum value for the frequency input).	

Table 92: Codification 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 pls/rev
	Default	1024	1024
	Level	BASIC	
	Address	1190	
	Function	Defines the number of pls/rev for encoder A (encoder in the terminal board).	

C191 Number of Pls/Rev for Encoder B

C191			
	Range	256 ÷ 10000	256 ÷ 10000 pls/rev
	Default	1024	1024
	Level	BASIC	
	Address	1191	
	Function	Defines the number of pls/rev for encoder B (encoder that can be connected to ES836 option board).	

C192 Timeout for Speed Alarm

C192			
	Range	0 ÷ 65000	0.00 ÷ 650.00 sec
	Default	500	5.00 sec
	Level	ENGINEERING	
	Address	1192	
	Function	If the speed alarm (**C194**) is enabled and the speed error exceeds the speed threshold (**C193**), this parameter determines the speed error timeout. Even if the alarm speed is disabled, time set in **C192** and error threshold set in **C193** are used to signal a speed searching error to digital outputs set with BRAKE or LIFT mode. Digital outputs are then disabled.	

C193 Speed Error Threshold

C193			
	Range	0 ÷ 32000	0 ÷ 32000 rpm
	Default	300	300 rpm
	Level	ENGINEERING	
	Address	1193	
	Function	If the speed alarm (**C194**) is enabled 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, time set in **C192** and error threshold set in **C193** are used to signal a speed searching error to digital outputs set with BRAKE or LIFT mode. Digital outputs are then disabled.	

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

C198	Range	0 ÷ 3	See Table 93
	Default	0	0 [Fdbk. NO ; Ref. NO]
	Level	ENGINEERING	
	Address	1199	
	Function	This parameter permits to reverse the speed sign measured by encoder inputs.	

NOTE

When tuning the encoder, the encoder sign used as feedback is automatically adjusted to the direction of rotation of the connected motor.

Table 93: Codification 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

37. BRAKING RESISTANCE MENU

37.1. Overview

The Braking Resistance Menu enables the clamp transistor command and sets its max. duty cycle in the drive braking resistance. If no braking resistance is installed, promptness of the DC bus voltage control can be adjusted in order to avoid OVERVOLTAGE alarm, causing abrupt deceleration.
To enable the clamp transistor command for the braking resistance, set **C210=[With resistor]**. In this operating mode, when DC bus voltage exceeds a preset threshold value depending on the drive voltage class, the clamp transistor closes in the braking resistor, so energy in excess is dissipated to the resistor and DC bus voltage does not exceed voltage ratings.
The max. duty cycle of the braking resistor is parameterized with **C212** and **C211**: maximum duty cycle (100 * Ton / (Ton+Toff) [%]) and maximum time of continuous supply (Ton) respectively. If the braking resistor activation is Ton = **C212** , when this interval is over, the relevant command will be disabled for a time equal to Toff = (100 – **C212**) * **C211** / **C212** [sec].

Example:
A lifting application implementing a Sinus Penta 0086 at 400V requires a braking resistor with a 50% duty cycle. The braking period is 30s. According to the tables in the "Braking Resistors" section (**Installation Instructions** manual) the applicable braking resistor is 10Ω – 24 kW.
The max. continuous duty for said resistor is 62s: the braking period is then compatible with that rating. Otherwise, a higher rated resistor should be applied.
Parameter setting:
C210=[With resistor].
C211=30s
C212=50%

Factory-setting assumes that no braking resistor is provided. In this case, **C210** sets promptness, with respect to variations of DC bus, for the deceleration ramp slowing-down, in order not to overload the bus capacitor bank.
If **C210** is set to zero in FOC control, deceleration slows down when given values of the voltage bar are reached (depending on the drive voltage class).
If **C210** is > 0, DC bus voltage is controlled by considering the derivative of the bus voltage. The higher the value in **C210**, the lower the values for voltage variation affecting deceleration ramp times.

NOTE The clamp transistor is not commanded if the drive is supplied from a Regenerative source (see **C008** = xT Regen, where x can be 2, 4, 5, or 6).

37.2. List of Parameters C210 to C212

Table 94: List of parameters C210 to C212.

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C210	Automatic extension of down ramp	ENGINEERING	1210	See Table 72
C211	Max. time of continuous supply	ENGINEERING	1211	2.00sec
C212	Duty Cycle Braking (Ton/(Toff+Ton))	ENGINEERING	1212	10%

C210 Automatic Extension of Down Ramp

C210	Range	-1 ÷ 32000	–0.01: (With Resistance); 320.00%
	Default	See Table 72	
	Level	ENGINEERING	
	Address	1210	
	Function	If **C210** = **[With Resistor]**, this parameter commands enabling resistor and DC bus relating to this operating condition, allowing dissipating energy regenerated from the motor. If no braking resistor is used, energy regenerated from the motor cannot be dissipated. In this condition, the down ramp is extended if the variation in DC bus voltage is too rapid or exceeds certain threshold values. Set a higher value in parameter **C210** for a more sensitive ramp extension (a lower rating of regenerated power allows obtaining longer ramps), thus avoiding overvoltage.	

NOTE

Parameter **C210** decreases the DC bus voltage threshold setting the ramp extension. The k factor is as follows:
k = Pout/(Pmax*100***C210**),
k ranges between 1.0 and 1.3

The greater the k factor, the lower the DC bus level setting the ramp extension.

For example, when **C210**=0.2, power Pout shall exceed 5% of Pmax in order to obtain k>1.
When **C210**=2, 0.5% of Pmax is required to obtain k>1.

NOTE

Parameter **C210** is interlocked with parameter **P031** (Gradient variation acceleration reset) so that **C210** ≠ **–0.01:With resistance** cannot be programmed in conjunction with **P031** = 0:No.

C211 Max. Time of Continuous Supply for Braking Resistance

C211	Range	0 ÷ 32000	0 ; 320.00 sec
	Default	200	2.00 sec
	Level	ENGINEERING	
	Address	1211	
	Function	This parameter determines the max. continuous operating time required for the braking resistance. If the braking resistance is used for a time **C211** without being activated, the braking resistance command is automatically disabled for a time of inactivity set in **C212**.	

C212 Duty Cycle Braking (Ton/(Toff+Ton))

C212			
	Range	0 ÷ 100	0 ÷ 100%
	Default	10	10%
	Level	ENGINEERING	
	Address	1212	
	Function	**C212** = (Ton/(Ton+Toff))*100 This parameter determines the operating duty cycle allowed for the braking resistance. It is expressed as a percentage and defines the time of inactivity of the braking resistance when it is continuously operating for the max. time set in **C211**.	

38. DC BRAKING MENU

38.1. Overview

When the IFD or VTC control algorithm are used, DC current can be injected into the motor to stop it. DC current may be automatically injected at stop and/or at start; DC current injection may also be controlled by the terminal board. All relevant parameters are included in the DC BRAKING MENU. The intensity of the DC current injected is expressed as a percentage of the rated current of the active motor.

38.1.1. DC Braking at Start and Non-condensing Function

To activate DC braking at start, set C216 to [YES]. Braking occurs after sending a START command, with a speed reference other than zero, before the acceleration ramp. A START command may be one of the following: RUN command or REV command sent via terminal board; START command from keypad, etc., depending on the preset control mode. DC braking level and duration are set in the following parameters:

C220 Expressed as a percentage of the rated current of the controlled motor.
C218 Expressed in seconds.

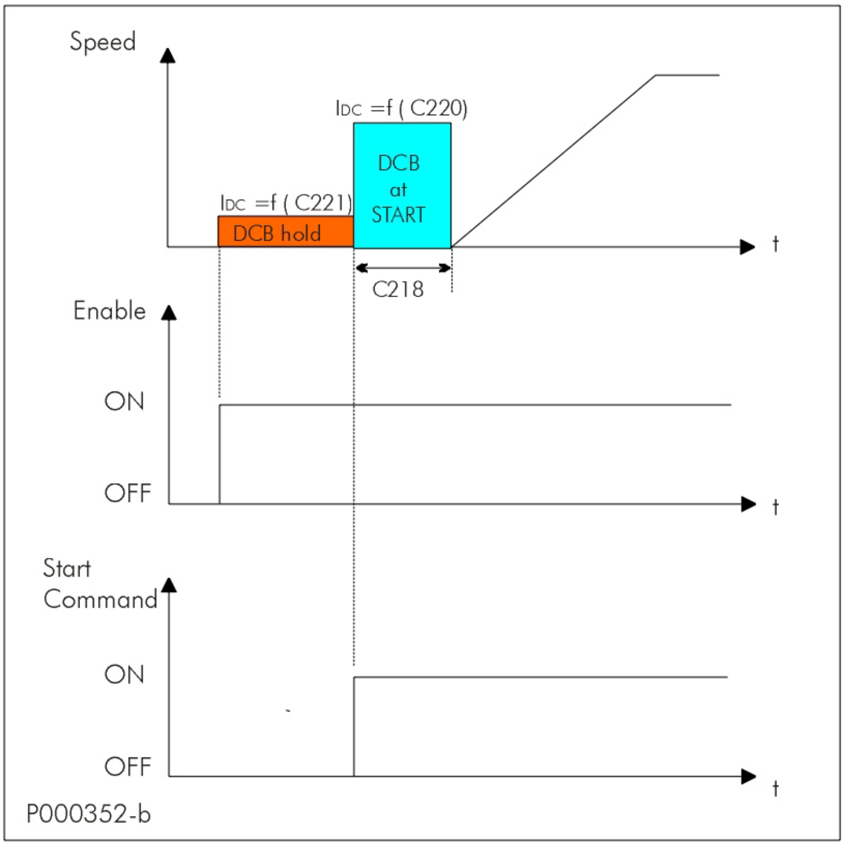


Figure 51: DCB Hold and DCB at Start.

Output speed, holding and DC braking current when the DCB Hold and DCB at Start functions are active.

The non-condensing function consists in injecting DC into the motor. DC current brakes the motor and heats the motor windings, thus avoiding condensation. This function is active only for the IFD control if **C221** is other than zero and **ENABLE** = ON. For the other control algorithms, the non-condensing function is performed by injecting current during motor fluxing. Parameter **C221**, expressed as a percentage of the rated current of the controlled motor, determines the level of direct current injected into the braking resistance.

Parameters used to program this function are the following:

C216 enabling DCB at Start;
C218 setting the duration of DCB at Start;
C220 setting the intensity of the DC braking;
C221 setting the intensity of the holding current (this function is active for the IFD control only).

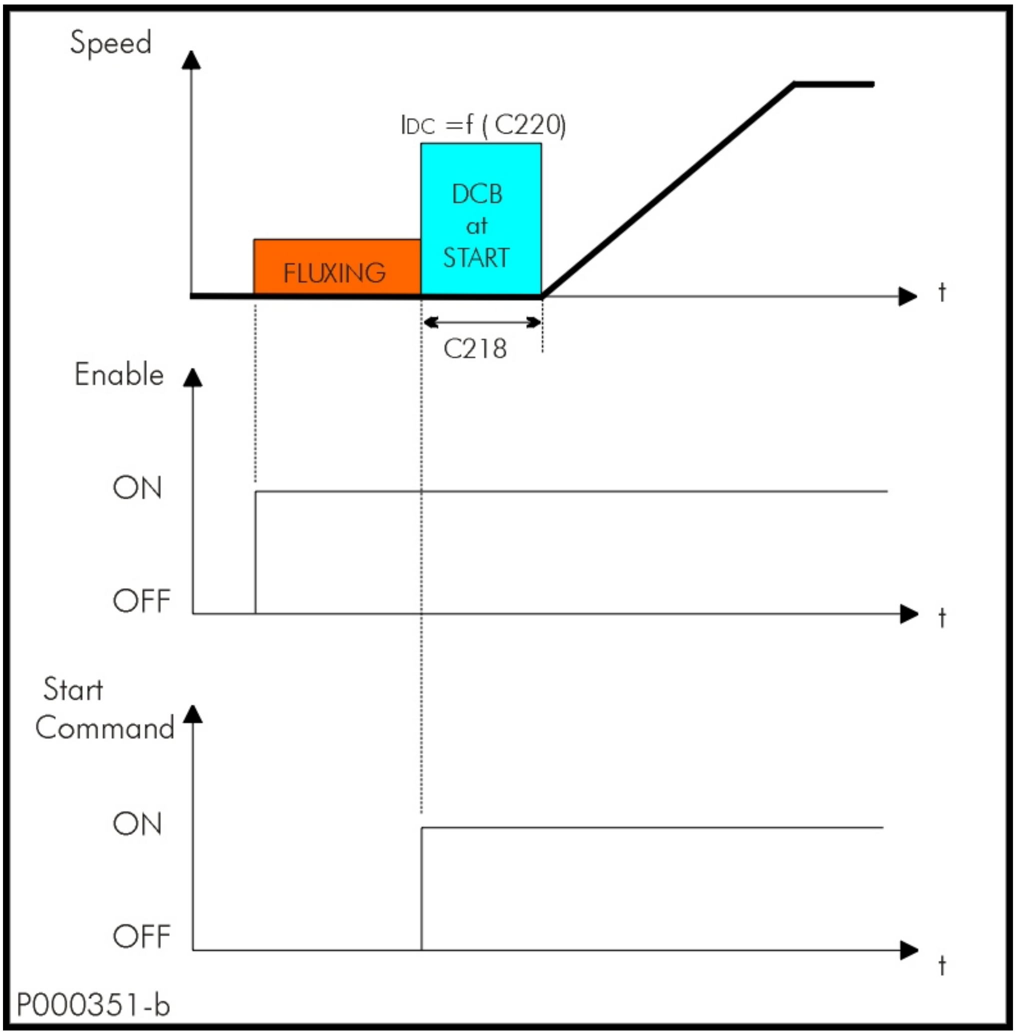


Figure 52: DCB at Start with VTC Control.

Output Speed and DC Braking when the DCB At Start Function is active for the Vector Torque control.

38.1.2. DC BRAKING AT STOP

To activate this function, set **C215** to [YES] or, in Power Down mode, set **C234** (Power Down Stop Mode) as DCB.
DC Braking occurs after sending a "stop with ramp" command. The speed level for DC Braking is set in **C219**. If the drive is in Power Down mode and **C234** is set as DCB, the speed level is set in **C235** (Power Down Stop Level).
The figure below illustrates the output speed and DC Braking trends when the DC Braking at Stop function is active.

Parameters used to program this function are the following:

C215 function enabling;
C217 braking duration;
C219 motor speed at the beginning of DC Braking;
C220 intensity of DC braking.
In Power Down mode, if **C234** (Power Down Stop Mode) is set as DCB:
C235 motor speed at the beginning of DC Braking.

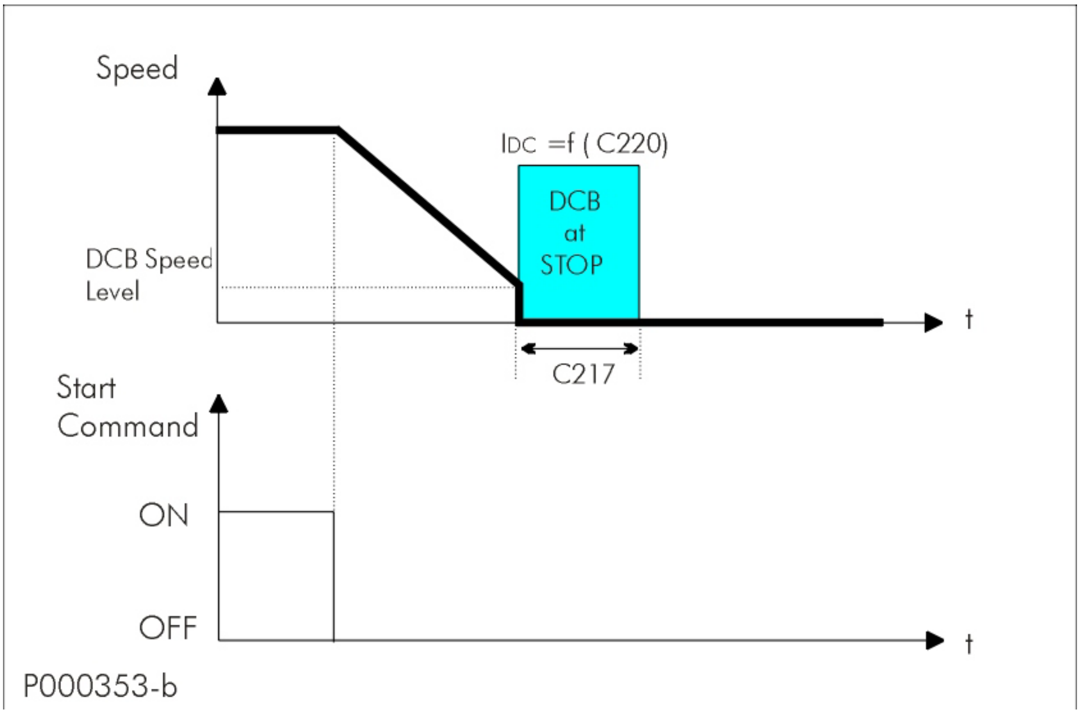


Figure 53: DCB at Stop.

Motor speed and DC Braking patterns when the DC BRAKING AT STOP function is active.

38.1.3. DC BRAKING COMMAND SENT FROM TERMINAL BOARD

Activate the digital input set as DCB (**C160**) to send a DC Braking command. DC Braking duration is determined by the following formula:

$t^* = C217 * (n_{OUT} / C219)$ with $n_{OUT} / C219$ equal to max. 10.

Possible cases:

a) **t1 > t*** time t1 for braking command is longer than t*.

To restart the motor following the preset acceleration ramp when DC Braking is over, just disable the DCB command and disable and enable again the **START** command (see figure below).

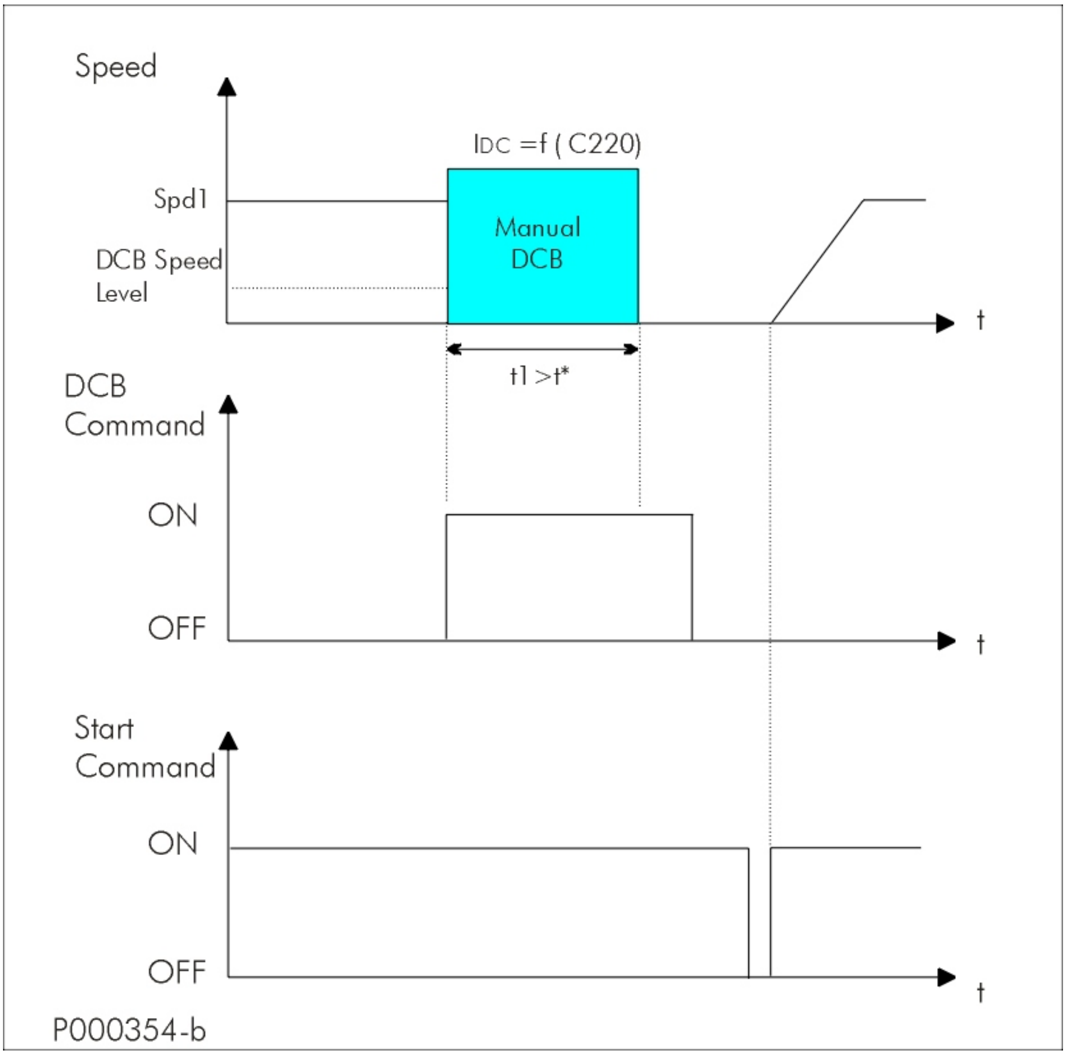


Figure 54: Manual DCB (Example 1).

Motor Speed, DC Braking, Manual DCB Command and START Command if t1>t*.

b) **t1 < t*** time t1 for braking command is shorter than t*.
Two different cases may occur, depending on the control algorithm and the setup of the motor speed searching function.

IFD or VTC Control when the Speed Searching function is disabled (C245 [NO]):
Prematurely disable the manual braking command to stop DC braking. If the motor is still rotating, it will start idling. To restart the motor following the preset acceleration ramp, simply disable and enable the START command (see Figure 54).

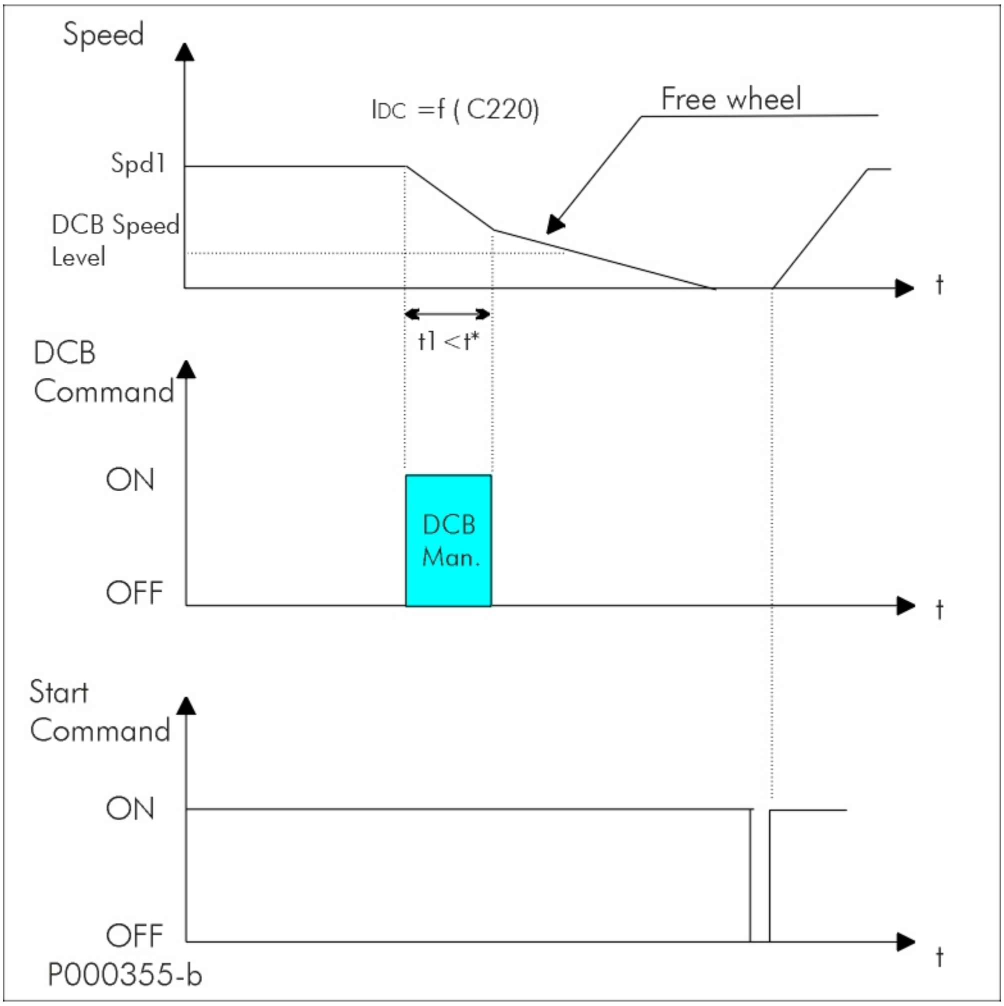


Figure 55: Manual DCB (Example 2).

Motor Speed, DC Braking, Manual DCB Command and START Command if t1<t* and the control algorithm is either IFD Voltage/Frequency or VTC VectorTorque when the Speed Searching Function is disabled.

IFD Control when the Speed Searching function is enabled (C245 [YES]):

Prematurely disable the manual braking command to activate the Speed Searching function. When the motor speed searching occurs, the motor speed is increased depending on the preset acceleration ramp (see Figure 55).

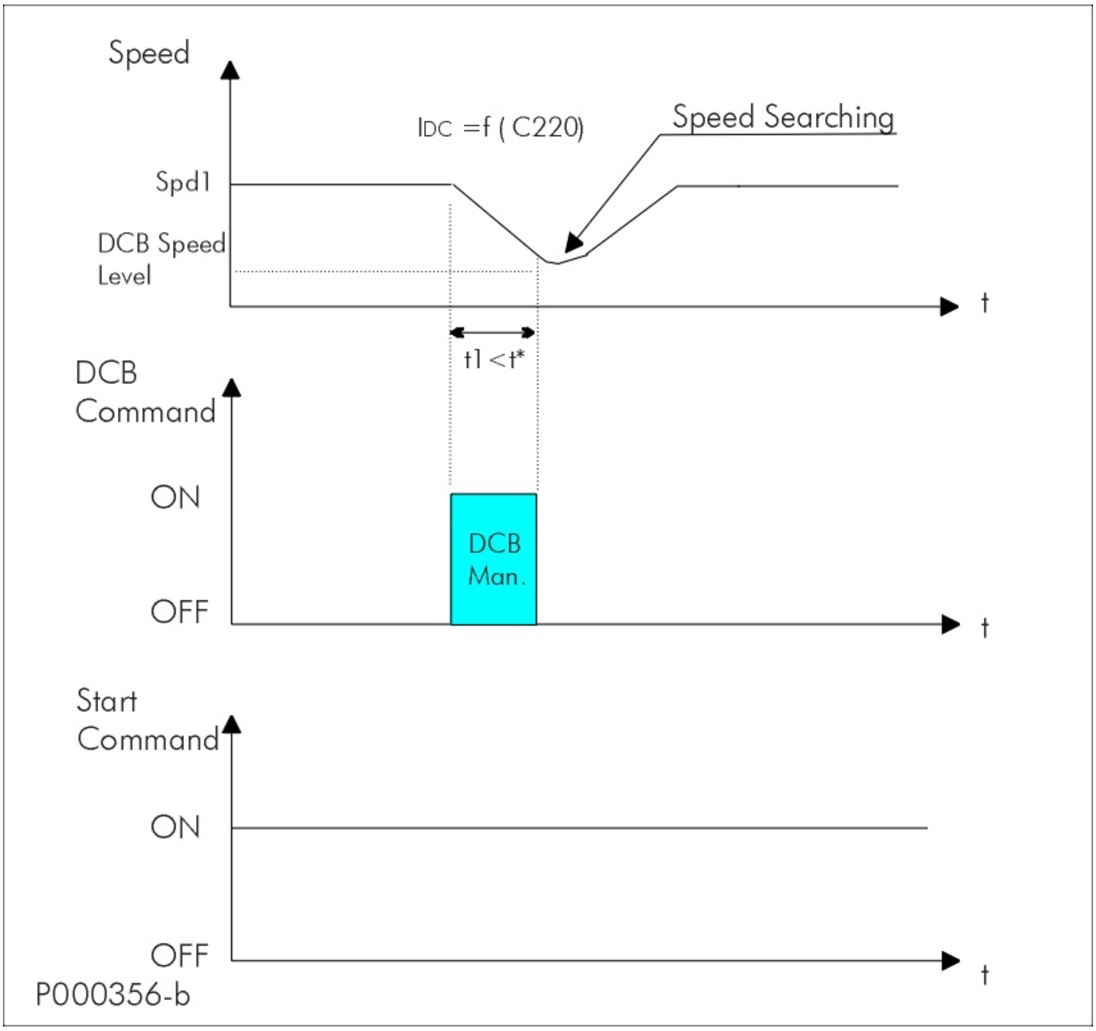


Figure 56: Manual DCB (Example 3).

Motor Speed, DC Braking and Manual DCB Command and START Command if t1<t*, the control algorithm is IFD and the Speed Searching Function is enabled.

38.2. List of Parameters C215 to C224

Table 95: List of parameters C215 to C224.

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
C215	Enabling DCB at Stop function	ADVANCED	1215	0:NO
C216	Enabling DCB at Start function	ADVANCED	1216	0:NO
C217	DCB at Stop duration	ADVANCED	1217	0.5
C218	DCB at Start duration	ADVANCED	1218	0.5
C219	Speed at the beginning of DCB at Stop	ADVANCED	1219	50rpm
C220	DCB current level	ADVANCED	1220	100%
C221	DCB Hold	ADVANCED	1221	0%
C222	Ramp braking time for Motor 1 DCB	ENGINEERING	1222	See Table 72
C223	Ramp braking time for Motor 2 DCB	ENGINEERING	1223	
C224	Ramp braking time for Motor 3 DCB	ENGINEERING	1224	

C215 Enabling DCB at Stop Function

C215			
	Range	0 ÷ 1	0: No; 1: Yes
	Default	0	0: No
	Level	ADVANCED	
	Address	1215	
	Control	IFD and VTC	
	Function	Enables DC Braking during deceleration when the speed set in **C219** is reached (or the speed set in **C235** if in Power Down mode and **C234** [DCB] is reached).	

C216 Enabling DCB at Start Function

C216			
	Range	0 ÷ 1	0: No; : Yes
	Default	0	0: No
	Level	ADVANCED	
	Address	1216	
	Control	IFD and VTC	
	Function	Enables the DC Braking at Start function.	

C217 DCB at Stop Duration

C217			
	Range	1 ÷ 600	0.1; 60.0 sec.
	Default	5	0.5
	Level	ADVANCED	
	Address	1217	
	Control	IFD and VTC	
	Function	Determines the duration of the DCB at Stop function.	

C218 DCB at Start Duration

C218			
	Range	1 ÷ 600	0.1; 60.0 sec.
	Default	5	0.5
	Level	ADVANCED	
	Address	1218	
	Control	IFD and VTC	
	Function	Determines the duration of the DCB at Start function.	

C219 Speed at the Beginning of DCB at Stop

C219			
	Range	0; 1000	0; 1000 rpm
	Default	50	50rpm
	Level	ADVANCED	
	Address	1219	
	Control	IFD and VTC	
	Function	Determines the speed at the beginning of DCB at stop while decelerating.	

C220 DCB Current Level

C220			
	Range	0; MIN [120%; (drive Imax /motor Inom)*100)%]	
	Default	100	100%
	Level	ADVANCED	
	Address	1220	
	Control	IFD and VTC	
	Function	Determines the level of direct current injected to brake the motor. It is expressed as a percentage of the rated current of the controlled motor.	

C221 DCB Hold

C221			
	Range	0 ÷ 100	0; 100%
	Default	0	0%
	Level	ADVANCED	
	Address	1221	
	Control	IFD	
	Function	Determines the level of direct current injected during the Hold function. To activate this function, set a value other than zero in parameter **C221**. DC level is expressed as a percentage of the rated current of the controlled motor.	

C222 (C223, C224) Ramp Braking Time for DCB

C222 (Motor 1) C223 (Motor 2) C224 (Motor 3)			
	Range	2 ÷ 32000	2 ÷ 32000 msec
	Default	See Table 71	
	Level	ENGINEERING	
	Address	1222, 1223, 1224	
	Control	IFD and VTC	
	Function	This parameter represents the time required for flux weakening before DCB.	

39. POWER DOWN MENU

39.1. Overview

In the case of power failure, the drive can be kept powered on by exploiting the kinetic energy of the motor and the load: energy recovered due to motor slowing down is used to power the drive, thus avoiding loosing the drive control when a black–out occurs.
All parameters relating to the Power Down function are included in the Power Down submenu in the Configuration menu.
The following options are available (parameter **C225**):
– [NO]: the Power Down function is inhibited (factory setting). Only in that case, alarm **A064** (Mains Loss) can be enabled by setting **C225** to [3: Alarm].
– [YES]: after the time set in **C226** (Power Down start delay), starting from the instant when power down occurs, a deceleration ramp takes place (deceleration ramp in Power Down **C227**). The time period of the deceleration ramp can be user-defined.
– [YES V]: in case of power down for a time longer than **C226**, the motor coasts to stop, so that DC bus voltage value is kept constant at **C230**. To do so, a PI (proportional–integral) regulator is used, which is adjusted through parameter **C231** (proportional term) and **C232** (integral term).

NOTE — If the mains loss deactivates the **ENABLE** command, the motor cannot coast to stop, because the **ENABLE** command is required for the hardware enabling of IGBTs.

NOTE — If a drive is DC-powered by a Regenerative Penta (or an equivalent drive stabilizing DC bus voltage), Power Down cannot occur (**C008** = xT Regen, where x can be 2, 4, 5, or 6).

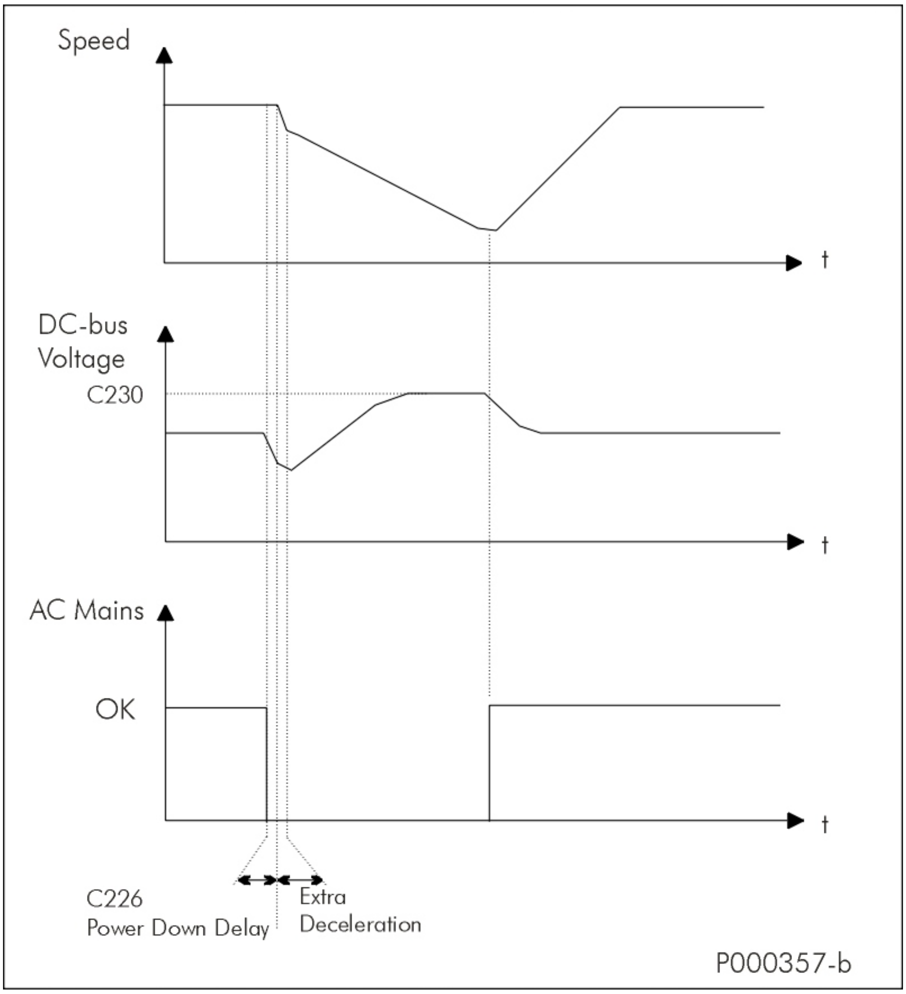


Figure 57: Power Down (Example).

The figure above illustrates the patterns of the motor speed and the DC bus voltage in case of mains loss. In the example above, power supply is restored before the drive turns off and before the deceleration ramp is over, so the motor accelerates with the preset acceleration ramp.

If power supply is restored during the deceleration ramp in Power Down, the connected motor accelerates following the selected acceleration ramp. A speed value for the end of Power Down can be set in C235; the desired operating mode at stop can be set in C234.
When the motor speed attains the end level of Power Down, the following functions can be selected in parameter C234:

– [Stop]: The drive will control the motor until it stops down, independently of the value set in C235; when the motor stops and power supply is restored, the RUN command must be disabled and enabled again to accelerate the motor.

– [DCB]: When the speed of the Power Down end set in C235 is attained, DC braking occurs. If power supply is restored during DC braking, the RUN command must be disabled and enabled again to accelerate the motor.

– [Stand–By]: When the speed of the Power Down end set in C235 is attained, the drive is in stand–by; if power supply is restored when the drive is in stand-by, the RUN command must be disabled and enabled again to accelerate the motor.

39.2. List of Parameters C225 to C235

Table 96: List of parameters C225 to C235.

Parameter	FUNCTION	Access Level	MODBUS Address	Default Values
C225	Procedure in case of Power Down	ENGINEERING	1225	3:Alarm
C226	Power Down enable delay	ENGINEERING	1226	10 ms
C227	Stop ramp time in Power Down	ENGINEERING	1227	20 sec
C228	Start increment of ramp gradient in P.D.	ENGINEERING	1228	0.10%
C229	Improved sensitivity of DC bus control	ENGINEERING	1229	1
C230	Voltage level of DC bus in Power Down	ENGINEERING	1230	339V for class 2T 679V for class 4T(380;480V) 707V for class 4T(481;500V) 813V for class 5T 976V for class 6T
C231	PI Proportional constant for automatic deceleration	ENGINEERING	1231	0.050
C232	PI Integral time for automatic deceleration	ENGINEERING	1232	0.5 sec
C234	Ramp action at the end of Power Down	ENGINEERING	1234	0: Stop
C235	Motor speed at the end of Power Down	ENGINEERING	1235	0 rpm

C225 Procedure in Case of Power Down

C225	Range	0 ÷ 3	0: Disabled 1: Yes 2: YesV 3: Alarm
	Default	3	3: Alarm
	Level	ENGINEERING	
	Address	1225	
	Function	Type of power down: 0: **Disabled** The Power Down function is disabled. 1: **Yes** In case of mains loss after a time longer than the time set in **C226** starting from the mains loss detection, the deceleration ramp set in **C227** is performed. 2: **YesV** In case of mains loss, deceleration is automatically regulated by a PI regulator (see **C231** and **C232**), so that voltage level in DC link is kept constant at the reference value set in **C230**. IFD control: because no torque demand regulation is available, the deceleration ramp gradient is adjusted depending on the gradient value set in **C227**. 3: **Alarm** In case of power failure, the **A064 Mains Loss** alarm trips.	

NOTE

If a drive is DC-powered by a Regenerative Penta (or an equivalent drive stabilizing DC bus voltage), Power Down cannot occur (**C008** = xT Regen, where x can be 2, 4, 5, or 6).

C226 Power Down Enable delay

C226			
	Range	1 ÷ 250	1 ÷ 250 ms
	Default	10	10 ms
	Level	ENGINEERING	
	Address	1226	
	Function	This parameter determines the Power Down delay after a mains loss is detected by the drive. When Power Down is disabled (**C225** =Disable) and the mains loss alarm is enabled (**C233**=Yes), the Power Down enable delay is applied to the alarm tripped.	

NOTE Setting a too long Power Down delay in case of mains loss can cause the drive to switch off.

C227 Stop Ramp Time in Power Down

C227			
	Range	1 ÷ 32000	1 ÷ 32000 sec
	Default	20	20 sec
	Level	ENGINEERING	
	Address	1227	
	Function	Determines the gradient of the deceleration ramp occurring at Power Down (after the first extra deceleration stage) if **C225** = Yes. IFD Control algorithm: **C227** is the basic gradient for deceleration adjustment when **C225**= Yes V.	

C228 Start Increment of Ramp Gradient in Power Down

C228			
	Range	-100 ÷ 10000	-1.00 ÷ + 100.00 %
	Default	10	0.10%
	Level	ENGINEERING	
	Address	1228	
	Function	Determines an increase in deceleration ramp gradient at the beginning of the Power Down function. This is required to increase DC bus voltage. **C228 = 0%** start deceleration is due to C227 (C228 has no effect) **C228 = 100%** start deceleration is 100 times faster than deceleration set in C227 (start ramp = C227/100 sec) **C228 = -1.00%** start deceleration is zero (deceleration ramp of infinite time)	

C229 Improved Sensitivity of DC Bus Control

C229			
	Range	1 ÷ 250	1 ÷ 250
	Default	1	1
	Level	ENGINEERING	
	Address	1229	
	Function	Based on the DC bus voltage trend, this function allows detecting mains loss in advance. If the value for this coefficient is too high, erroneous mains loss conditions can be detected, due to a sudden drop in DC bus voltage.	

C230 Voltage Level of DC Bus in Power Down

C230	Range	250 ÷ 450 for Class 2T 400 ÷ 800 for Class 4T 500 ÷ 960 for Class 5T 600 ÷ 1150 for Class 6T	250 ÷ 450 V for Class 2T 400 ÷ 800 V for Class 4T 500 ÷ 960 V for Class 5T 600 ÷ 1150 V for Class 6T
	Default	339 for Class 2T 679 for Class 4T (380÷ 480V) 707 for Class 4T (481÷ 500V) 813 for Class 5T 976 for Class 6T	339 V for Class 2T 679 V for Class 4T (380÷ 480V) 707 V for Class 4T (481÷ 500V) 813 V for Class 5T 976 V for Class 6T
	Level	ENGINEERING	
	Address	1230	
	Function	Determines the reference value for DC bus voltage in case of automatic deceleration in Power Down; **C225** = Yes V.	

C231 PI Proportional Constant for Automatic Deceleration

C231	Range	0 ÷ 32000	0.000 ÷ 32.000
	Default	50	0.050
	Level	ENGINEERING	
	Address	1231	
	Function	Proportional coefficient used in PI regulator controlling automatic deceleration in case of Power Down; **C225** =Yes V.	

C232 PI Integral Time for Automatic Deceleration

C232	Range	1 ÷ 32000	0.001 ÷ 31.999 sec 32000 = Disabled
	Default	500	0.5 sec
	Level	ENGINEERING	
	Address	1232	
	Function	Integral time used in PI regulator controlling automatic deceleration in case of Power Down; **C225** =Yes V.	

C234 Ramp Action at the End of Power Down

C234			
	Range	0 ÷ 2	0: Stop 1: Stand–by 2: Dcb
	Default	0	0: Stop
	Level	ENGINEERING	
	Address	1234	
	Function	When the motor speed during Power Down attains the Power Down end value set in **C235**, three operating modes are possible depending on **C234** programming: [Stop] If the drive is capable of bearing DC bus voltage, it will control the motor until it stops irrespective of the speed value set in **C235**. If power supply is restored when the deceleration ramp is over, the RUN command must be disabled and enabled again to accelerate the motor. If power supply is restored when the motor is still decelerating, the speed of reference is forced to the motor with the preset acceleration ramp. [Stand–by] When decelerating, once the speed value set in **C235** is attained, the drive is put on stand–by and the motor keeps decelerating (motor idling). If power supply is restored, the same conditions as described in the step above (see [Stop]); instead of stopping the motor, the drive is put on stand–by. [DCB] When decelerating, once the speed value set in **C235** is attained, DC braking occurs. Its duration depends on the speed value set in **C235** and on DC braking parameters (see the DC BRAKING MENU): t* = **C217** * (**C235** /**C219**) with **C235**/**C219** equal to max. 10. If power supply is restored, the same conditions as described in the step above occur (see [Stop]); instead of stopping the motor, the drive performs DC braking.	

C235 Motor Speed at the End of Power Down

C235			
	Range	0 ÷ 5000	0 ÷ 5000 rpm
	Default	0	0 rpm
	Level	ENGINEERING	
	Address	1235	
	Function	Motor speed at the end of Power Down. If **C234** is set as [Stand–by], the drive is put on stand-by; if **C234** is set as [DCB], it determines DC braking. Both conditions occur during the deceleration ramp due to Power Down and when the speed value set in **C235** is attained.	

40. SPEED SEARCHING MENU

40.1. Overview

When a command is sent to disable the drive, the motor idles. When the drive activates again, the Speed Searching function allows the drive to reach the motor speed.
All parameters relating to this function are included in the Speed Searching submenu in the Configuration menu.
For FOC control, the motor speed of rotation is always known, so this function is always active and independent of the parameters of the relevant menu.

NOTE The Speed Searching parameters are used for IFD control only.

When **C245** is set to [YES], do the following to activate the Speed Searching function:
– open and close the **ENABLE** command before t_{SSdis} is over (**C246**);
– disable the DC Braking command before the DC braking preset time is over (see the DC BRAKING MENU);
– reset any alarm tripped (with reference other than 0) before t_{SSdis} is over.
Speed searching does not take place when the drive turns off due to mains loss.
If the drive restarts after a time longer than t_{SSdis} (**C246**), frequency output is generated following the acceleration ramp, and no speed searching takes place.
If **C246 0: (Always On)**, speed searching (if enabled with **C245**) occurs when the drive restarts (RUN), irrespective of the time elapsed from disabling.
The figures below show output frequency and motor rpm during speed searching.
After time t_0 for rotor demagnetization, speed searching occurs as follows (see 3 steps below):

Speed at the beginning of the speed searching function depends on the settings in C249.

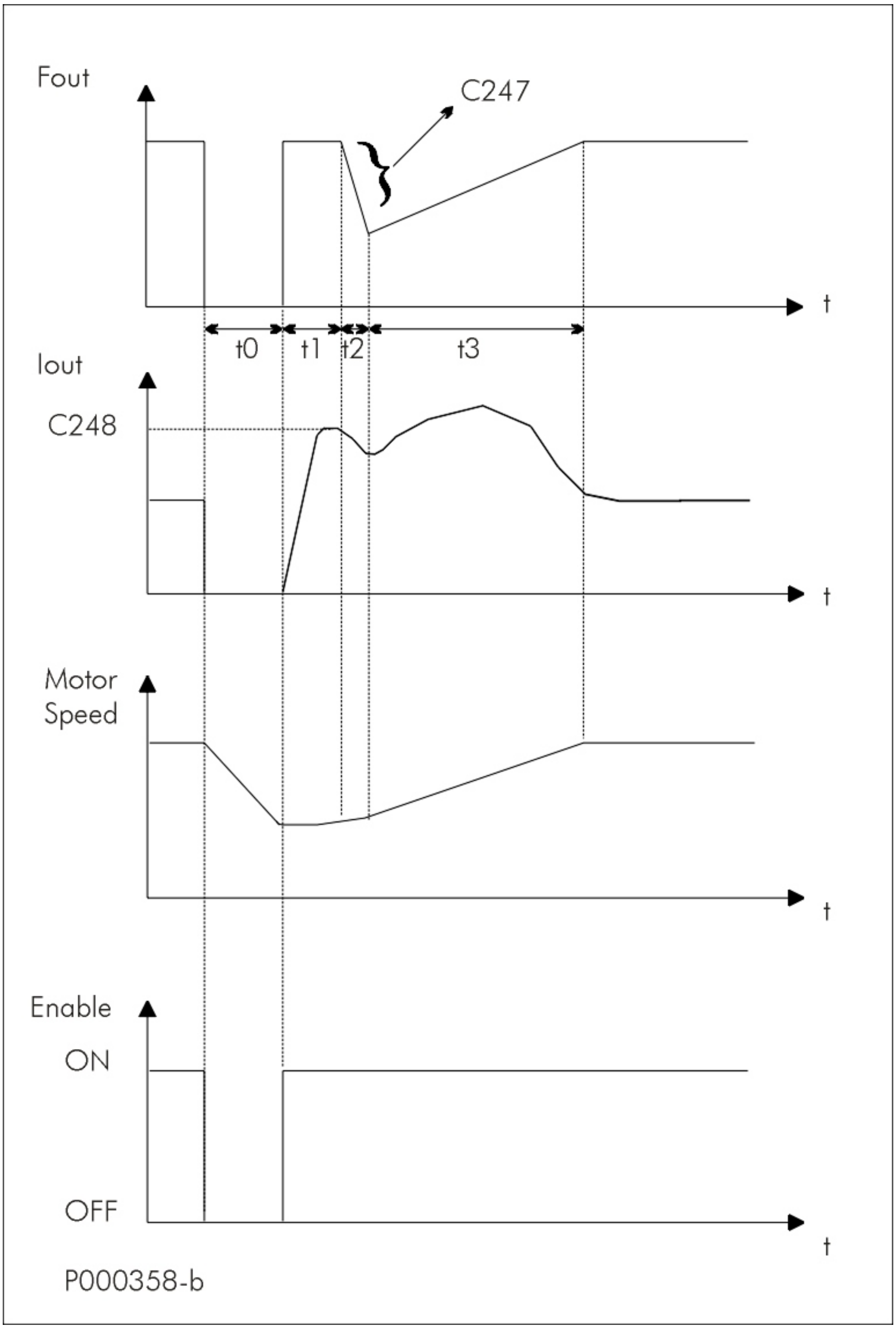


Figure 58: Speed Searching (Example 1).

– Output Frequency and motor RPM for the Speed Searching Function (**C245** = [YES]) activated by the **ENABLE** command.
$t_O < t_{SSdis}$ (**C246**) or **C246** = 0.

Three stages:

Time t_1 The drive output frequency corresponds to the last value which was active before disabling the drive; output current matches with the value set in **C248**;
Time t_2 Output frequency is decremented following the ramp set in **C247** for rotation speed searching;
Time t_3 The connected motor accelerates following the acceleration ramp.

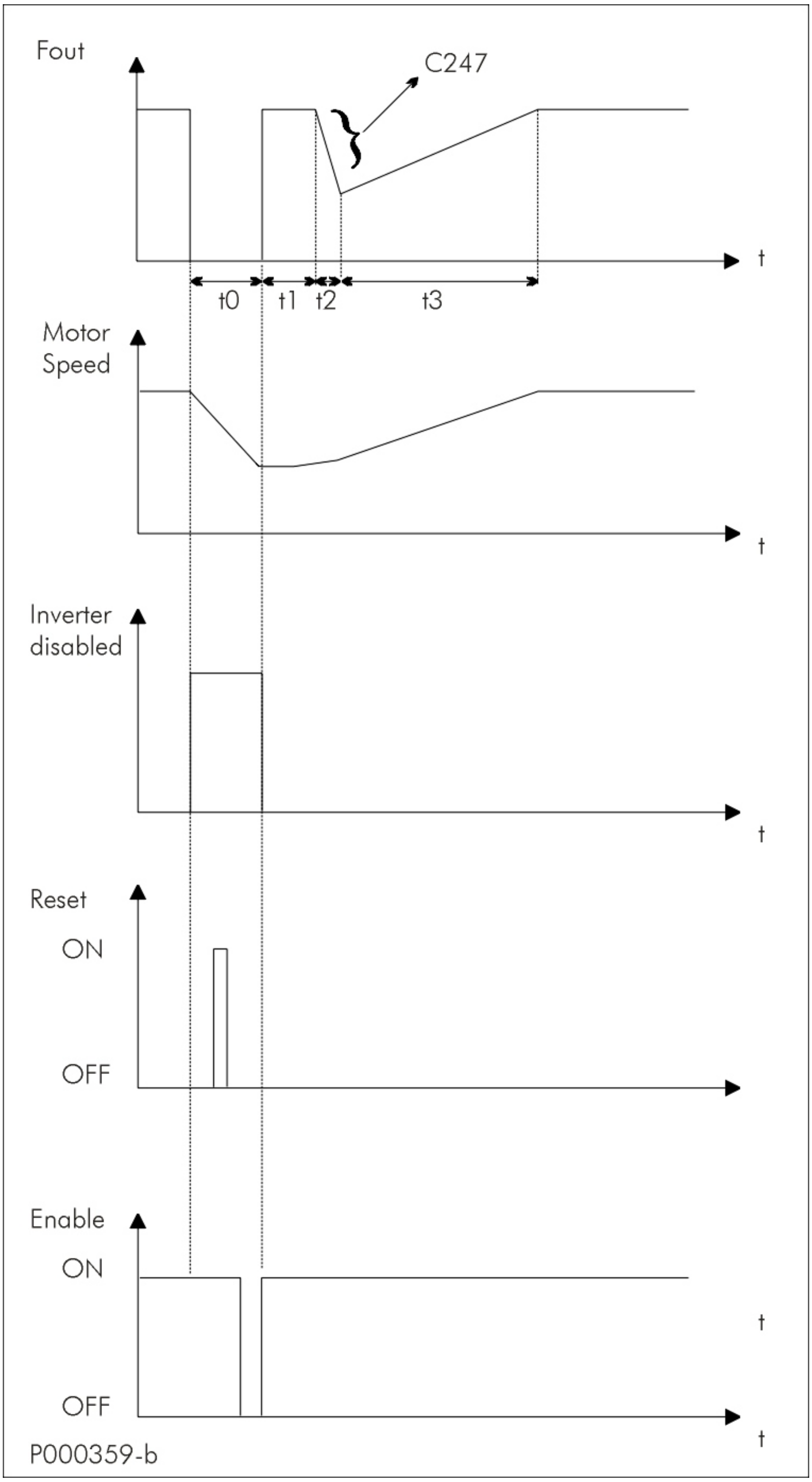


Figure 59: Speed Searching (Example 2).

Frequency, Motor Rpm, Drive Lock, **RESET** and **ENABLE** during Speed Searching (**C245** =[YES]) due to an Alarm Trip $t_{OFF} < t_{SSdis}$ (**C246**) or **C246** = 0.

NOTE

If the Safety at Start function is disabled (**C181** = [Inactive]), it is not necessary to open and close the **ENABLE** contact; Speed searching matches with the **RESET** command.

40.2. List of Parameters C245 to C248

Table 97: List of parameters C245 to C248.

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
C245	Speed Searching enable	ENGINEERING	1245	1: YES
C246	Speed Searching disable if ENABLE is open	ENGINEERING	1246	1sec
C247	Speed Searching time as % deceleration ramp	ENGINEERING	1247	10%
C248	Current used for Speed Searching	ENGINEERING	1248	75%
C249	Speed searching starting level	ENGINEERING	1249	Last speed

C245 Speed Searching Enable

C245			
	Range	0 ÷ 1	0: No ÷ 1: Yes
	Default	0	0: No
	Level	ENGINEERING	
	Address	1245	
	Control	IFD	
	Function	This parameter enables the speed searching function. The Speed Searching function is enabled in the following cases: – when the **ENABLE** contact is open and closed before time t_{SSdis} (C246); – when the DC Braking command is disabled before the preset time is over (see the DC BRAKING MENU); – when an alarm is reset (with a reference other than 0) before time t_{SSdis}.	

C246 Speed Searching Disable if ENABLE is Open

C246			
	Range	0; 3000	0 : (Always ON) ÷ 3000 sec
	Default	1	1 sec
	Level	ENGINEERING	
	Address	1246	
	Control	IFD	
	Function	Determines the maximum allowable time passing between the drive disable and enable command when the Speed Searching function is activated. When the drive is restarted, output frequency will depend on the preset acceleration ramp. When C246 = 0: (Always ON) , speed searching will always occur, independently of the time passing between the drive disable and enable.	

C247 Frequency Decrease Rate

C247			
	Range	1 ÷ 1000	1 ÷ 1000%
	Default	10	10%
	Level	ENGINEERING	
	Address	1247	
	Control	IFD	
	Function	This parameter sets the frequency decrease rate during the speed search stage. The frequency decrease rate (expressed in Hz/s) is given from the following formula: (f_{max} x **C247**) / 10 This means that when **C247**=100%=1, the Penta drive takes 10s to go from the max. frequency to 0Hz. When C247=10%=0.1 (default value), the system takes 100s to go from the max. frequency to 0Hz. The maximum frequency of the connected motor is given from the following formula: f_{max} = (npoles x **C029**) / (2 x 60).	

NOTE The frequency decrease rate is not dependent on the preset ramp times.

NOTE When the Penta drive enters the current limitation mode, the time the system takes for speed searching can be longer than the preset time.

C248 Current Used for Speed Searching

C248			
	Range	20; MIN [105%; ((Drive Imax /Motor.Inom)*100)%]	
	Default	75	75%
	Level	ENGINEERING	
	Address	1248	
	Control	IFD	
	Function	Determines the max. current level for speed searching; it is expressed as a percentage of the rated motor current.	

C249 Speed Searching Starting Level

C249			
	Range	0 ÷ 3	0: Last speed 1: MaxSpd/Last dir. 2: MaxSpd/Pos. Dir. 3: MaxSpd/Neg.Dir.
	Default	0	0: Last speed
	Level	ENGINEERING	
	Address	1249	
	Control	IFD	
	Function	Speed Searching starts according to the value set in **C249**: **C249 = 0:[Last Speed Value]** – the last speed search value generated before disabling the system is used for speed searching. **C249 = 1:[MaxSpd/LastDir.]** – the max. speed programmed for the motor in the last direction of rotation of the connected motor is produced. **C249 = 2:[MaxSpd/Pos.Dir]** – the speed searching function will begin with the max. speed programmed for the motor in the positive direction of rotation independently of the last frequency value produced before disabling the drive. **C249 = 3:[MaxSpd/Neg.Dir]** – as "2", but the direction of rotation of the connected motor will always be negative.	

41. AUTORESET MENU

41.1. Overview

The Autoreset function can be enabled in case an alarm trips. You can enter the maximum number of autoreset attempts and the time required for resetting the attempt number. If the Autoreset function is disabled, you can program an autoreset procedure at power on, which resets an active alarm when the drive is shut off. Undervoltage alarms or mains loss alarms can be saved in the fault list in the Autoreset menu.
To activate the Autoreset function, set a number of attempts other than zero in parameter **C255**. If the number of attempts reset within a time interval t < **C256** is equal to the value set in **C255**, the autoreset function is disabled; it will be enabled again only when a time longer than or equal to **C256** has passed.
If the drive is turned off when an alarm is active, the alarm tripped is stored to memory and will be active at next power on. Regardless of the Autoreset function setup, an automatic reset of the last alarm stored can be obtained when the drive is next turned on (**C257** [Yes]). Undervoltage alarm **A047** (DC bus voltage below allowable threshold with motor running) or Mains Loss alarm **A064** (mains loss when the motor is running and the Power Down function is disabled) are not stored in the fault list when the drive is powered off (factory-setting). To enable parameter storage, set **C258** to [Yes].

41.2. List of Parameters C255 to C258

Table 98: List of parameters C255 to C258.

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
C255	Autoreset attempt number	ENGINEERING	1255	0
C256	Attempt counting reset time	ENGINEERING	1256	300 sec
C257	Alarm reset at Power On	ENGINEERING	1257	0: [Disabled]
C258	Enable Undervoltage and Mains Loss alarms	ENGINEERING	1258	0: [Disabled]

C255 Autoreset Attempt Number

C255			
	Range	0 ÷ 100	0: ÷ 100
	Default	0	0
	Level	ENGINEERING	
	Address	1255	
	Function	If set different from Disable (Disable = 0), this parameter enables the Autoreset function and sets the max. number of reset attempts for a time interval set in **C256**. If a time equal to the time set in **C256** passes starting from the last alarm tripped, the autoreset attempt count is reset.	

C256 Attempt Counting Reset Time

C256			
	Range	0; 1000	0; 1000 sec.
	Default	300	300 sec.
	Level	ENGINEERING	
	Address	1256	
	Function	Determines the time that passes from the last alarm tripped to reset the autoreset attempt number.	

C257 Alarm Reset at Power On

C257	Range	0; 1	0: [Disabled]; 1: [Yes]
	Default	0	0: [Disabled]
	Level	ENGINEERING	
	Address	1257	
	Function	At power on, this parameter enables the automatic reset of the alarms tripped when the drive is powered off.	

C258 Enable Saving Undervoltage and Mains Loss Alarms

C258	Range	0; 1	0: [Disabled]; 1: [Yes]
	Default	0	0: [Disabled]
	Level	ENGINEERING	
	Address	1258	
	Function	This parameter saves Undervoltage and Mains Loss alarms to the fault list.	

42. MOTOR THERMAL PROTECTION MENU

42.1. Overview

The Motor Thermal Protection function protects the motor against overloads.
Some Sinus Penta models offer the possibility to set the heatsink temperature for the activation of cooling fans.
All relevant parameters are included in the Motor Thermal Protection menu.

NOTE

Each connected motor has its own thermal model.
If the drive is used to control only one motor and its control mode is selected through the selection of the different motors, the motor thermal protection is ensured by setting PTC protection for all motors.

For each programmable motor, thermal protection can be configured in 4 modes, which can be selected with parameter **C265** (or **C268** or **C271** for motor 2 and 3 respectively), depending on the cooling system being used (configuration modes 1, 2 and 3) or whether a PTC is used (configuration 4):

0:NO	[NO]	The Motor Thermal Protection function is disabled (factory-setting);
1:YES	[No Derated]	The Motor Thermal Protection function is active with pick-up current **It** independent of operating speed;
2:YES A	[Forced Cooled]	The Motor Thermal Protection function is active with pick-up current **It** depending on operating speed, with fan-cooled motor de-rating;
3: YES B	[Self Cooled]	The Motor Thermal Protection function is active; pick-up current **It** depends on operating speed and de-rating is suitable for motors having a fan keyed to the shaft.
4: PTC	[PTC]	Thermoswitch on AIN2analog input (for PTC features, see the **Sinus Penta's Installation Instructions** manual).

When **C265**=1, 2 and 3, the motor thermal model is considered. The heating of a motor is proportional to the square of the current flowing (I_o^2). The Motor overheated alarm (**A075**) will trip after the time "t" computed based on the motor thermal model is over.
The alarm can be reset only after a given time depending on the thermal constant (**C267**) of the motor, thus allowing for the correct cooling of the motor.

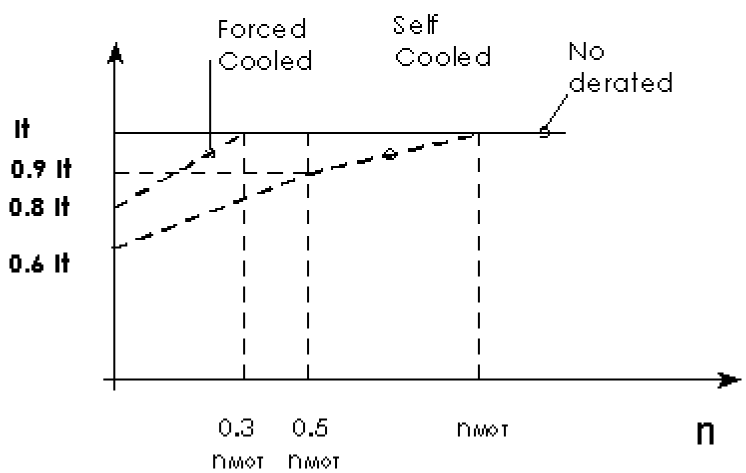


Figure 60: Trip current drop depending on speed values.

The graph above shows how trip current **It** drops depending on the generated speed based on the value set in parameter **C265**.

NOTE

The motor heating can be monitored with measure **M026a**.
This value is expressed as a percentage of the asymptotic value that can be attained.

When **C265**=4, the thermal protection function is implemented from a PTC sensor: the PTC alarm (**A055**) trips when voltage acquired by AIN2 used as a PTC signal input exceeds a preset threshold value when the characteristic temperature is attained. Alarm A055 can be reset only if temperature decreases by 5% with respect to the trip temperature.

42.2. Choosing the Characteristic Parameters

Parameter **C266** relates to the instantaneous pick-up current that the internal thermal protection function will begin to monitor the current. The default value of 120% is a typical value and this can generally stay as is.

The motor thermal time is specific to the motor design and it varies between different motor manufacturers.

If the motor thermal time is unknown, the thermal time constant (**C267**) can be set up as described in the sections below (IEC Class, Maximum Locked Rotor Time – Basic and Maximum Locked Rotor Time – Enhanced).
The first method is the most simple and gives an approximate result. The other two methods are more complex, but give more accurate results.

42.2.1. IEC Class

The motor can be protected as defined in the IEC 60947-4-1 standard for the thermal overload relays.
If the protection class is known, in order to set-up the thermal protection for a certain IEC trip class, the value of **C267** can be entered as:

IEC Class	C267 [s]
10	360
20	720
30	1080

Table 99: Suggested values for the motor thermal time constant.

The standard above defines a 7.2 ratio between LRC and FLC.
The value to be entered in **C267** is then defined from the formula below:

C267 = IEC Class x 36.

If the ratio between LRC and FLC is not 7.2, please refer to the graph in Figure 61.

42.2.2. Maximum Locked Rotor Time – Basic

If the IEC class is not known, then the IEC class can be approximated by the procedure described below.

The following values must be known:
- Full Load Current (FLC) of the motor
- Locked Rotor Current (LRC)
- Maximum Locked Rotor Time (LRT) or Direct On Line (DOL) Start Time

The FLC of the motor can be obtained directly from the nameplate on the motor. The LRC and LRT must be obtained from the manufacturer or the motor datasheets.
The LRC, also referred to as starting current or motor start-up current, is the current that a motor draws at start-up when full voltage is applied to the terminals.
LRT is the time a motor can safely maintain LRC from a cold start. This information might also be available as a thermal withstand curve or a thermal damage curve. If this is the case, then the LRC and LRT must be deduced from the curves.

The following formula can be applied:

$$\text{IEC Class} = \frac{LRC \times LRT}{FLC \times 6}$$

Once the approximated IEC class has been calculated, use the motor thermal time constant (**C267**) that corresponds to the closest IEC class from
Table 99 above.

Example 1a: the 7.5kW motor in Table 100 can be approximated to have a trip class of:

$$\text{IEC Class} = \frac{820 \times 20}{100 \times 6} = 27.3$$

The motor thermal time constant that you would select is IEC class 30, **C267** = 1080s.

NOTE — As an even quicker guide, the IEC trip class can generally be approximated as the locked rotor time.

Output [kW]	IEC Frame	Locked Rotor Current - LRC [% FLC]	Full Load Current - FLC [A]	Locked Rotor Time (cold) - LRT [s]	Rated speed [rpm]	
0.12	63	450	0.41	44	1415	
0.18	63	460	0.58	59	1400	
0.25	71	500	0.7	106	1400	
0.37	71	500	1.03	81	1395	
0.55	80	600	1.3	37	1430	
0.75	80	570	1.61	35	1420	
1.1	90S	700	2.37	31	1445	
1.5	90L	750	3.28	22	1450	
2.2	112M	720	4.42	55	1455	
4	112M	660	7.85	26	1445	
5.5	132S/M	850	10.34	26	1465	
7.5	132S/M	820	14	20	1465	Example 1a/1b
9.2	160M	560	17.4	59	1460	
11	160M	600	20.84	42	1465	
15	160L	650	28.4	37	1465	
18.5	180M/L	800	34.83	26	1470	
22	180L	790	39.4	35	1475	
30	200L	700	55.6	40	1475	
37	225S/M	720	65.2	35	1480	
45	225S/M	740	78.11	33	1480	
55	250S/M	720	95.2	37	1480	
75	250S/M	750	131.25	35	1480	
90	280S/M	780	154.41	55	1485	
110	315S/M	760	189	64	1485	
132	315S/M	780	225.53	55	1485	
150	315S/M	750	260	44	1485	
160	315S/M	760	277	44	1485	
185	355M/L	720	320	117	1490	
200	355M/L	660	342	108	1490	
220	355M/L	700	375	84	1490	
250	355M/L	690	425	79	1490	Example 2
260	355M/L	650	445	90	1490	
280	355M/L	710	471	86	1490	
300	355M/L	670	504	103	1490	
315	355M/L	670	529	92	1490	
330	355M/L	650	554	70	1490	

Table 100: Typical datasheet for 4-pole, 50Hz-400V motors.

42.2.3. MAXIMUM LOCKED ROTOR TIME – ENHANCED

If a more precise calculation is required, when the ratio between LRC and FLC is different from 7.2, you can refer to the graph below, where the x axis shows the LRC/FLC ratio, and the y axis shows the multiplicative constant to be applied to the LRT to calculate the value of parameter **C267**:

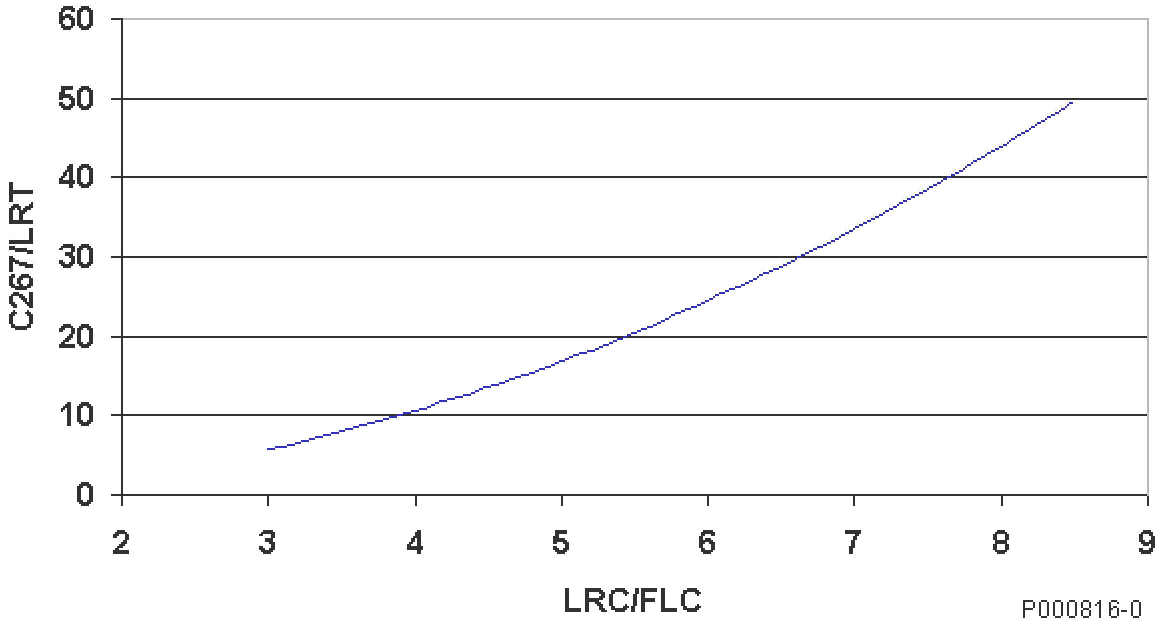


Figure 61: Set up of parameter C267 depending on the LRC/FLC ratio.

Example 1b: When using a 7.5kW motor, the multiplicative constant corresponding to an LRC/FLC=8.2 is approx. 46 if referring to the graph above.

As a result, the motor thermal time constant that you would select is 27.3 x 46, **C267** = 1257s, which is a more accurate value than 1080s computed in Example 1a.

Example 2: The 250kW motor in Table 100 can be approximated to have a trip class of:

$$\text{IEC Class} = \frac{690 \times 79}{100 \times 6} = 90.85$$

Because this value is not given in Table 99, the motor thermal time constant that you would select is directly **C267** = 90.85 x 36 = 3260s, or 90.85 x 33 = 2998s if the value "33" is considered, resulting from Table 100 with a ratio between LRC/FLC=6.9.

42.3. Thermal Protection Trip Delay

The graph below shows the thermal protection trip delay depending on the IEC Class and the current flowing (which is supposed to be constant).
Parameter **C266** (pick-up current) is factory set to 120%.

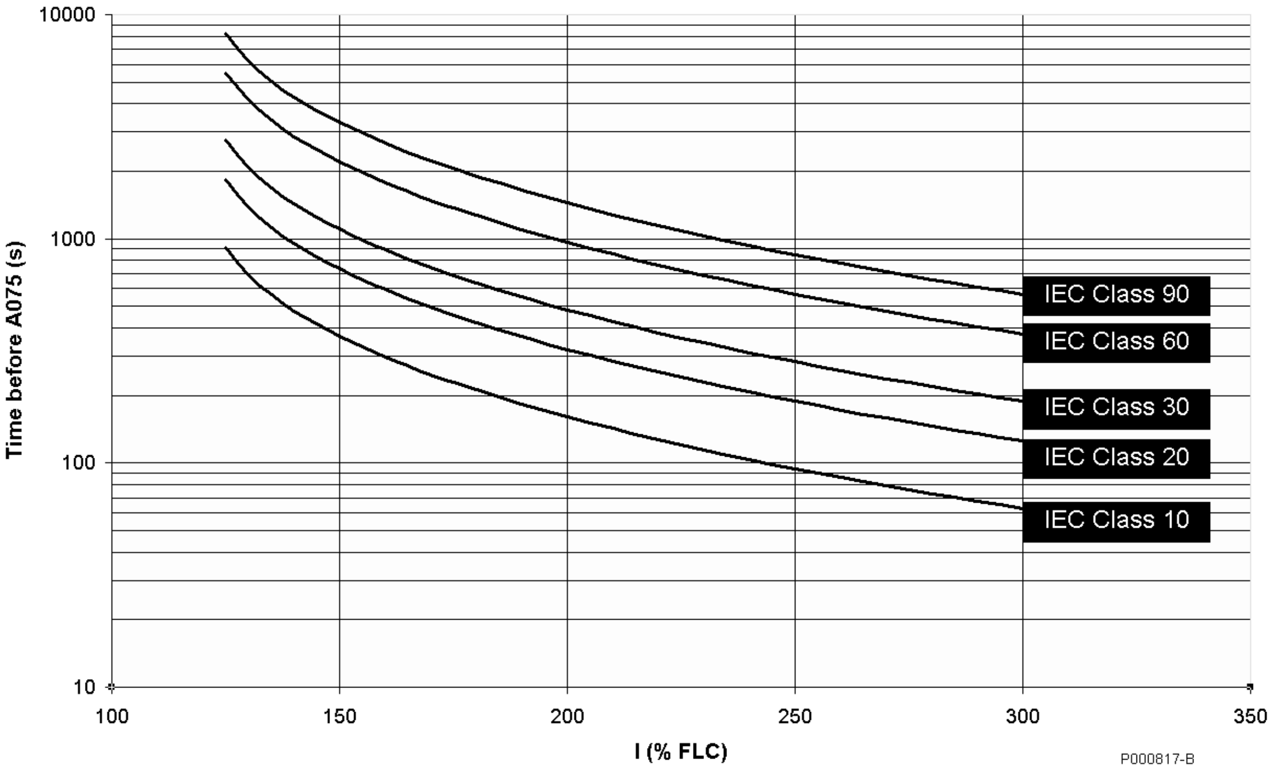


Figure 62: Trip delay of alarm A075 based on the IEC Class.

Example: The protection level is compliant with IEC Class 30. If the current flowing is 200% of the FLC, alarm **A075** will trip after approx. 480s (8 minutes).

42.4. List of Parameters C264 to C274

Table 101: List of parameters C264 to C274.

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
C264	Heatsink temperature for fan activation	ADVANCED	1264	50°C
C265	Thermal Protection activation for motor 1	BASIC	1265	0:[Disabled]
C266	Pick-up current for motor 1[Inom%]	ADVANCED	1266	120%
C267	Thermal time constant for motor 1	BASIC	1267	360s
C268	Thermal Protection activation for motor 2	ADVANCED	1268	0:[Disabled]
C269	Pick-up current for motor 2 [Inom%]	ADVANCED	1269	120%
C270	Thermal time constant for motor 2	ADVANCED	1270	360s
C271	Thermal Protection activation for motor 3	ADVANCED	1272	0:[Disabled]
C272	Pick-up current for motor 3 [Inom%]	ADVANCED	1271	120%
C273	Thermal time constant for motor 3	ADVANCED	1273	360s
C274	PTC Thermal Protection Enable	BASIC	1274	0:[Disabled]

C264 Heatsink Temperature for Fan Activation

C264			
	Range	-1 ÷ 100	-1: [Always ON] ÷ 50°C
	Default	50	50°C
	Level	ADVANCED	
	Address	1264	
	Function	The heatsink cooling fans are switched on each time the drive is enabled (and the IGBTs are switching). When disabled, the fans are switched off only if the heatsink temperature drops below the value set in **C264**. Set "Always ON" for cooling fan continuous operation. The real temperature of the heatsink can be displayed in measure parameter **M064**.	

NOTE

This parameter has effect only for the Penta models where fans are controlled directly by the drive control board (N), as displayed on the Product screen in the PRODUCT MENU .

Display

```
P R O D U C T   N A M E
P E N T A
T y p e   0 0 2 0   4 T     N
```

The last field of line 3 shows a code relating to the type of fan operation:

- _ : Fans are not controlled by ES821control board
- S : ES821 Control board detects the correct operation of the cooling fans; in cause of fan fault, the relevant alarm trips.
- P : Fan activation depends on the thermoswitch condition detected by the control board.
- N : The temperature sensor controlling the fan operation is an NTC. Temperature is measured by ES821 control board (**M064**); the threshold for switching off the fans when the drive is disabled is set in parameter **C264**. In this case only, fan activation depends on parameter **C264**.

C265 (C268, C271) Thermal Protection Activation

C265 (Motor 1) C268 (Motor 2) C271 (Motor 3)	Range	0 ÷ 3	0 : [Disabled] 1 : [No Derating] 2 : [ForcedCool.] 3 : [Self-cool.]
	Default	0	0 : [Disabled]
	Level	BASIC (C265); ADVANCED (C268, C271)	
	Address	1265; 1268; 1271	
	Function	This parameter enables the Motor Thermal Protection function. It also selects the type of thermal protection among different trip patterns.	

C266 (C269, C272) Pick-up Current

C266 (Motor 1) C269 (Motor 2) C272 (Motor 3)	Range	1 ÷ min [120%; [((Imax/Imot)*100) %]	1 ÷ min [120%; [((Imax/Imot)*100) %]
	Default	120	120%
	Level	ADVANCED	
	Address	1266, 1269, 1272	
	Function	This parameter sets the thermal protection pick-up current expressed as a percentage of the rated current of motor 1 (2, 3).	

C267 (C270, C273) Thermal Time Constant

C267 (Motor 1) C270 (Motor 2) C273 (Motor 3)	Range	1 ÷ 10800	1 ÷ 10.800 s
	Default	360	360s (corresponding to IEC Class 10)
	Level	BASIC (C267); ADVANCED (C270, C273)	
	Address	1267; 1270; 1273	
	Function	This parameter sets the thermal time constant of the connected motor. The time constant is the time within which the calculated thermal stage has reached 63% of its final value. The motor attains its thermal time constant when it operates in constant load conditions for a time equal to approx. 5 times the constant set in this parameter.	

C274 PTC Thermal Protection Enable

C274	Range	0 ÷ 1	0: Disabled ÷ 1: Enabled
	Default	0	Disabled
	Level	ADVANCED	
	Address	1274	
	Function	This parameter enables the PTC probe (AIN2 analog output)	

NOTE

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

43. MAINTENANCE MENU

43.1. Overview

The Maintenance menu allows setting partial counters for the drive supply time (ST) and operation time (OT). When the preset time is reached, a warning message appears.

43.2. List of Parameters C275 to C278

Table 102: List of parameters C275 to C278.

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C275	Operation time counter reset	ENGINEERING	1275	NO
C276	Operation time threshold	ENGINEERING	1276	0h
C277	Supply time counter reset	ENGINEERING	1277	NO
C278	Supply time threshold	ENGINEERING	1278	0h

C275 Operation time counter reset

C275			
	Range	0 ÷ 1	0: [NO] ÷ 1 [YES]
	Default	0	NO
	Level	ENGINEERING	
	Address	1275	
	Function	This parameter resets the partial counter for the drive operation time.	

C276 Operation Time Threshold

C276			
	Range	0 ÷ 65000	0 ÷ 650000h
	Default	0	0h
	Level	ENGINEERING	
	Address	1276	
	Function	This parameter sets the threshold for the operation time of the drive. When this time is exceeded, Warning 48 "**W48 OT Over**" appears. To reset the warning message, reset the partial counter or set the counter threshold to zero.	

C277 Supply Time Counter Reset

C277			
	Range	0 ÷ 1	0: [NO] ÷ 1 [YES]
	Default	0	NO
	Level	ENGINEERING	
	Address	1277	
	Function	This parameter resets the partial counter for the drive supply time.	

C278 Supply Time Threshold

C278			
	Range	0 ÷ 65000	0 ÷ 650000h
	Default	0	0h
	Level	ENGINEERING	
	Address	1278	
	Function	This parameter sets the threshold for the supply time of the drive. When this time is exceeded, Warning 49 "**W48 ST Over**" appears. To reset the warning message, reset the partial counter or set the counter threshold to zero.	

44. PID CONFIGURATION MENU

44.1. Overview

The Sinus Penta is provided with two separate PID (Proportional, Integral, Derivative) regulators allowing performing regulation loops such as pressure control, delivery control, etc., with no need to connect external auxiliary devices.
The PID Configuration Menu defines configuration parameters for the two PID regulators.
The configuration parameters for the PID regulator can be modified only when the drive is in stand-by and they set the following variables: reference sources, feedback sources and type of PID output implementation.
The programming parameters for the two PID regulators, including coefficients of proportional, integral and derivative terms, output saturation, etc., are covered in the PID PARAMETERS MENU and the PID2 PARAMETERS MENU.

44.2. Operation and Structure of the PID Regulator

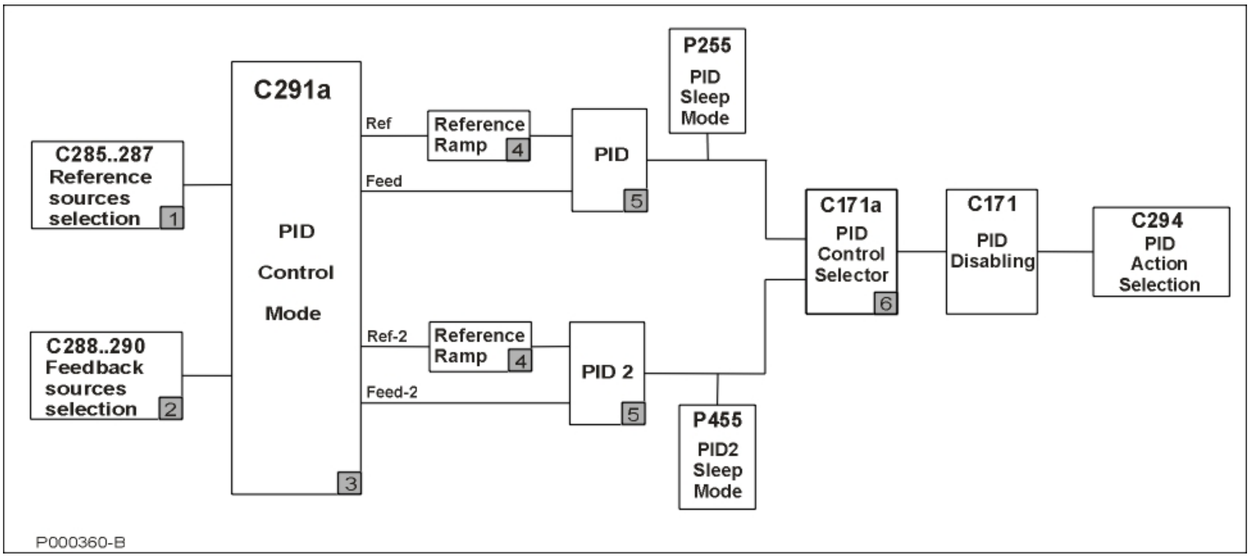


Figure 63: Structure of the PID Regulator.

The figure above illustrates the block diagram of the PID regulator. Each block is described below:

Block 1: PID reference sources.
Multiple reference sources can be selected at a time (up to 3 reference sources can be selected with parameters C285, C286, C287).
The resulting reference value depends on the setup in C291a (see block 3).
Dynamic selection is possible between two reference sources using the digital input configured as the source selector (see C179); this parameter has effect only if the Two PIDs mode is activated.

Block 2: PID feedback sources.
Multiple feedback sources can be selected at a time (up to 3 feedback sources can be selected with parameters C288, C289, C290).
The resulting reference value depends on the setup in C291a (see block 3).
Dynamic selection is possible between two feedback sources using the digital input configured as the source selector (see C179); this parameter has effect only if the Two PIDs mode is activated.

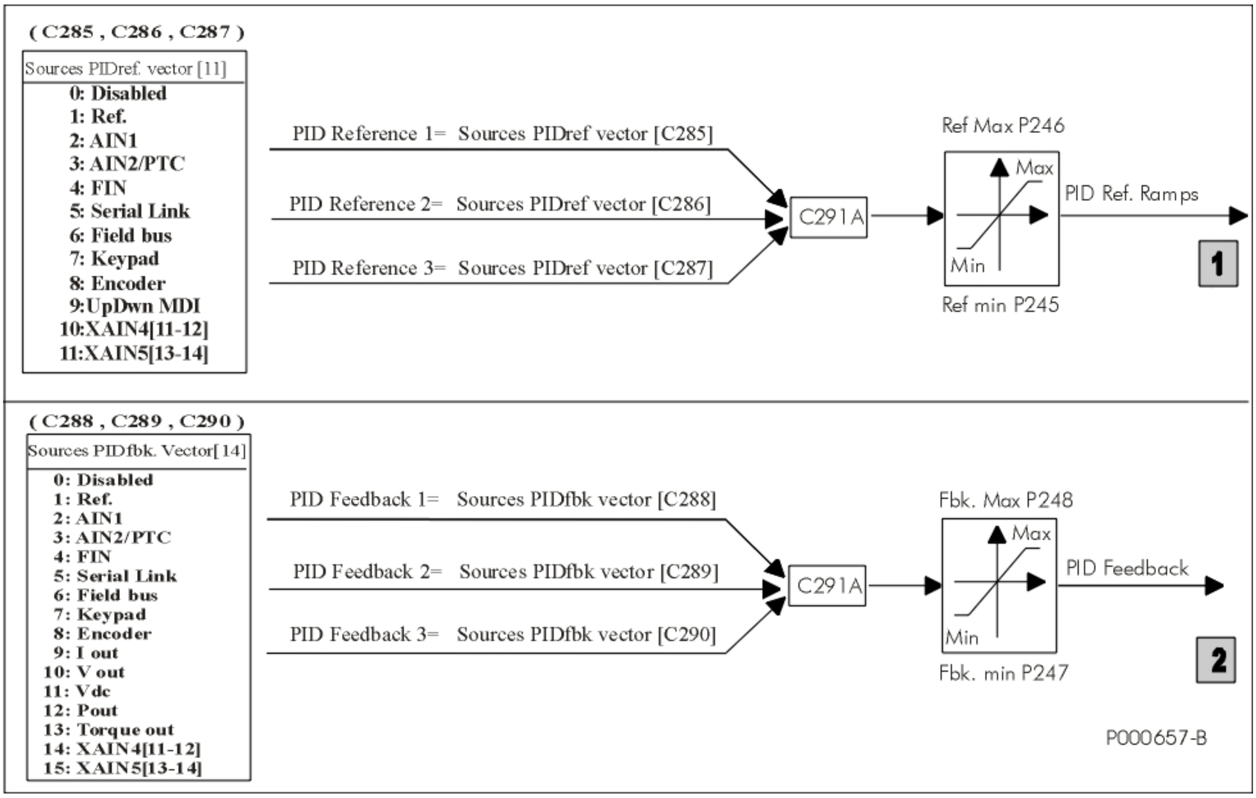


Figure 64: Reference source and feedback source selection.

NOTE

The signals selected in the Sources Vector are to be considered as percentage values; therefore, analog signals are expressed as a percentage of the preset maximum values and minimum values. For example, when selecting a reference source, if P052 Ref. max. = 8V and P051 Ref. min. = –3V, 100% will be considered when Ref. = 8V and –100% will be considered when Ref. = –3V.

NOTE

Among the allowable variables for the PID feedback, electrical variables Iout (output current), Vout (output voltage), Vdc (DC bus voltage), Pout (output power) and Torque out (output torque – only with VTC and FOC control).
Their percentage values relate to rated current values and rated voltage values of the selected motor and to 1500VDC respectively.

NOTE

In Local mode, the PID regulator is disabled if set as C294 = Reference Sum or Voltage Sum.

Block 3: PID Control Mode

This block allows applying different processing types to the feedback signals and allows enabling/disabling the PID2 integrated into the system (see C291a).

Block 4: Ramp over PID Reference

A ramp may be applied to the PID references sent from block 3. The same ramp is applicable for both blocks: the processed references are the ones actually used in the PID regulator. The parameters of the PID reference ramp are illustrated in the figure below. The initial rounding-off is applied to the reference whenever a new acceleration/deceleration ramp is started, while the end reference is applied at the end of each ramp.

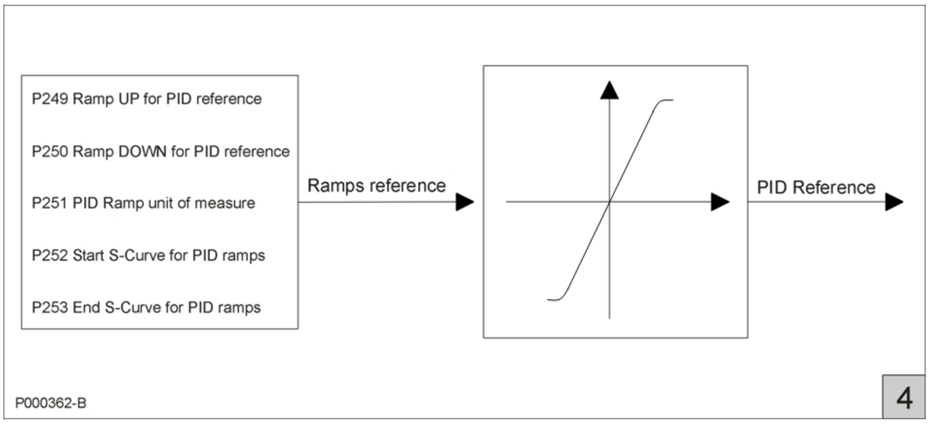
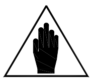


Figure 65: PID ramp reference.



NOTE The PID2 ramp reference control is the same, but parameters **P2xx** are replaced with parameters **P4xx**.

Block 5: PID regulators
This is the real PID regulator. Its output may be disabled by an external digital command (if programmed with **C171**). If the PID regulator is used as a reference source and **P255** (**P455** for PID2) is not set to zero, the PID output value control is enabled. If the PID output equals the preset minimum value for a time longer than **P255** (**P455** for PID2), the drive is automatically put on stand-by.

In the last block, the PID output is applied to the function defined by the "Regulator Implementation" parameter (**C294**).

The PID regulator structure is detailed in the diagram below (block 4).

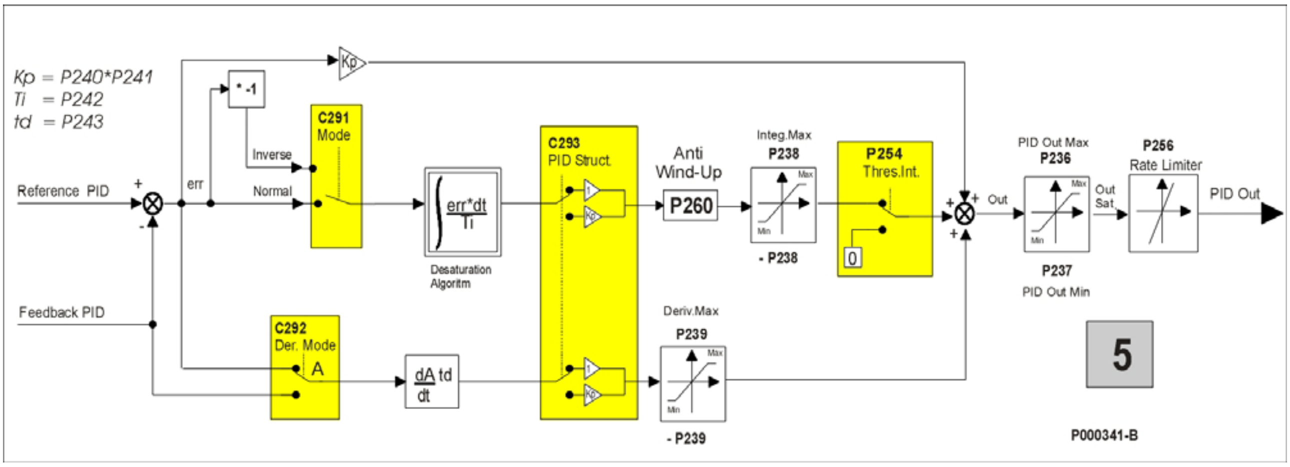
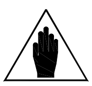


Figure 66: Details of the PID regulator structure.



NOTE The PID2 structure is the same as the PID structure, but parameters **P2xx** are replaced with **P4xx** and parameter **C291** is replaced with parameter **C291b**. Parameters **C292** and **C293** are in common for PID and PID2.

Block 6: Digital input for PID control selection.
Block 6 activates only when both PIDs are enabled (**C291a** = **2 PID**) or when in 2-Zone mode (**C291a** = **2-Zone MIN** or **2-Zone MAX**).

In Two PIDs mode:
if **C171a** = **0: Disabled**, the PID output is summed with the PID2 output;
if **C171a** is enabled, the logic state of the configured input determines which is the output of the PID regulator to be used: 0 → PID, 1→ PID2.

In 2-zone mode:
if **C171a** is enabled, when the selected input is activated, the 2-zone mode (MIN or MAX) is disabled. In that case, the PID regulator always operates on the error resulting from **C285–C288** and with parameters **P2xx**.

The PID regulator output may be used as:

- an external output;
- a speed/torque reference of the drive;
- a speed/torque reference increase or, if the IFD control is used, the PID regulator input may be used for correcting the output voltage.

If the PID regulator output is the speed reference of the drive, the selected speed/torque ramp is applied.

SERIAL LINK

The ***Serial Link*** source is an input from the MODBUS link: the reference value shall be written by the user to the following addresses:

Table 103: Reference sources from serial link.

MODBUS Address	Input	User Level	Type of Reference	Description	Unit of Measure
1418	I031	BASIC	PID Reference	PID reference value	Set in **P267**
1420	I033	BASIC	PID Feedback	PID feedback value	Set in **P267**

44.3. List of Parameters C285 to C294

Table 104: List of parameters C285 to C294.

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
C285	Selection of PID reference n. 1	ENGINEERING	1285	2:AIN1
C286	Selection of PID reference n. 2	ENGINEERING	1286	0:Disable
C287	Selection of PID reference n. 3	ENGINEERING	1287	0:Disable
C288	Selection of PID feedback n. 1	ENGINEERING	1288	3:AIN2/PTC
C289	Selection of PID feedback n. 2	ENGINEERING	1289	0:Disable
C290	Selection of PID feedback n. 3	ENGINEERING	1290	0:Disable
C291	PID operating mode	ENGINEERING	1291	0:Disable
C291a	PID control mode	ENGINEERING	1295	0:Standard SUM
C291b	PID2 operating mode	ENGINEERING	1296	1: Normal
C292	Selection of the variable for calculating the derivative term	ENGINEERING	1292	0:Measure
C293	Proportional Multiplier of derivative and integral terms	ENGINEERING	1293	0:NO
C294	PID implementation	ENGINEERING	1294	1:Reference

C285 (C286,C287) Selection of PID Reference n. 1 (2, 3)

<table>
<tr><td rowspan="2">C285 (C286, C287)</td><td>Range</td><td>0 ÷ 8</td><td>0: Disable
1: REF
2: AIN1
3: AIN2/PTC
4: Pulse Input
5: Serial Link
6: Fieldbus
7: Keypad
8: Encoder
9: Up Down from MDI
10: XAIN4
11: XAIN5</td></tr>
<tr><td>Default</td><td>C285 = 2
C286 = 0
C287 = 0</td><td>C285 = 2: AIN1
C286 = 0
C287 = 0</td></tr>
<tr><td></td><td>Level</td><td colspan="2">ENGINEERING</td></tr>
<tr><td></td><td>Address</td><td colspan="2">1285 (1286, 1287)</td></tr>
<tr><td></td><td>Function</td><td colspan="2">C285 selects the first PID reference source from the PID regulator. Up to three reference sources may be configured (285 – C287) considered as a sum.
The sources are used by the PID and are expressed in percentage values (with reference to their max. value and min. value set in the References menu).
If multiple reference sources are selected, their sum is considered. They are saturated between P246 and P245 (PID reference maximum and minimum value respectively).
Reference sources 10 and 11 can be selected only after setting XAIN in parameter R023.</td></tr>
</table>

C288 (C289,C290) Selection of PID Feedback n.1 (2, 3)

<table>
<tr><td rowspan="2">C288 (C289, C290)</td><td>Range</td><td>0 ÷ 13
0 ÷ 15 when ES847 is fitted</td><td>0: Disable
1: REF
2: AIN1
3: AIN2/PTC
4: Pulse Input
5: Serial Link
6: Fieldbus
7: Keypad
8: Encoder
9: Iout
10: Vout
11: Vdc
12: Pout
13: Tout
14: XAIN4
15: XAIN5</td></tr>
<tr><td>Default</td><td>C288= 3
C289= 0
C290= 0</td><td>C288= 3: AIN2/PTC
C289= 0: Disable
C290= 0: Disable</td></tr>
<tr><td></td><td>Level</td><td colspan="2">ENGINEERING</td></tr>
<tr><td></td><td>Address</td><td colspan="2">1288 (1289, 1290)</td></tr>
<tr><td></td><td>Function</td><td colspan="2">C288 selects the first PID feedback source. Up to three feedback sources can be configured among the available reference sources. If multiple sources are selected, their sum is considered. They are saturated based on parameters P247 and P248 (PID reference maximum and minimum value respectively). See also parameter C285.
Feedback sources 14 and 15 can be selected only after setting XAIN in parameter R023.</td></tr>
</table>

C291 PID Operating Mode

C291	Range	0 ÷ 2	0: Disable 1: Normal 2: Reverse
	Default	0	0: Disable
	Level	ENGINEERING	
	Address	1291	
	Function	This parameter defines how to compute the PID output. Three computing modes are available: 0: **Disable**, 1: **Normal**, 2: **Reverse**. If 0:**Disable** is selected, the PID regulator is inactive and its output is always set to zero. In **Normal** mode, the real PID output is considered. If **2: Reverse** is selected, the output implemented by the PID regulator results from the subtraction of the max. output value set in **P236** from the output obtained by the PID regulator. This operating mode can be used for special applications (see the Keeping Fluid Level Constant (Example) at the end of this chapter).	

C291a PID Control Mode

C291a	Range	0 ÷ 7	0: Standard SUM 1: Standard DIFF 2: Average 3: Minimum 4: Maximum 5: 2-Zone MIN 6: 2-Zone MAX 7: 2 PIDs
	Default	0	0: Standard SUM
	Level	ENGINEERING	
	Address	1295	
	Function	This parameter sets the PID control mode. Functions 0 to 4 set the processing mode of the feedback signal as detailed below. 1) If **C179 Input for Source Selection** = **0: Disabled**: **STANDARD SUM**: All the selected feedback signals are summed up. **STANDARD DIFF**: The sum of the selected feedback signals is subtracted from the feedback signal programmed in **C288**. **AVERAGE**: The resultant of the feedback is given from the arithmetical average of the selected signals. **MINIMUM**: The signal having the smallest value among the selected signals is considered as the feedback. **MAXIMUM**: The signal having the largest value among the selected signals is considered as the feedback. 2) If **C179** is enabled: **STANDARD SUM**: **C288**+**C290** or **C289**+**C290**. **STANDARD DIFF**: **C288**–**C290** or **C289**–**C290**. **AVERAGE**: AVG(**C288**,**C290**) or AVG(**C289**,**C290**). **MINIMUM**: MIN(**C288**,**C290**) or MIN(**C289**,**C290**). **MAXIMUM**: MAX(**C288**,**C290**) or MAX(**C289**,**C290**). The references are always summed with each other, unless they are managed with the Source Selection (see **C179**).	

	Function	Functions 5 and 6 (2-Zone Mode) automatically disable the Source Selection function that can be programmed with **C179**. In functions 5 and 6 only the references selected with **C285-C286** and the feedback values selected with **C288-C289** are used. **2-Zone MIN**: The PID operates on the system with an algebraic error over MAX(**C285–C288**,**C286–C289**). This means that the system takes control of the PID having the minimum feedback in respect to its setpoint. **2-Zone MAX**: The PID operates on the system with an algebraic error under MIN(**C285–C288**,**C286–C289**). This means that the system takes control of the PID having the minimum feedback in respect to its reference. **NOTE:** When **C171a Input for PID Control Selection** is activated and the selected input is activated, the 2-zone (MIN or MAX) mode is disabled and the PID always operates on the error resulting from **C285–C288**.
		Function 7 (Two PIDs programming) automatically disables the Source Selection function that can be programmed with **C179**. The two PIDs use only the signals selected with **C285/C288** for PID and with **C286/C289** for PID2. **2 PID:** PID and PID2 operate in parallel; the outputs of the two PIDs are matched based on the configuration of **C171a:** If **C171a** = **0: Disabled**, the outputs of the two PIDs are summed to each other; If **C171a** is enabled, the output of the PID regulator depends on the logic state of the configured input: 0 → PID, 1→ PID2.

C291b PID2 Operating Mode

C291b	Range	1 ÷ 2	1: Normal 2: Inverse
	Default	1	1: Normal
	Level	ENGINEERING	
	Address	1296	
	Function	This parameter sets how to calculate the PID2 output. Two modes are available: 1: **Normal**, 2: **Inverse**. In **Normal** mode, the output of the PID regulator is the actual PID2 output. If 2: **Inverse** is selected, the error sign is reversed. The Inverse operating mode can be used for special applications only (see Keeping Fluid Level Constant (Example)).	

C292 Selection of the Variable for Calculating the Derivative Term

C292	Range	0 ÷ 1	0: Measure 1: Error
	Default	0	0: Measure
	Level	ENGINEERING	
	Address	1292	
	Function	This parameter sets the variable used for calculating the derivative term. By default, the derivative term is computed according to the feedback measure, but it can also be computed according to the PID error: Error = Reference – Feedback.	

C293 Proportional Multiplier of Derivative and Integral Terms

C293			
	Range	0 ÷ 1	0: No 1: Yes
	Default	0	0: No
	Level	ENGINEERING	
	Address	1293	
	Function	This parameter defines if the proportional term is used for the multiplication of the derivative and integral terms as well. 0: No means that the proportional term DOES NOT multiply the integral term.	

C294 PID implementation

C294			
	Range	0 ÷ 3	0: Analog output 1: Reference 2: Reference sum 3: Voltage sum
	Default	1	1: Reference
	Level	ENGINEERING	
	Address	1294	
	Function	This parameter sets the type of implementation carried out by the PID regulator. *C294 = Analog Output:* The PID regulator is independent of the drive operation, unless a digital input is configured for PID disabling; if the digital input closes, the PID regulator is disabled and the output is set to zero. In order to use the PID regulator output externally to the drive, configure one of the analog outputs as PID Out. *C294 = Reference:* The PID regulator output is the speed/torque reference of the connected motor (depending on the type of reference configured when the motor is running); any other reference source which will be selected will be ignored. If the output is a speed reference, 100% corresponds to the max. absolute value between min. speed and max. speed set for the motor being used. Mot1 <– Max { | C028 |; | C029 | } Mot2 <– Max { | C071 |; | C072 | } Mot3 <– Max { | C114 |; | C115 | } On the other hand, if 100% relates to a torque value, this is the max. absolute value between the min. limit and the max. limit of the torque of the active motor. Mot1 <– max { | C047 |; | C048 | } Mot2 <– max { | C090 |; | C091 | } Mot3 <– max { | C133 |; | C134 | } *C294 = Reference Sum:* The PID regulator output is a correction of the speed/torque reference of the active motor (depending on the type of reference configured when the motor is running). The percentage value of the PID output relates to the instant value of the speed/torque reference. For example, if the speed reference of the active motor is 800rpm and the PID output is ignored, if this drops to 50%, the overall speed setpoint will be 800 + 800*(50/100) = 1200rpm. Therefore, the PID regulator can never reversed the reference sign. *C294 = Voltage Output Sum:* This configuration is active only when the control algorithm of the active motor is Voltage/Frequency. In this case, the PID regulator output is a correction of the output voltage. The percentage value of the PID output relates to the instant voltage value. For example, if a motor is in Voltage/Frequency mode and the drive output voltage is 200V rms at 25 Hz with a PID implementation = 0, if the PID implementation drops to –10%, the implemented voltage will be 200 + 200*(–10/100) = 180V.	

44.4. Keeping Fluid Level Constant (Example)

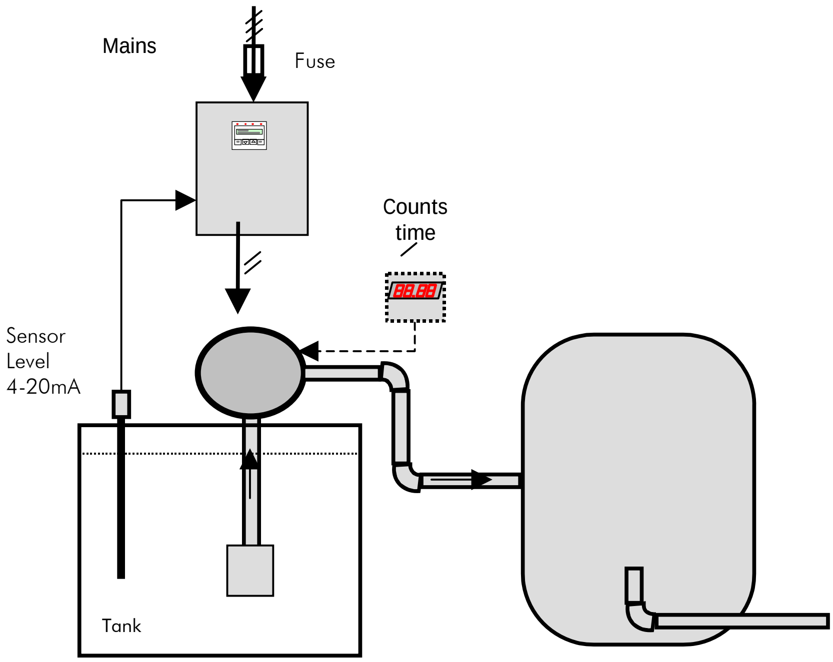


Figure 67: Keeping fluid level constant (Example).

Suppose that the maximum level in the tank is to be kept at 50% and that a 4–20mA level probe is used, with an output of 4mA for the min. level and 20mA for the max. level. The PID reference is sent from keypad, while the probe feedback is sent to AIN2/PTC analog input, which is configured as follows:

R	W	S	P060-Type of Reference for Input AIN2/PTC	2: 4-20mA [SW1-3 On]	
R	W	S	P061-Reference Minimum Value for Input AIN2/PTC	4.0	mA
R	W	S	P062-Reference Maximum Value for Input AIN2/PTC	20.0	mA
R	W	S	P063-Offset for Input AIN2/PTC	0.000	mA
R	W	S	P064-Filter AIN2/PTC Constant	5	ms

The reference shall be saved from keypad, thus avoiding setting it up again when the drive is shut off.

R	W	S	P068-Storage of UP/DN values at Power Off	1: Yes
R	W	S	P068a-Reset of Speed/Torque UP/DN value at Stop	0: No
R	W	S	P068b-Reset of PID UP/DN value at Stop	0: No
R	W	S	P068c-Reset of Speed/Torque UP/DN value at Source Selection	0: No
R	W	S	P068d-Reset of PID UP/DN value at Source Selection	0: No
R	W	S	P069-Amplitude of UP/DN and KPD Reference	1: Unipolar

The PID regulator implementation and the PID output computing mode must also be set.

R	W	S	C285-Selection of Reference Type 1 PID	2: AIN1 [5-6]
R	W	S	C286-Selection of Reference Type 2 PID	0: Disabled
R	W	S	C287-Selection of Reference Type 3 PID	0: Disabled
R	W	S	C288-Selection of Feedback Type 1 PID	3: AIN2 [7-8]
R	W	S	C289-Selection of Feedback Type 2 PID	0: Disabled
R	W	S	C290-Selection of Feedback Type 3 PID	0: Disabled
R	W	S	C291-PID Operating Mode	1: Normal
R	W	S	C291a-PID Control Mode	0: Standard SUM
R	W	S	C291b-PID2 Operating Mode	1: Normal
R	W	S	C292-Quantity Selection to Compute Derivative Term	0: Measure
R	W	S	C293-Kp Used as a Multiplier for Integral and Derivative Terms	0: No
R	W	S	C294-PID Operation	1: Reference

The PID regulator parameters are defined in the PID PARAMETERS MENU. This configuration limits the PID output between 0 and 100% for a proper rotation of the connected pump. Set **P255** = 1000 ts: if the PID output is equal to the min. value for 5 seconds, the drive is put on stand by.

R	W	S	P236-PID Maximum Output	100.00	%	
R	W	S	P237-PID Minimum Output	0.00	%	
R	W	S	P237a-Wake-Up mode for PID	0: Disabled		
R	W	S	P237b-Wake-Up level for PID	0.00	%	
R	W	S	P238-Maximum Value of PID Integral Term	100.00	%	
R	W	S	P239-Maximum Value of PID Derivative Term	100.00	%	
R	W	S	P240-Proportional Coefficient Value	5.000		
R	W	S	P241-Proportional Term Multiplicative Factor	0: 1		
R	W	S	P242-Integral Time (Multiples of Tc)	500	Tc	Disabled
R	W	S	P243-Derivative Time (Multiples of Tc/1000)	0	mTc	
R	W	S	P244-Cycle Time Tc	5	ms	
R	W	S	P245-PID Reference Min. Value	-100.00	%	
R	W	S	P246-PID Reference Max. Value	100.00	%	
R	W	S	P247-PID Feedback Minimum Value	-100.00	%	
R	W	S	P248-PID Feedback Maximum Value	100.00	%	
R	W	S	P249-PID Ramp UP Acceleration Time	0.00	s	
R	W	S	P250-PID Ramp DOWN Deceleration Time	0.00	s	
R	W	S	P251-Unit of Measure for PID Ramps	2: 1 s		
R	W	S	P252-Start S-Curve for PID Ramps	1	%	
R	W	S	P253-End S-Curve for PID Ramps	1	%	
R	W	S	P254-PID Out Threshold Enabling Integral Implem.	0.0	%|Refmax	
R	W	S	P255-Inverter Disabling Time for PID Output Equal to Min. Value	5	s	Disabled
R	W	S	P256-Time Spent by PID Output from 0% to 100%	1	ms	

When the level of liquid in the tank exceeds the reference value set from keypad, a negative error is produced (Error = Reference – Feedback). Because the complemented output computing mode is selected and because the complemented output is the speed reference, the higher the error absolute value, the higher the PID output value. This means that the quicker the level increases, the quicker the pump suction. On the other hand, if the level is lower than the reference, a positive error is produced, because the PID output is limited to 0%, the pump will not activate; if the PID output is equal to the min. value for a timer longer than **P255** = 1000***P244** = 5sec , the drive is put on stand by.

45. BRIDGE CRANE MENU

45.1. Overview

For lifting applications, it may be necessary to consider the opening/closing of a mechanical brake in order to obtain a proper control of the connected motor.
For example, if a mechanical brake takes 500ms to open after the start command – the delay is due to the type of brake – the motor will not be running for 500ms, while the speed reference increases the preset ramp. The motor then pushes against the brake, and when it can rotate freely, the motor torque will not match with the torque required to move the connected load.
If the speed setpoint is kept to zero for a given time after sending the start command (considering the time required for the mechanical brake to open), the motor control will implement the proper torque for the motor speed as soon as the motor can start rotating.
The brake closure can be controlled via a digital input that is properly set up; when the drive detects the brake closure, it automatically adjusts the value of the current injected into the motor to the fluxing value. This is required when, during the lifting stage, the mechanical brake closes when the load is suspended after reaching negligible speed. In that case, the torque produced by the motor is capable of keeping the load hanging; when the brake closes, this has no effect on the speed regulator, because the motor is already standstill. When the brake closes, no torque must be generated to keep the load hanging, so the current injected into the motor drops to the value required for the motor fluxing.

NOTE The Bridge CRANE menu is used for VTC and FOC Control only.

NOTE For safety reasons, the brake closure contact must be an NO contact (closed contact only when the brake is engaged).

NOTE In addition to parameters **C300** to **C302**, a dedicated MDO must be set as 6:BRAKE (see the DIGITAL OUTPUTS MENU).

45.2. List of Parameters C300 to C302

Table 105: List of parameters C300 to C302.

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
C300	Positive pretensioning torque [%Cnom]	ENGINEERING	1300	0.0%
C301	Positive pretensioning torque time	ENGINEERING	1301	0
C300a	Negative pretensioning torque [%Cnom]	ENGINEERING	1308	0.0%
C301a	Time period of negative pretensioning torque	ENGINEERING	1309	0
C302	Closed brake input (NO contact)	ENGINEERING	1302	0: None

C300/C300a Pretensioning Torque [%Cnom]

C300/C300a			
	Range	-5000 ÷ +5000	-500.0% ÷ +500.0%
	Default	0	0.0 %
	Level	ENGINEERING	
	Address	1300/1308	
	Control	VTC and FOC	
	Function	If not set to zero, this parameter defines the torque value (expressed as a percentage of the rated torque of the selected motor) reached before the speed ramp starts after sending a START command. After sending a START command, the drive brings the motor torque to the level set in C300/C300a and torque is adjusted by the speed loop for the time set in C301/C301a in order to keep the motor standstill. Once this time has elapsed, the speed ramp can start and the motor follows the required speed profile. The torque sign defines the running direction. The sign of the speed reference determines which value percent is to be used; C300 is for the positive sign, C300a is for the negative sign.	

C301/C301a Pretensioning Torque Time

C301/C301a			
	Range	0 ÷ 32000	0 ÷ 32000 ms
	Default	0	0
	Level	ENGINEERING	
	Address	1301/1309	
	Control	VTC and FOC	
	Function	Delay time passing between the start command and the speed ramp start. During this time, the motor torque output is set in C300/C300a to keep the load suspended.	

C302 Closed Brake Input (NO contact)

C302			
	Range	0 ÷ 12 0 ÷ 20 if ES847 or ES870 is installed	0 → Inactive, 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 20 → XMDI1 ÷ XMDI8
	Default	0	0 → Inactive
	Level	ENGINEERING	
	Address	1302	
	Control	VTC and FOC	
	Function	This parameter determines the digital input assigned to the mechanical brake closure feedback (NO contact, which closes only when the brake is engaged). When the brake closure is detected after a deceleration ramp, the current required for motor fluxing is injected into the motor. If no digital input is available for the detection of the brake closure, set max. time in C183, in order to avoid injecting current into the motor after the deceleration ramp. When the motor is not running, the START command is disabled and the speed setpoint is at zero for a time longer than the one set in C183, the drive will be put on standby.	

46. SERIAL COMMUNICATIONS

46.1. Overview

Sinus Penta drives may be connected to other devices through a serial link. This allows reading and writing the parameters accessed through the remotable display/keypad.

Elettronica Santerno also supplies the RemoteDrive software package allowing controlling the drive through a computer connected via serial link.
The RemoteDrive offers the following functionality: image copy, keypad emulation, oscilloscope functions and multifunction tester, data logger, history data table compiler, parameter setting and data reception–transmission–storage from and to a computer, scan function for the automatic detection of the connected inverters (up to 247 connected inverters).

46.2. MODBUS–RTU PROTOCOL

Messages and data are sent by means of standard protocol MODBUS in RTU mode. This standard protocol performs control procedures using an 8–bit binary representation.
In RTU mode, a message begins with a silence interval equal to 3.5 times the transmission time of a character.
If the character transmission stops for a time equal to 3.5 times the transmission time of a character, the controller will consider this time interval as the end of the message. Similarly, a message starting with a shorter silence time is considered as part of the previous message.

Message beginning	Address	Function	Data	Error control	End of message
T1–T2–T3–T4	8 bits	8 bits	n x 8 bits	16 bits	T1–T2–T3–T4

Use parameter R004 (TimeOut) to increase the silence time interval up to max. 10000ms for the systems that do not recognize standard timeouts.

Address
The address field acknowledges any value ranging from 1 to 247 as the address of the slave peripheral device. The master device queries the peripheral device specified in the address field; the peripheral device will respond with a message containing its address to let the master device know which the slave source of the response is. A master device query with a 0 address is addressed to all slave devices, which will not respond at all (broadcast mode).

Function
The function related to the message may be chosen within the legal field ranging from 0 to 255. A response of the slave device to a message of the master device will simply return the function code to the master device if no error took place; otherwise, the most significant bit in this field is set to 1.
The only functions allowed are 03h: Read Holding Register and 10h: Preset Multiple Register (see below).

Data
The data field contains any additional information for the function being used.

Error Control
The error control is performed through the CRC (Cyclical Redundancy Check) method. The16–bit value of the relevant field is computed when the message is sent by the transmitter and is then re–computed and checked by the receiver.
CRC Register is computed as follows:
1. CRC Register is set to FFFFh
2. Exclusive OR is executed between CRC register and the first 8 bits of the message; the result is saved to a 16–bit register.
3. This register is right–shifted of one place.
4. If the right bit is 1, exclusive OR is executed between the 16–bit register and value 1010000000000001b.
5. Steps 3 and 4 are repeated until 8 shifts are performed.
6. Exclusive OR is performed between the 16–bit register and the next 8 bits of the message.
7. Steps 3 to 6 are repeated until all message bytes are processed.
8. The result is a CRC, that is attached to the message by sending the less significant byte as the first byte.

Supported Functions
03h: Read Holding Register
Allows reading the register state of the slave device. This function does not allow the broadcast mode (address 0).

Additional parameters are the address of the basic digital register to be read and the output number to be read.

QUERY	RESPONSE
Slave address	Slave address
03h Function	03h Function
Register address (high)	Byte number
Register address (low)	Data
Register N. (high)	…
Register N. (low)	Data
Error correction	Error correction

10h: Preset Multiple Register
Sets the state of multiple registers for the slave device. In broadcast mode (address 0), the state of those registers is set in all the connected slave devices. Additional parameters are the basic register address, the number of registers to be set, the relevant value and the number of bytes used for the data items.

QUERY	RESPONSE
Slave address	Slave address
10h Function	10h Function
Register 1 addr. (Hi)	Register 1 addr. (Hi)
Register 1 addr. (Lo)	Register 1 addr. (Lo)
Register N. (Hi)	Register N. (Hi)
Register N. (Lo)	Register N. (Lo)
Byte number	Error correction
Data (Hi)	
Data (Lo)	
…	
Data (Hi)	
Data (Lo)	
Error correction	

Error Messages

If a message error is detected, the inverter will send a message to the master:

Slave address	Function (MSB = 1)	Error code	Error correction

The error code meaning is the following:

Code		DESCRIPTION
0x01	ILLEGAL FUNCTION	The function sent by the Master is different from 0x03 (Read Holding Registers) and 0x10 (Preset Multiple Registers).
0x02	ILLEGAL ADDRESS	The Master wrote to or read from an illegal address.
0x03	ILLEGAL DATA VALUE	The numerical value the Master tried to write is not included in the correct range.
0x06	DEVICE BUSY	The drive refused the Master writing attempt (e.g. because it is running and a Cxxx parameter is activated).
0x07	ANOTHER USER WRITING	Other users are writing to the selected parameter when the Master is trying to write to this parameter (e.g. display/keypad in editing mode or Upload/Download to/from keypad).
0x09	BAD ACCESS LEVEL	The parameter the Master is trying to write to is not included in the selected User Level (e.g. it is trying to write an ADVANCED parameter when the BASIC user level is selected).

47. SERIAL LINKS MENU

47.1. Overview

NOTE — Please refer to the Sinus Penta's **Installation Instructions Manual** for the description of the serial links and connections.

NOTE — For a greater immunity against communication interference, an optional optoisolated serial board (ES822) may be used instead of RS485 serial link. Serial links RS232 and RS485 can interface with ES822 board.
Please refer to the Sinus Penta's **Installation Instructions Manual** for the description of the optional optoisolated board.

NOTE — The parameters described in this menu are **Rxxx** parameters.
Once changed and saved, they become active only when the drive is next switched on or when the control board is reset (by holding down the **RESET** key for more than 5 secs).

Drives of the SINUS PENTA series may be connected to peripheral devices through a serial link. This enables both reading and writing of all parameters normally accessed through the display/keypad. Two-wire RS485 is used, which ensures better immunity against disturbance even on long cable paths, thus reducing the communication errors.

Two serial links are available. **Serial Link 0** is provided with a 9-pole, male D connector; **Serial Link 1** is provided with an RJ45 connector (or a three-phone connector) connected to the display/keypad.

NOTE — The display/keypad connected through RJ45 connector dialogues correctly with the drive using the default values preset in the parameter set for serial link 1.

The drive will typically behave as a slave device (i.e. it only answers to queries sent by another device). A master device (typically a computer) is then needed to start serial communications.
The following items may be configured for both serial links:

1. The drive MODBUS address.
2. The drive response delay to a Master query.
3. The baud rate of the serial link (expressed in bits per second);
4. The time added to the 4 byte–time;
5. The serial link watchdog (which is active if the relevant parameter is not set at 0);
6. The type of parity used for serial communications.

47.1.1. Watchdog Alarms

The Watchdog alarms determined by the serial link may be the following:

- **A061** Serial alarm n.0 WDG
- **A062** Serial alarm n.1 WDG
- **A081** Keypad Watchdog

The first two alarms trip when no legal message is sent from the serial link to the drive for a time longer than the time set in the relevant watchdog parameters; **these alarms are active only if parameters R005 or R012 are set other than zero.**
The third alarm trips only if the **display/keypad used as a reference/command source** detects a communication loss for a time longer than 2 seconds.

47.2. List of Parameters R001 to R013

Table 106: List of parameters R001 to R013.

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
R001	Drive MODBUS Address for Serial Link 0 (D9-pole)	ENGINEERING	588	1
R002	Response Delay for Serial Link 0 (D9-pole)	ENGINEERING	589	5msec
R003	Baud Rate for Serial Link 0 (D9-pole)	ENGINEERING	590	6:38400 bps
R004	Time added to 4byte–time for Serial Link 0 (D9-pole)	ENGINEERING	591	2msec
R005	Watchdog time for Serial Link 0 (D9-pole)	ENGINEERING	592	0.0sec
R006	Parity Bit for Serial Link 0 (D9-pole)	ENGINEERING	593	1:Disabled 2 Stop-bit
R008	Drive MODBUS address for Serial Link 1 (RJ45)	ENGINEERING	595	1
R009	Response Delay for Serial Link 1 (RJ45)	ENGINEERING	596	5 msec
R010	Baud Rate for Serial Link 1 (RJ45)	ENGINEERING	597	6:38400 bps
R011	Time Added to 4byte–time for Serial link 1 (RJ45)	ENGINEERING	598	2msec
R012	Watchdog Time for Serial Link 1 (RJ45)	ENGINEERING	599	0.0sec
R013	Parity Bit for Serial Link 1 (RJ45)	ENGINEERING	600	1:Disabled 2 Stop-bit

R001 Drive MODBUS Address for Serial Link 0 (D9-pole)

R001			
	Range	1 ÷ 247	1 ÷ 247
	Default	1	1
	Level	ENGINEERING	
	Address	588	
	Function	This parameter determines the address assigned to the drive connected through RS485 of serial link 0 (9-pole, male D connector).	

R002 Response Delay for Serial Link 0 (D9-pole)

.R002			
	Range	1 ÷ 1000	1 ÷ 1000 msec
	Default	5	5 msec
	Level	ENGINEERING	
	Address	589	
	Function	This parameter determines the drive response delay after a master query sent through serial link 0 (9-pole, male D connector).	

R003 Baud Rate for Serial Link 0 (D9-pole)

R003			
	Range	1 ÷ 7	1: 1200 bps 2: 2400 bps 3: 4800 bps 4: 9600 bps 5: 19200 bps 6: 38400 bps 7: 57600 bps
	Default	6	6: 38400bps
	Level	ENGINEERING	
	Address	590	
	Function	This parameter determines the baud rate, expressed in bits per second, for serial link 0 (9-pole, male D connector).	

R004 Time added to 4–Byte–Time for Serial Link 0 (D9-pole)

R004	Range	1 ÷ 10000	1 ÷ 10000 msec
	Default	2	2 msec
	Level	ENGINEERING	
	Address	591	
	Function	This parameter determines the limit time when no character is received from serial link 0 (9-pole, male D connector) and the message sent from the master to the drive is considered as complete.	

R005 Watchdog Time for Serial Link 0 (D9-pole)

R005	Range	0 ÷ 60000	0 ÷ 6000.0 sec
	Default	0	0.0 sec
	Level	ENGINEERING	
	Address	592	
	Function	If not set at zero, this parameter determines the time limit after which alarm **A061** WDG Serial 0 Alarm trips if the drive does not receive any legal message through serial link 0 (9-pole, male D connector).	

R006 Parity Bit for Serial Link 0 (D9-pole)

R006	Range	0 ÷ 3	0: Disabled 1 Stop–bit 1: Disabled 2 Stop–bit 2: Even (1 Stop bit) 3: Odd (1 Stop bit)
	Default	1	1: Disabled 2 Stop–bit
	Level	ENGINEERING	
	Address	593	
	Function	This parameter determines whether the parity bit is used or not when creating the MODBUS message through serial link 0 (9-pole, male D connector).	

R008 Drive MODBUS Address for Serial Link 1 (RJ45)

R008	Range	1 ÷ 247	1 ÷ 247
	Default	1	1
	Level	ENGINEERING	
	Address	595	
	Function	This parameter determines the address assigned to the drive connected to the network through RS485 of serial link 1 (RJ45 connector).	

NOTE

The display/keypad connected through RJ45 connector dialogues correctly with the drive using the default values preset in the parameter set for serial link 0 (RJ45).

R009 Response Delay for Serial Link 1 (RJ45)

R009	Range	1 ÷ 1000	1 ÷ 1000 msec
	Default	5	5 msec
	Level	ENGINEERING	
	Address	596	
	Function	This parameter determines the drive response delay after a master query sent through serial link 1 (RJ45 connector).	

R010 Baud Rate for Serial Link 1 (RJ45)

R010	Range	1 ÷ 7	1: 1200 bps 2: 2400 bps 3: 4800 bps 4: 9600 bps 5: 19200 bps 6: 38400 bps 7: 57600 bps
	Default	6	6: 38400bps
	Level	ENGINEERING	
	Address	597	
	Function	This parameter determines the baud rate, expressed in bits per second, for serial link 1 (RJ45 connector).	

R011 Time Added to 4–Byte–Time for Serial Link 1 (RJ45)

R011	Range	1÷10000	1 ÷ 10000 msec
	Default	2	2 msec
	Level	ENGINEERING	
	Address	598	
	Function	This parameter determines the time limit when no character is received from serial link 1 (RJ45 connector) and the message sent from the master to the drive is considered as complete.	

R012 Watchdog Time for Serial Link 1 (RJ45)

R012	Range	0 ÷ 60000	0 ÷ 6000.0 sec
	Default	0	0.0 sec
	Level	ENGINEERING	
	Address	599	
	Function	If this parameter is not set at zero, it determines the time limit after which alarm A062 WDG Serial Link 1 Alarm trips if the drive does not receive any legal message through serial link 1 (RJ45 connector).	

R013 Parity Bit for Serial Link 1 (RJ45)

R013	Range	0 ÷ 3	0: Disabled 1 Stop–bit 1: Disabled 2 Stop–bit 2: Even (1 Stop bit) 3: Odd (1 Stop bit)
	Default	1	1: Disabled 2 Stop–bit
	Level	ENGINEERING	
	Address	600	
	Function	This parameter determines whether the parity bit is used or not when creating the MODBUS message through serial link 1 (RJ45 connector).	

48. FIELDBUS CONFIGURATION MENU

48.1. Overview

NOTE — See the OPTIONAL BOARDS FOR FIELDBUS section in the Sinus Penta's **Installation Instructions Manual** for the description of the optional board required.

NOTE — The parameters included in this menu are **Rxxx** parameters.
Once saved, they are active only when the drive is next switched on or when the control board is reset (by holding down the **RESET** key for more than 5 secs).

CAUTION — This menu is not applicable to ES919 communications boards (see relevant section in the Sinus Penta's **Installation Instructions Manual**). ES919 boards act as gateways and change the **MODBUS** RS485 packets into the packets of each protocol being used.
The exchanged parameters are all the **Mxxx** measures from the Sinus Penta to the Master and all the **Ixxx** inputs from the Master to the Sinus Penta (as detailed in the MEASURES MENU, Table 76: Remote command inputs from serial link. and Table 77: Reference inputs from serial link.)

48.1.1. Alarm A070 (Communication Suspended)

Alarm **A070** trips if the Sinus Penta is not sent any legal message via FIELDBUS within the timeout set in parameter **R016**.
Set parameter **R016** to 0 to disable alarm **A070**.
A legal message is the word of the digital inputs (**M035**) with bit 15=1 written by the master.
Important: this is enabled only when the drive receives the first message with bit 15=1.

To reset alarm **A070**, force communication between the Master and the Penta drive with bit 15 of the digital input word always set to 1 and reset the drive control board. If communications between the Master and the Slave (Penta) cannot be restored, alarm **A070** is reset after setting parameter **R016** to zero and after resetting the Penta drive. When the drive is next powered on, resetting the alarm reset will affect the drive control board.

48.2. List of Parameters R016 to R017

Table 107: List of parameters R016 to R017.

Parameter	FUNCTION	User Level	MODBUS Address	Default Values
R016	Fieldbus Watchdog Time	ENGINEERING	603	0 ms
R017	Analog Outputs controlled by the Fieldbus	ENGINEERING	604	000b

<u>R016 Fieldbus Watchdog Time</u>

R016	Range	0 ÷ 60000	0 ÷ 60000 ms
	Default	0	0 ms
	Level	ENGINEERING	
	Address	603	
	Function	If not set at zero, this parameter determines the time limit after which **A070** Fieldbus WDG trips (no legal writing is received from the fieldbus in a given time interval).	

NOTE — The Watchdog activates only once the drive has received the first legal message from the master, as described in Alarm A070 (Communication Suspended). This avoids untimely activation due to different start times between the master and the drive.

R017 Analog Outputs Controlled by the Fieldbus

R017	Range	000b ÷ 111b binary 0000h ÷ 0007h hex 0 ÷ 7 decimal	000b → None 001b → AO1 010b → AO2 100b → AO3
	Default	000b	000b → None
	Level	ENGINEERING	
	Address	604	
	Function	To select analog outputs controlled by the fieldbus, select the bit corresponding to the analog output to be controlled. Example: R017 = 0011b = 3 decimal → analog outputs AO1 and AO2 are controlled directly by the fieldbus, irrespective of their configuration in the ANALOG AND FREQUENCY OUTPUTS MENU.	

48.3. Exchanged Parameters

The tables below state the Sinus Penta parameters exchanged via Fieldbus.

Each table contains:
1) the parameter code;
2) its description;
3) its range;
4) its unit of measure (also indicated on the display);
5) the ratio between the Sinus Penta value (exchanged via Fieldbus) and the represented hardware value (as displayed).

N.B.: Each parameter is exchanged as an integer number with a 16-bit sign (from –32768 to +32767).

NOTE Bytes are exchanged in **big-endian mode** (the most significant value is stored to the smallest memory address).
When using an Intel based master/PLC chipset, then the data below will be byte-swapped.

48.3.1. From the Master to the Sinus Penta

Word	1) Code	2) Description	3) Range	4) Unit of Measure	5) Scaling
1	M042	Speed reference/limit from FIELDBUS (integer portion)	– 32000 ÷ + 32000	rpm	1
2	M043	Speed reference/limit from FIELDBUS (decimal portion)	– 99 ÷ + 99	rpm	x 100
3	M045	Torque reference/limit from FIELDBUS	– 5000 ÷ + 5000	%	x 10
4	M047	PID reference from FIELDBUS	– 10000 ÷ + 10000	%	x 100
5	M035	Digital Inputs from FIELDBUS	–	–	–
6		Command for Digital Outputs from FIELDBUS	–	–	–
7	AO1	Analog Output 1 controlled by FIELDBUS	+ 111 ÷ + 1889	–	–
8	AO2	Analog Output 2 controlled by FIELDBUS	+ 111 ÷ + 1889	–	–
9	AO3	Analog Output 3 controlled by FIELDBUS	+ 111 ÷ + 1889	–	–
10	M049	PID Feedback from FIELDBUS	– 10000 ÷ + 10000	–	x 100

Word 1: Speed reference/limit from FIELDBUS (integer portion)

Word 1 of the memory map details the integer portion of the speed reference (**M042**) in either IFD, VTC or FOC mode.

bit [15..8]	bit [7..0]
Speed reference integer portion	

The speed reference from the FIELDBUS is obtained by adding the decimal portion to the integer portion (see Word 2).

This value is included in the global speed reference of the drive (measure **M000**) along with the other reference sources if at least one of parameters **C143** to **C146** is set as 6:FieldBus.

The speed limit from FIELDBUS is significant if parameter **C147** is set as 6:FieldBus and the type of reference of the active motor (parameters **C011** / **C054** / **C097**) is set as 2:Torque with Speed Limit.

Word 2: Speed reference/limit from FIELDBUS (decimal portion)

Word 2 details the decimal portion of the speed reference (**M043**) ONLY IN FOC MODE. The value sent by the Master to the Sinus Penta as the decimal portion of the speed reference must be multiplied by 100.
In order to send a speed reference of XXX.50rpm, the low byte of the word must contain the value 50_{10} or 00110010_2 (0.50_{10} x 100 = 50_{10}).

Example: **M042**=210; **M043**=50 ⇒ speed ref. = 210.50 rpm

bit [15..8]	bit [7..0]
Speed reference decimal portion	

Word 3: Torque reference/limit from FIELDBUS

The torque reference from the FIELDBUS (**M045**) is significant if at least one of parameters **C143** to **C146** is set as 6:FieldBus and if the type of reference of the active motor (parameters **C011/C054/C097**) is set as 1:Torque or as 2:Torque with Speed Limit, or if the drive is in slave mode from digital input.

The torque limit from the FIELDBUS is significant if parameter **C147** is set as 6:FieldBus.

The value sent by the Master to the Sinus Penta as the torque reference/torque limit must be multiplied by 10.
In order to send a torque reference/torque limit of 50%, the word must contain the value 500_{10} or 111110100_2 ($50\%_{10}$ x 10 = 500_{10}).

bit [15..8]	bit [7..0]
Torque reference/limit	

Word 4: PID reference from FIELDBUS

The PID reference (**M047**) can be sent from the fieldbus if at least one of the parameters **C285** to **C287** is set as 6:Fieldbus.

The value sent by the Master to the Sinus Penta as the PID reference must be multiplied by 100.
E.g. In order to send a PID reference of 50%, the word must contain the value 5000_{10} or 111110100_2 ($50\%_{10}$ x 100 = 5000_{10}).

bit [15..8]	bit [7..0]
PID reference from FIELDBUS	

Word 5: Digital Inputs from FIELDBUS
The virtual digital inputs via the Fieldbus are the low byte of the word:

bit 15	bit [14..8]	bit [7..0]							
1		MDI8	MDI7	MDI6	MDI5	MDI4	MDI3 (RESET)	MDI2 (ENABLE)	MDI1 (START)

The logic status of these bits is included in the overall status of the drive digital inputs (measure **M031**) along with the other command sources if at least one of the parameters **C140** ÷ **C142** is set as 6:FieldBus.

NOTE Auxiliary virtual terminal board XMDI1.. 8 cannot be simulated via fieldbus.

CAUTION Bit 15 must always be written =1; this means that data exchanged between the master and the drive is consistent, thus keeping the watchdog counter reset (see Alarm A070 (Communication Suspended)).

Word 6: Command for Digital Outputs from FIELDBUS

Digital commands from FIELDBUS are the 4 lower bytes of the word:

bit [15...4]	bit [3..0]			
	CMD 4	CMD 3	CMD 2	CMD 1

Byte format:

Bit	Command	Position in the selection vector
0	Fbus CMD 1	D34
1	Fbus CMD 2	D35
2	Fbus CMD 3	D36
3	Fbus CMD 4	D37

Columns 2 and 3 state the name and position of the commands sent via fieldbus.
Example: to control digital input 1 via fieldbus through command 4, set the parameters below in the **DIGITAL OUTPUTS MENU:**

P270 = 1: Digital Digital Output Mode
P271 = D37: Fbus CMD4 Variable A Selection
P278 = 1: True Output Logic Level

Words 7, 8, 9: Analog Outputs controlled by FIELDBUS

Parameter **R017** needs to be properly set up to distinguish which Analog Outputs are to be controlled by the Fieldbus.

Byte format:

Bit	Analog Output controlled by the fieldbus
0	AO1
1	AO2
2	AO3

Example: **R017** = 011_2 = 3_{10} → analog outputs AO1 and AO2 are controlled directly by the fieldbus, independently of their configuration in the ANALOG AND FREQUENCY OUTPUTS MENU.

The correspondence between the exchanged value and the real value (in volts) of the digital outputs is as follows:

Exchanged value	Voltage (V)	Current (mA)
+ 1889	+ 10	+ 20 mA
+ 1000	0	0
+ 111	– 10	– 20 mA

Word 10: PID feedback from FIELDBUS

The PID feedback (**M049**) can be sent from the fieldbus if at least one of the parameters **C288** to **C290** is set as 6:Fieldbus.

The value sent by the Master to the Sinus Penta as the PID feedback must be multiplied by 100.
E.g. In order to send a PID feedback of 50%, the word must contain the value 5000_{10} or 1111110100_2 ($50\%_{10}$ x 100 = 5000_{10}).

bit [15..8]	bit [7..0]
PID feedback from FIELDBUS	

48.3.2. FROM THE SINUS PENTA TO THE MASTER

Word	1) Code	2) Description	3) Range	4) Unit of Measure	5) Scaling
1		Status + Alarms	–	–	–
2	M026	Output Current	0 ÷ 65000	A	x 10
3	M004	Motor Speed	– 32000 ÷ + 32000	rpm	x 1
4		Third measure that may be configured with P330	All the measures	See selected measure	See selected measure
5		Fourth measure that may be configured with P331	All the measures	See selected measure	See selected measure
6	DIN	Digital Inputs	–	–	–
7	DOU	Digital Outputs	–	–	–
8	REF	REF Analog Input	– 16380 ÷ + 16380	–	–
9	AIN1	AIN1Analog Input	– 16380 ÷ + 16380	–	–
10	AIN2	AIN2 Analog Input	– 16380 ÷ + 16380	–	–

Word 1: Status + Alarms

The Status and Alarms are displayed over the fieldbus in the following format:

bit [15..8]	bit [7..0]
Status	Alarms

The Status codes may be found in
Table 116.
The Alarm codes may be found in Table 113.

Word 2: Output Current

The output current measure (M026) is displayed as a value that must be divided by 10 to obtain the actual motor current.

As a result, if the returned value from the Sinus Penta to the Master is 100, then the actual output motor current is 10A.

bit [15..8]	bit [7..0]
Output Current	

Word 3: Motor Speed

The output motor speed (M004) is displayed as follows:

bit [15..8]	bit [7..0]
Motor Speed	

Words 4 & 5: Third & Fourth measure that may be configured with P330 & P331
Words 4 & 5 may be configured with P330 and P331 – more details are given in the FIELDBUS PARAMETERS MENU.
Both words 4 & 5 are represented as follows:

bit [15..8]	bit [7..0]
Mxxx represented by P330 and P331	

Word 6: Digital Inputs

Digital input status in the word:

bit [15..8]								bit [7..0]							
XMDI8	XMDI7	XMDI6	XMDI5	XMDI4	XMDI3	XMDI2	XMDI1	MDI8	MDI7	MDI6	MDI5	MDI4	MDI3 (RESET)	MDI2 (ENABLE)	MDI1 (START)

Word 7: Digital Outputs

Digital output status in the word:

bit [15..14]	bit [13..8]						bit 7	bit 6	bit [5..4]	bit [3.0]			
	XMDO6	XMDO5	XMDO4	XMDO3	XMDO2	XMDO1		[*]		MDO4	MDO3	MDO2	MDO1 /FOUT

[*] Status of the Pre-charge contactor

Words 8, 9, 10: REF, AIN1, AIN2 Analogue Signal

Full scale value ± 16380 is a rated value corresponding to an input range of ± 10V. This value can be altered due to automatic compensation of the tolerance of the input stage.

bit [15..8]	bit [7..0]
REF / AIN1 / AIN2	

NOTE

The measures of the analog inputs sent from the Sinus Penta to the Master are the unfiltered measure values detected in the A/D converter output.
For filtered measures, use M037, M038 and M039 respectively.

49. EXPANSION BOARD CONFIGURATION MENU

49.1. Overview

NOTE

Parameters in this menu are **Rxxx** parameters.
Once saved, they are active only when the drive is next switched on or when the control board is reset (by holding down the **RESET** key for more than 5 secs).

49.2. List of Parameters R021 to R023

Table 108: List of parameters R021 to R023.

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
R021	Data Logger setting	ENGINEERING	551	Disable
R023	I/O board setting	ENGINEERING	553	None

R021 Data Logger Setting

R021			
	Range	1 ÷ 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 ÷ 4	0: None 1: XMDI/O 2: XMDI/O + XAIN 3: XMDI/O + PT100 4: XMDI/O + XAIN + PT100
	Default	0	0: None
	Level	ENGINEERING	
	Address	553	
	Function	Based on the settings in the relevant parameter, this parameter enables controlling digital I/O (XMDI/O), analog inputs (XAIN) and PT100 probes located on optional control boards.	

NOTE

ES847 is required to control analog inputs (XAIN) and PT100 probes.
Either ES847 or ES870 can be used to control digital I/O (XMDI/O).

50. PROFIDRIVE BOARD CONFIGURATION MENU

50.1. Overview

This menu allows programming the PROFIdrive expansion board. It can be viewed only if the PROFIdrive board is connected to ES821control board.

NOTE

Parameters in this menu are **Rxxx** parameters.
Once changed and saved, they become active only when the drive is next switched on or when its control board is reset by holding down the **RESET** key for more than 5 secs.

NOTE

For the correct operation of the PROFIdrive board, please refer to the **Sinus Penta's Installation Instructions manual** and to the PROFIdrive COMMUNICATIONS BOARD USER MANUAL.

50.2. List of Parameters R025 to R045

Table 109: List of parameters R025 to R045.

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
R025	Slave address	ENGINEERING	547	1
R026	PZD3 OUT	ENGINEERING	548	1: DIGITAL INPUTS
R027	PZD4 OUT	ENGINEERING	549	0: NOT USED
R028	PZD5 OUT	ENGINEERING	550	0: NOT USED
R029	PZD6 OUT	ENGINEERING	554	0: NOT USED
R030	PZD7 OUT	ENGINEERING	555	0: NOT USED
R031	PZD8 OUT	ENGINEERING	556	0: NOT USED
R032	PZD9 OUT	ENGINEERING	557	0: NOT USED
R033	PZD10 OUT	ENGINEERING	558	0: NOT USED
R034	PZD3 IN	ENGINEERING	559	0: NOT USED
R035	PZD4 IN	ENGINEERING	581	0: NOT USED
R036	PZD5 IN	ENGINEERING	582	0: NOT USED
R037	PZD6 IN	ENGINEERING	583	0: NOT USED
R038	PZD7 IN	ENGINEERING	584	0: NOT USED
R039	PZD8 IN	ENGINEERING	585	0: NOT USED
R040	PZD9 IN	ENGINEERING	586	0: NOT USED
R041	PZD10 IN	ENGINEERING	587	0: NOT USED
R044	Drive Profile Communication Mode	ENGINEERING	520	0: DP V0
R045	Drive Profile Selection	ENGINEERING	521	1: VENDOR SPECIFIC 1

R025 SLAVE ADDRESS

R025			
	Range	0 ÷ 126	0 ÷ 126
	Default	1	1
	Level	ENGINEERING	
	Address	547	
	Function	This parameter sets the address for the PROFIdrive board.	

NOTE — The programmed value has effect only if the board address selectors are set to zero (see the Sinus Penta's Installation Instructions manual).

R026 to R033 PZD3(/10) OUT

R026			
	Range	0 ÷ 6	0: NOT USED 1: DIGITAL INPUTS 2: AUXILIARY DIGITAL INPUTS (I/O expansion board) 3: DIGITAL OUTPUT COMMANDS 4: TORQUE REFERENCE 5: PID REFERENCE 6: PID FEEDBACK
	Default	1	1: DIGITAL INPUTS
	Level	ENGINEERING	
	Address	548 ÷ 550 // 554 ÷ 558	
	Function	These parameters allow selecting the inputs to be downloaded from the Master PLC to the drive through the eight process data items that can be mapped in the fast communication area between the Master and the Slave station.	

R034 ÷ R041 PZD3(/10) IN

R034			
	Range	0 ÷ 91	0 ÷ 91
	Default	0	0: NOT USED
	Level	ENGINEERING	
	Address	559 // 581 ÷ 587	
	Function	These parameters allow selecting the measures to be passed to the drive from the Master PLC through the eight process data items that can be mapped in the fast communication area between the Master and the Slave station. You can select any measure from the MEASURES MENU.	

R044 DRIVE PROFILE COMMUNICATION MODE

R044			
	Range	0 ÷ 1	0: DP V0 1: DP V1
	Default	0	0: DP V0
	Level	ENGINEERING	
	Address	520	
	Function	This parameter sets the version of the PROFIdrive protocol.	

R045 DRIVE PROFILE SELECTION

R045	Range	0 ÷ 2	0: PROFIDRIVE 1: VENDOR SPECIFIC 1 2: VENDOR SPECIFIC 2
	Default	0	1: VENDOR SPECIFIC 1
	Level	ENGINEERING	
	Address	507	
	Function	This parameter sets the control mode (Command and Reference) for the Slave station. 0: PROFIDRIVE 1: VENDOR SPECIFIC 1 2: VENDOR SPECIFIC 2	

	Command	Reference
PROFIDRIVE	According to the PROFIdrive protocol.	According to the PROFIdrive protocol.
VENDOR SPECIFIC 1	According to the PROFIdrive protocol.	One-to-one scale of the programmed reference.
VENDOR SPECIFIC 2	The eight low bits in the CONTROL WORD represent the eight digital inputs in the control board.	One-to-one scale of the programmed reference.

NOTE

Bit 11 in the control board enables or not the Fieldbus line watchdog in any of the three control modes above, provided that parameter **R016** is set higher than zero.

NOTE

The watchdog activates only after the drive has received the first legal message sent from the master (see Alarm A070 (Communication Suspended), thus preventing alarm **A070** from tripping due to different power-on times between the master station and the Penta drive.

51. DATA LOGGER MENU

51.1. Overview

The Data Logger menu is to be used if the Penta drive cannot dialog with ES851 Data Logger board through the RemoteDrive software.
Parameter **R116** imposes to ES851 the type of connection required for the communication mode being used.

NOTE — The parameters described in this menu are Rxxx parameters.
Once changed and saved, they become active only when the drive is next switched on or when the control board is reset (by holding down the **RESET** key for more than 5 secs).

CAUTION — The parameters set from this menu are not saved to non-volatile memory of the Data Logger board.
They must be confirmed and saved using the RemoteDrive software.

51.2. List of Parameters R115 and R116

Table 110: List of parameters R115 and R116.

Parameter	FUNCTION	User Level	MODBUS Address	DEFAULT VALUES
R115	SIM Card PIN	BASIC	563	"0000"
R116	Preset connection status	ENGINEERING	134	0: no active preset

R115 SIM Card PIN

R115			
	Range	0x0000 ÷ 0xAAAA	"0" ÷ "9999"
	Default	0x0000	"0000"
	Level	BASIC	
	Address	563	
	Function	This parameter indicates the digits of the PIN of the SIM card fitted in the GSM/GPRS modem. The digits must be aligned left; the # symbol, which is codified as 0xA (hex) is intended as the number terminator.	

NOTE — Max. 4 digits are allowed for the SIM card PIN.
The PIN can be composed of less than 4 digits and the # symbol can be used as the PIN terminator.

R116 Preset Connection Status (Line 2)

R116 Line 2			
	Range	0 ÷ 20	See Table 111
	Address	1337	
	Function	This parameter indicates if preset configurations are actually set up for the types of connections supported by ES851.	

R116 Preset Connections (Line 4)

R116 Line 4	Range	0 ÷ 20	See Table 111
	Default	0	0: no active preset
	Level	ENGINEERING	
	Address	134	
	Function	This parameter allows forcing one of the available connecting modes to ES851 Data Logger. The parameters used for Ethernet connections and modem connections are the ones stored in the Penta drive. Configurations 19 and 20 support both dial in and dial out.	

NOTE

After imposing any of the preset values given in Table 111, ES851 Data Logger is forced to Interlocked mode (see the Data Logger Measures Menu).

Table 111: Preset connections.

Value	COM	Baudrate [bps]	Stop bit	Parity	Delay [ms]
0	No active presetting				
1	Ethernet enabled				
2	PPP null modem				
3	1(RS232)	38400	2	no	2
4	1(RS232)	38400	1	no	2
5	1(RS232)	38400	2	no	20
6	1(RS232)	38400	1	no	20
7	1(RS232)	9600	2	no	2
8	1(RS232)	9600	1	no	2
9	1(RS232)	9600	2	no	20
10	1(RS232)	9600	1	no	20
11	2(RS485)	38400	2	no	2
12	2(RS485)	38400	1	no	2
13	2(RS485)	38400	2	no	20
14	2(RS485)	38400	1	no	20
15	2(RS485)	9600	2	no	2
16	2(RS485)	9600	1	no	2
17	2(RS485)	9600	2	no	20
18	2(RS485)	9600	1	no	20
19	Dial Out analog modem				
20	Dial Out GSM modem				

52. EEPROM MENU

52.1. Overview

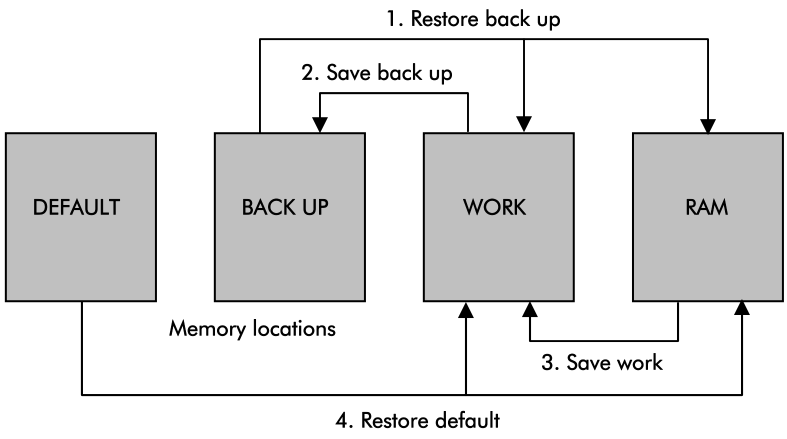
The drive has four different memory zones:

- RAM → Volatile memory containing the drive's current parameterization;
- Default Zone → Non-volatile memory that cannot be accessed by the user, containing the factory-setting of the drive parameters.
- Work Zone → Non-volatile memory where customized parameters are saved. Whenever the drive is reset, this parameterization is loaded to the RAM.
- Back–up Zone → Non-volatile memory storing a new drive parameterization. Back-up parameters are modified only when the user explicitly saves the back–up zone.

Any parameter can be changed by the user. The drive will immediately use the new parameter value.
The user may save the parameter value in the Work zone. If no new value is saved for a given parameter, the drive will use the parameter value stored in the Work zone when next turned on.

- "P" parameters can be written at any moment.
- According to factory-setting, "C" parameters (see **P003** to modify them even when fluxing and the motor is not running) can be written only if the drive is not running and the **ENABLE** command is disabled (terminal **MDI2** open).
- "R" parameters have the same features as "C" parameters, but the new parameter value, once written and saved, will be used only at next power on. To use the new parameter value immediately, turn the drive off and on or press the **RESET** key for at least 5 seconds.

The Work zone may be copied to the BACKUP zone through **I012** included in the Eeprom menu and described in the section below.
I012 input also allows copying the Backup zone to the WORK zone in order to restore the parameter values stored in the WORK zone.
I012 input also allows restoring the factory-setting values for all parameters in the WORK zone.



52.2. List of Inputs I009 to I012

Table 112: List of programmable inputs I009 to I012.

Input	FUNCTION	User Level	MODBUS Address
I009	Parameter save	BASIC	1396
I012	EEPROM control	BASIC	1399

I009 Parameter save

I009			
	Range	131 ÷ 2466	131 ÷ 2466
	Default	This is not a parameter: at power on and whenever the EEPROM command is executed, **I009** is set to zero.	
	Level	BASIC	
	Address	1396	
	Function	Allows only one parameter to be saved to EEPROM. The value to be saved must be the same as the value set in the Address field of the parameter concerned.	

I012 EEPROM Control

I012			
	Range	0, 2, 4, 5, 11	0: No Command 2: Restore Backup 4: Save Backup 5: Save Work 11: Restore Default
	Default	This is not a parameter: at power on and whenever the EEPROM command is executed, **I012** is set to zero.	
	Level	BASIC	
	Address	1399	
	Function	This parameter saves and restores the entire set of parameters that can be accessed by the user: **2: Restore Backup**: the parameters stored in the Backup zone are copied and stored in the WORK zone. They represent the new RAM parameterization; the previous RAM parameters are cleared. **Backup → RAM → Work;** **4: Save Backup**: the parameters in the WORK zone are saved to a copy of the Backup zone. **Work → Backup;** **5: Save Work**: the current values of the parameters stored in the RAM zone are saved to non-volatile memory in the Work zone. All the parameters are saved with this command. **RAM → Work;** **11: Restore Default**: factory-setting values are restored for all parameters; each factory-setting value is stored to non-volatile memory in the Work zone. **Default → RAM → Work.**	

53. ALARMS AND WARNINGS

CAUTION — If a protection trips or the drive enters the emergency mode, the drive is locked and the motor starts idling!

53.1. What Happens When a Protection Trips

NOTE — Before operating the drive in emergency conditions, carefully read this section and the following section, **What To Do When an Alarm Trips**.

The drive alarms are detailed below.

When a protection / alarm trips:

1) the **ALARM** LED on the keypad comes on;
2) the page displayed on the keypad is the root page of the **FAULT LIST**;
3) the **FAULT LIST** is refreshed;
4) when using the Drive Profile board, the drive reports faults as hexadecimal values, which are assigned and coded according to the DRIVECOM specification. See Table 116.

In factory-setting, when the drive is switched on after an alarm has tripped—which has not been reset—it is kept in emergency condition.
If the drive is in emergency mode when switched on, this could be due to an alarm tripped before the drive was reset.
To avoid storing the alarms tripped before the drive is switched off, set parameter **C257** in the **Autoreset Menu**.
The drive stores the moment when an alarm trips to the **FAULT LIST** (supply–time and operation–time). The drive status when the alarm tripped and some measures sampled when the alarm tripped are also stored to the Fault List.
The readout and storage of the fault list can be very useful to detect the cause responsible for the alarm and its possible solution (see also the Fault List Menu).

NOTE — Alarms **A001** to **A039** relate to the main microcontroller (DSP Motorola) of ES821 control board, which detected a fault on the control board itself. No fault list is available for Alarms **A001** to **A039** and no Reset command can be sent via serial link; alarms can be reset through the **RESET** terminal on the terminal board or the **RESET** key on the keypad. No software for the keypad interface is available; the drive parameters and measures cannot be accessed via serial link.
Avoid resetting alarms **A033** and **A039**, as they trip when the flash memory is not provided with its correct software. Alarms **A033** and **A039** can be reset only when proper software is downloaded for the the inverter flash memory.

CAUTION — Before resetting an alarm, deactivate the **ENABLE** signal on terminal **MDI2** to disable the inverter and prevent the connected motor from running at uncontrolled speed, unless parameter **C181**=1 (the Safety Start function is active): after resetting an alarm or after supplying the inverter, this will start only if the **ENABLE** contact is opened and closed again.

53.2. What To Do When an Alarm Trips

⚠	CAUTION	If a protection trips or the drive is in emergency condition, the drive is locked and the motor starts idling!
⚠	CAUTION	Before resetting an alarm, disable the **ENABLE** signal on terminal **MDI2** to disable the drive and to prevent the connected motor from running at uncontrolled speed.

Proceed as follows:

1. Disable the **ENABLE** signal on terminal **MDI2** to disable the drive and to lock the motor, unless parameter **C181**=1 (the Safety Start function is active): after resetting an alarm or after supplying the drive, this will start only if the **ENABLE** contact is open and closed.
2. If the motor is idling, wait until it stops.

Check the **FAULT LIST** carefully for any information about the alarm tripped, in order to determine the cause responsible for the alarm and its possible solutions.

Any information stored to the FAULT LIST is also required when contacting Elettronica Santerno's Customer Service.

3. In the following sections, find the relative alarm code and follow the instructions.
4. Solve any external problems that may have been responsible for the protection trip.
5. If the alarm tripped due to the entry of wrong parameter values, set new correct values and save them.
6. Reset the alarm.
7. If the alarm condition persists, please contact Elettronica Santerno Customer Service.

A **RESET** command must be sent to reset the alarms tripped. Do one of the following:

- Enable the **RESET** signal in **MDI3** terminal in the hardware terminal board;
- Press the **RESET** key on the keypad;
- Enable the **RESET MDI3** signal in one of the virtual terminal boards enabled as remote control sources (see the CONTROL METHOD MENU).

To activate the **Autoreset** function, enable parameter **C255** (see the AUTORESET MENU); the drive will automatically try to reset the alarms tripped.

53.3. Alarm List

Table 113: List of the possible alarms.

Alarm	Alarm Message	Description
A001 ÷ A032	…	*Control board failure*
A033	TEXAS VER KO	Incompatible Texas Software Version
A039	FLASH KO	Texas Flash not programmed
A040	User Fault	Alarm caused by the user
A041	PWMA Fault	General hardware fault from IGBT, side A
A042	Illegal XMDI in DGI	Illegal configuration of XMDI in the DGI menu
A043	False Interrupt	*Control board failure*
A044	SW OverCurrent	Software overcurrent
A045	Bypass Circuit Fault	Fault of the precharge By–Pass
A046	Bypass Connector Fault	Precharge By–Pass connector fault
A047	UnderVoltage	Dc bus voltage lower than Vdc_min
A048	OverVoltage	Dc bus voltage exceeding Vdc_max
A049	RAM Fault	*Control board failure*
A050	PWMA0 Fault	Hardware Fault from IGBT converter, side A
A051	PWMA1 Fault	Hardware overcurrent, side A
A052	Illegal XMDI in DGO	Illegal configuration of XMDI in the DGO menu
A053	PWMA Not ON	Hardware failure, IGBT A power on impossible
A054	Option Board not in	Failure in detecting preset option I/O board
A055	PTC Alarm	External PTC tripped
A056	PTC Short Circuit	External PTC in short circuit
A057	Illegal XMDI in MPL	Illegal configuration of XMDI in the MPL menu
A059	Encoder Fault	Error of motor speed measure
A060	NoCurrent Fault	Current is zero in FOC control
A061	Ser WatchDog	Watchdog tripped in serial link 0 (9-pole D connector)
A062	SR1 WatchDog	Watchdog tripped in serial link 1 (RJ45)
A063	Generic Motorola	*Control board failure*
A064	Mains Loss	No power is supplied from the mains
A065	AutoTune Fault	Autotune failed
A066	REF < 4mA	REF Current input (4÷20mA) lower than 4mA
A067	AIN1 < 4mA	AIN1 Current input (4÷20mA) lower than 4mA
A068	AIN2 < 4mA	AIN2 Current input (4÷20mA) lower than 4mA
A069	XAIN5 < 4mA	XAIN5 Current input (4÷20mA) lower than 4mA
A070	Fbs WatchDog	Fieldbus Watchdog tripped
A071	1ms Interrupt OverTime	*Control board failure*
A072	Parm Lost Chk	Parameter download/upload error
A073	Parm Lost COM1	Parameter download/upload error
A074	Drive OverHeated	Drive thermal protection tripped
A075	Motor OverHeated	Motor thermal protection tripped
A076	Speed Alarm	Motor speed too high
A078	MMI Trouble	*Control board failure*
A079	FOC No Encoder	FOC control but Encoder not enabled
A080	Tracking Error	Encoder speed tracking error
A081	KeyPad WatchDog	Communication watchdog via keypad
A082	Illegal Encoder Cfg	Functions programmed for MDI6 and MDI7 or encoder B selected and encoder board not detected.
A083	External Alarm 1	External alarm 1
A084	External Alarm 2	External alarm 2
A085	External Alarm 3	External alarm 3
A086	XAIN5 > 20mA	XAIN5 Current input (4÷20mA or 0÷20mA) greater than 20mA
A087	±15V LOSS	± 15V Loss
A088	ADC Not Tuned	*Control board failure*
A089	Parm Lost COM2	Parameter download/upload error
A090	Parm Lost COM3	Parameter download/upload error
A091	Braking Resistor Overload	Overvoltage tripped with braking resistor activated due to continuous operation time exceeding the max. programmed time

A092	SW Version KO	*Control board failure*
A093	Bypass Circuit Open	By-Pass relay open
A094	HeatSink Overheated	IGBT heatsink temperature too high
A095	Illegal Drive Profile Board	Drive Profile board not correctly configured
A096	Fan Fault	Fault of the cooling fans
A097	Motor Not Connected	Motor not connected
A098	Illegal Motor Selected	Illegal motor selected via MDI
A099	2nd Sensor Fault	Fault of fan sensor 2
A100	MDI6 Illegal Configuration	Function programmed for MDI6 along with frequency input A
A101	MDI8 Illegal Configuration	Function programmed for MDI8 along with frequency input B
A102	REF > 20mA	REF Current input (4÷20mA or 0÷20mA) greater than 20mA
A103	AIN1 > 20mA	AIN1 Current input (4÷20mA or 0÷20mA) greater than 20mA
A104	AIN2 > 20mA	AIN2 Current input (4÷20mA or 0÷20mA) greater than 20mA
A105	PT100 Channel 1 Fault	Hardware address out of measure range of the drive
A106	PT100 Channel 2 Fault	Hardware address out of measure range of the drive
A107	PT100 Channel 3 Fault	Hardware address out of measure range of the drive
A108	PT100 Channel 4 Fault	Hardware address out of measure range of the drive
A109	Amb.Overtemp.	Ambient overtemperature
A110 ÷ A120	…	*Control board failure*

A001 ÷ A032, A043, A049, A063, A071, A078, A088, A092, A110÷A120 Control Board Failure

A001 ÷ A032 A043 A049 A063 A071 A078 A088 A092 A110 ÷ A120	Description	Control board failure
	Event	There may be several causes: the board autodiagnostics file constantly checks its operating conditions.
	Possible cause	• Strong electromagnetic disturbance or radiated interference. • Possible failure of the microcontroller or other circuits on the control board.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A033 Texas Software KO

A033	Description	Incompatible Software Texas version
	Event	When switched on, DSP Motorola detected an incompatible version of the software downloaded to Flash Texas (software version incompatible with Motorola).
	Possible cause	The wrong software was downloaded.
	Solution	1. Download the correct DSP Texas software version. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A039 Texas Flash not Programmed

A039	Description	Texas Flash not programmed
	Event	When switched on, DSP Motorola detected that Flash Texas is not correctly programmed.
	Possible cause	A prior attempt to download DSP Texas software failed.
	Solution	1. Download the correct DSP Texas software version. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A040 User Alarm

A040	Description	Alarm trip caused by the user (as a testing procedure)
	Event	The user has forced the alarm to trip.
	Possible cause	Value 1 was entered to address MODBUS 1400 via serial link.
	Solution	Reset the alarm: send a **RESET** command.

A041 IGBT Fault Side A

A041	Description	General hardware fault from IGBT, side A
	Event	Power converter A generated a general alarm.
	Possible cause	• Electromagnetic disturbance or radiated interference. • Overcurrent, IGBT overtemperature, IGBT fault.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A042 Illegal XMDI in DGI

A042	Description	Illegal configuration of XMDI in the DGI menu.
	Event	• The drive checked if at least one XMDI input from ES847 or ES870 I/O option board is available in the DIGITAL INPUTS MENU; • The drive checked if **R023** (I/O Board setting) is set to 0 in the EXPANSION BOARD CONFIGURATION MENU
	Possible cause	Wrong settings.
	Solution	Check settings and enter correct settings.

A044 SW Overcurrent

A044	Description	SW Overcurrent
	Event	Immediate current limit tripped.
	Possible cause	• Abrupt variations of the connected load • Output short-circuit or ground short-circuit • Strong electromagnetic disturbance or radiated interference. If alarm **A044** tripped while accelerating: • Too short acceleration ramp; If alarm **A044** tripped while decelerating: • Too short deceleration ramp. • Excessive gain of the current regulator (**P155**) or too short integral time (**P156**) when using the **FOC** control algorithm. • Excessive gain of the speed regulator (**P128**) or too short integral time (**P126**) when using the **VTC** control algorithm.
	Solution	1. Check if the drive and the motor are properly dimensioned with respect to the connected load. 2. Make sure that no short-circuit is to be found between two phases or between one phase and the grounding outgoing from the drive (terminals **U, V, W**). (Remove voltage from the motor, set IFD control and operate the drive in no-load conditions.) 3. Check if the command signals are sent to the drive using screened cables where required (see Sinus Penta's **Installation Instructions** manual). Detect external sources for electromagnetic disturbance, check wiring and make sure that antidisturbance filters are installed on the coils of contactors and electrovalves (if fitted inside the cabinet). 4 If necessary, set longer acceleration times (see the RAMPS MENU). 5 If necessary, set longer deceleration times (see the RAMPS MENU). 6. If necessary, decrease the values set in the LIMITS MENU.

A045 Bypass Circuit Fault

A045	Description	Bypass precharge Fault
	Event	The drive forced to close its relay or contactor for the short-circuit of the precharge resistors in DC-link capacitors (DC bus), but it did not detect the relevant closing signal while precharging. See also **A046**.
	Possible cause	• Disconnection of auxiliary signal. • Precharge relay/contactor failure.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A046 Bypass Connector Fault

A046		
	Description	Precharge bypass connector fault.
	Event	Auxiliary signal for the closing of the bypass connector of the short-circuit precharge resistor is considered as closed before the relevant closing command is sent. See also **A045**.
	Possible cause	• Precharge bypass connector reversed. • Precharge relay/contactor failure.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A047 Undervoltage

A047		
	Description	DC bus Voltage lower than minimum voltage.
	Event	Voltage measured in DC bus capacitors has dropped below the min. value allowed for a proper operation of the drive class being used.
	Possible cause	• Supply voltage has dropped below 200Vac –25% (class 2T), 380V –35% (class 4T), 500V –15% (class 5T), 600Vac –5% (class 6T). • Alarm **A047** can trip even when voltage temporarily drops below the allowable min. value (which is caused for example by the direct starting of the connected load). • If the drive is powered directly by the bus bar, the bus feeder is responsible for the alarm. • Failure in DC bus voltage measure circuit.
	Solution	1. Check voltage in terminals **R**, **S**, **T**. Check mains voltage value **M030** and DC bus voltage value **M029**. Also check the values of **M030** and **M029** sampled in the **FAULT LIST** when the alarm tripped. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A048 Overvoltage

A048	Description	Overvoltage in DC bus (voltage in DC-link).
	Event	Voltage measured in DC bus (DC-link) capacitors has exceeded the max. value allowed for a proper operation of the drive class being used.
	Possible cause	• Check that voltage does not exceed 240Vac +10% (class 2T), 480V +10% (class 4T), 515Vac +10% (class 5T), 630Vac +10% (class 6T). • Alarm **A048** can trip due to very inertial loads and a too short deceleration ramp (see the RAMPS MENU). • Alarm **A048** can trip even when the motor is pulled by the load (eccentric load). • If the drive is powered directly by the bus bar, the bus feeder is responsible for the alarm trip. • Failure in DC bus voltage measure circuit.
	Solution	1. Check voltage in terminals **R**, **S**, **T**. Check mains voltage value **M030** and DC bus voltage value **M029**. Also check the values of **M030** and **M029** sampled in the **FAULT LIST** when the alarm tripped. 2. In case of very inertial loads and if the alarm tripped when decelerating, try to set a longer deceleration ramp. If short stop times are needed or if the motor is pulled by the load, try to activate the resistive braking unit. 3. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A050 IGBT Fault A

A050	Description	Hardware fault from IGBT converter, side A.
	Event	IGBT drivers of power converter A detected IGBT failure.
	Possible cause	• Strong electromagnetic disturbance or radiated interference. • Overcurrent, Overtemperature, IGBTs, IGBT fault.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A051 Overcurrent HW A

A051	Description	Hardware overcurrent, side A.
	Event	Hardware overcurrent detected by the drive output current circuit.
	Possible cause	See **A044** SW Overcurrent.
	Solution	See **A044** SW Overcurrent.

A052 Illegal XMDI in DGO

A052	Description	Illegal configuration of XMDI in the DGO menu.
	Event	• The drive checked if at least one XMDI input from ES847 or ES870 I/O option board is available in the DIGITAL INPUTS MENU; • The drive checked if **R023** (I/O Board setting) is set to 0 in the EXPANSION BOARD CONFIGURATION MENU
	Possible cause	Wrong settings.
	Solution	Check settings and enter correct settings.

A053 Not PWONA

A053	Description	Hardware failure; IGBT A power on failure.
	Event	IGBT A power on controlled by Motorola microcontroller has failed.
	Possible cause	Control board failure.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A054 Option Board not in

A054	Description	ES847 or ES870 not in.
	Event	The control board detects no ES847 or ES870 I/O expansion boards after parameter **R023** (I/O Board Setting) is set as ≠ 0.
	Possible cause	Option board not in or faulty.
	Solution	1. Check consistency of parameter **R023** (see the EXPANSION BOARD CONFIGURATION MENU). 2. Reset the alarm: send a **RESET** command. 3. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A055 PTC Alarm

A055	Description	External PTC resistor tripped.
	Event	The drive detected the opening of the PTC connected to **AIN2** input (R > 3600 ohm)
	Possible cause	• Opening of the PTC due to motor overheating. • Incorrect wiring of PTC. • Incorrect setting of **SW1** hardware switch on the control board (see **Installation Manual**).
	Solution	1. Allow the motor to cool, then reset the alarm. 2. Make sure that the PTC is correctly connected to **AIN2** analog input (see **Installation Manual**). 3. Make sure that **SW1** hardware switch is correctly set.

A056 PTC Short Circuit

A056		
	Description	External PTC resistor short circuit.
	Event	Detected the short circuit of the PTC connected to **AIN2** input (R < 10 ohm).
	Possible cause	• Short circuit in the PTC. • Incorrect wiring of PTC. • Incorrect setting of **SW1** hardware switch on the control board (see **Installation Manual**).
	Solution	1. Make sure that the PTC is correctly connected to **AIN2** analog input (see **Installation Manual**). 2. Make sure that **SW1** hardware switch is correctly set.

A057 Illegal XMDI in MPL

A057		
	Description	Illegal configuration of XMDI in the MPL Menu.
	Event	• The drive checked if at least one XMDI input from ES847 or ES870 I/O option board is available in the VIRTUAL DIGITAL OUTPUTS (MPL) MENU; • The drive checked if **R023** (I/O Board setting) is set to 0 in the EXPANSION BOARD CONFIGURATION MENU
	Possible cause	Wrong settings.
	Solution	Check settings and enter correct settings.

A059 Encoder Fault

A059		
	Description	Motor speed measure error.
	Event	During the encoder tune, a speed error measure occurred with respect to the estimated speed, although the sign of the measured speed is consistent with the estimated speed.
	Possible cause	• Incorrect parameterization of the encoder concerning the type and number of pulses/rev. • Voltage removed from one of the two encoders. • Incorrect mounting of the encoders. • Encoder failure.
	Solution	1. Check that the encoder parameters are correct (see the ENCODER/FREQUENCY INPUTS MENU). 2. Check that both encoders are properly connected. 3. Check mounting of the encoders. 4. Using an oscilloscope, check that the encoder signals are correct.

A060 No Current Fault (FOC)

A060	Description	The error detected in FOC control by the current loop exceeds the max. allowable value.
	Event	The FOC control detected a current regulation error.
	Possible cause	• One motor cable is disconnected. • Failure in the current measure circuit. • Wrong setting of current regulator parameters for FOC control.
	Solution	1. Check motor connections (terminals **U, V, W**). 2. Check parameterization of current regulators for FOC control (see the FOC REGULATORS MENU). Perform a new current regulator autotune (see AUTOTUNE MENU). 3. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A061, A062 Serial Link Watchdog

A061 (Serial Link 0) A062 (Serial Link 1)	Description	**A061**: Serial Link Watchdog 0 tripped **A062**: Serial Link Watchdog 1 tripped
	Event	The serial link watchdog has tripped. Communication failure: no read/write query sent to serial link for a time longer than the time set in the parameters relating to serial link watchdog (see the SERIAL LINKS MENU).
	Possible cause	• Serial link is disconnected. • Communication failure on remote master side. • Watchdog operating times too short.
	Solution	1. Check serial link. 2. Make sure that the remote master constantly sends read/write queries with max. intervals between two queries lower than the preset watchdog operating time. 3. Set longer watchdog operating times (see **R005** for serial link 0 and **R012** for serial link 1).

A064 Mains Loss

A064	Description	Mains loss
	Event	Mains loss.
	Possible cause	• One supply cable is disconnected. • Mains supply too weak. • Mains gap.
	Solution	1. Check voltage in terminals **R, S, T**. Check mains voltage value **M030**. Also check the value of **M030** sampled in the **FAULT LIST** when the alarm tripped. 2. This protection may be disabled or delayed (see the POWER DOWN MENU).

A065 Autotune KO

A065	Description	Autotune failed.
	Event	Autotune aborted or failed.
	Possible cause	• The **ENABLE** contact was opened before autotune was over. • Autotune aborted, maybe because the parameter values were inconsistent with the motor ratings.
	Solution	1. Reset the alarm: send a **RESET** command. 2. Check the motor parameters and make sure that they are consistent with the motor ratings (see the MOTOR CONTROL MENU) and perform a new autotune procedure. 3. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A066, A067, A068, A069 Current input < 4mA

A066 (REF) A067 (AIN1) A068 (AIN2) A069 (XAIN5)	Description	**A066**: REF Current input (4÷20mA) lower than 4mA **A067**: AIN1 Current input (4÷20mA) lower than 4mA **A068**: AIN2 Current input (4÷20mA) lower than 4mA **A069**: XAIN5 current input (4÷20mA) lower than 4mA
	Event	A current value lower than 4 mA has been detected over one input (REF, AIN1, AIN2, XAIN5) set with the following range: 4÷20mA.
	Possible cause	• Wrong setting of SW1 on ES821 control board (except for A069). • Signal cable disconnected. • Failure in the current signal source.
	Solution	1. Check setting of SW1(except for A069).. 2. Check that the signal cable is properly connected to its terminal. 3. Check the current signal source.

NOTE

The alarms above trip only if the relevant inputs have been selected (see CONTROL METHOD MENU and PID CONFIGURATION MENU).

A070 Fieldbus WatchDog

A070	Description	Watchdog Fieldbus tripped.
	Event	The watchdog fieldbus tripped and communication is suspended. Communication is interrupted: the Master did not send any valid message for a time longer than the time set in the parameter relating to the value set with parameter **R016** of the fieldbus watchdog time (see the FIELDBUS CONFIGURATION MENU).
	Possible cause	• Voltage removed from Fieldbus. • No communication from Master. • Watchdog times too short.
	Solution	1. Check fieldbus connections. 2. Check that the master ensures a constant sequence of legal messages (FIELDBUS CONFIGURATION MENU) with max. time intervals lower than the preset watchdog time. 3. Set longer watchdog times (see **R016**). 4. To reset alarm **A070**, force communication between the Master and the Penta drive with bit 15 of the digital input word always set to 1 and reset the drive control board. If communication between the Master and the Slave (Penta) cannot be restored, alarm **A070** is restored after setting parameter R016 to zero and after resetting the Penta drive. When the drive is next powered on, the alarm reset will affect the drive control board.

A072-3, A089-90 Parameter Upload/Download Error from Keypad to Drive

A072 A073 A089 A090	Description	Upload/download failed, one of the controls of the parameter consistency detected a fault.
	Event	A communication error occurred while uploading/downloading the programming parameters from the keypad to the drive.
	Possible cause	Temporary interruption to the serial link between keypad and control board.
	Solution	Check the connection between the keypad and the control board, reset the alarm and perform a new upload/download procedure.

A074 Overload

A074	Description	Drive thermal protection tripped.
	Event	The output current has been exceeding the drive rated current for long periods.
	Possible cause	• Current equal to **Imax** + 20% for **3 seconds**, or • Current equal to **Imax** for **120 seconds** (S05÷S30), • Current equal to **Imax** for **60 seconds** (S40÷S80)
	Solution	Check the drive current output during ordinary operation (**M026** in the **Measure Menu**); check the mechanical conditions of the connected load (load locked / overload).

A075 Motor Overheated

A075	Description	Motor thermal protection tripped.
	Event	The software motor thermal protection tripped. Output current has been exceeding the drive rated current for long periods.
	Possible cause	• Poor mechanical conditions of the connected load. • Wrong setting of parameters in the Thermal Protection Menu.
	Solution	1. Check mechanical conditions of the connected load. 2. Check parameters **C265**, **C266**, **C267** (and equivalent parameters for motors 2 and 3) in the MOTOR THERMAL PROTECTION MENU.

A076 Limit Speed

A076	Description	The motor speed is too high.
	Event	The motor speed is higher than the current value set in parameter **C031** (for motor 1, or equivalent parameters for motors 2 and 3). If **C031** = 0, the limit speed protection is disabled. If the encoder is disabled, the variable used for this software protection is: • The current speed setpoint for IFD. • The estimated motor speed for VTC control.
	Possible cause	• Value of parameter **C031** too low. • Torque reference too high for **SLAVE** mode.
	Solution	1. Check the compatibility of the parameter with respect to the maximum speed parameter. 2. In **SLAVE** mode, check the torque reference value.

A079 Encoder Not Enabled

A079	Description	FOC control, but encoder not enabled.
	Event	The FOC control is active, but no encoder has been enabled with parameter **C012** (for motor 1, or equivalent parameters for motors 2 and 3). Otherwise, no encoder enabled for speed measure with parameter **C189** (see the ENCODER/FREQUENCY INPUTS MENU).
	Possible cause	• **C012** = 0 (for motor 1, or equivalent parameters for motors 2 and 3). See the MOTOR CONTROL MENU. • The value set in **C189** does not enable any encoder for speed measure. • The **FOC** control has been improperly enabled.
	Solution	Set parameters correctly.

A080 Speed Tracking

A080	Description	Encoder speed measure error.
	Event	The system detected an error between the measured speed and the measure setpoint. Speed has been exceeding the value set in parameter **C193** for a time longer than the value set in parameter **C192**. This protection is enabled only if parameter **C194** is not set at zero.
	Possible cause	• Wrong setting in parameters **C192, C193, C194** (see the ENCODER/FREQUENCY INPUTS MENU). • Torque limit too low. • Connected load too heavy. • Encoder failure, encoder mechanical joint broken down, disconnection of one of the signal cables of the encoder.
	Solution	1. Set parameters **C192, C193** correctly. 2. Check torque limit value (see the INPUTS FOR REFERENCES MENU and the CONTROL METHOD MENU). 3. Check the mechanical load. 4. Make sure that the encoder works properly, check its mechanical connection to the motor and check that the encoder signal cables are properly connected to the terminals.

A081 Keypad Watchdog

A081	Description	Watchdog for the communication to the keypad.
	Event	Communication failed when the keypad was enabled as a reference source or a command source or when it was in Local mode (Watchdog time is equal to approx. 1.6 seconds)
	Possible cause	• Keypad cable disconnected. • Failure of one of the two connectors of the keypad. • Strong electromagnetic disturbance or radiated interference. • Keypad failure. • Incorrect setting in parameters relating to serial link 1 (see the SERIAL LINKS MENU).
	Solution	1. Check the connection of the keypad cable. 2. Make sure that the keypad cable connectors are intact (on both drive side and keypad side). 3. Check communication parameters of serial link 1.

A082 Encoder Configuration

A082	Description	Functions programmed for **MDI6** and **MDI7**, or **Encoder B** selected and encoder board not detected.
	Event	• **Encoder A** has been selected for speed measure or as a reference source, but different digital command functions are programmed for terminals **MDI6** and **MDI7**. • **Encoder B** has been selected for the speed measure or as a reference source, but the control board did not detect any optional encoder board.
	Possible cause	• Incorrect setting of the use of the encoders in parameter **C189**. • Incorrect programming of digital input functions. • Option board for Encoder B is not fitted, has been improperly mounted or is faulty. Possible connector failure.
	Solution	1. Check and adjust the value set in **C189** (see the ENCODER/FREQUENCY INPUTS MENU). 2. Check and adjust the control function programming for digital inputs **MDI6** and **MDI7** (see the DIGITAL INPUTS MENU). 3. Check if optional encoder board is fitted and properly mounted.

A083, A084, A085 External Alarm

A083 (EXT1) A084 (EXT2) A085 (EXT3)	Description	**A083**: External alarm 1 **A084**: External alarm 2 **A085**: External alarm 3
	Event	The External Alarm (1, 2, 3) functionality has been programmed, but the relevant digital input is disabled (see the DIGITAL INPUTS MENU). If multiple digital command sources are programmed, alarms **A083-A085** trip if one of the terminals in the active sources is disabled (see the CONTROL METHOD MENU).
	Possible cause	The cause for the alarm trip does not depend on the drive; check for the reason why the contact connected to terminal **MDIx** where the External Alarm function is programmed opens.
	Solution	Check external signal.

A087 ±15V Loss

A087	Description	Loss of ±15V.
	Event	• The voltage level of ±15V is inadequate.
	Possible cause	• Possible failure of the control board or other circuits in the Penta Drive.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A091 Braking Resistor Overload

A091	Description	Overvoltage due to the overload of the braking resistor that has been operating for a time equal to the maximum time due to settings in **C211** and **C212**.
	Event	The braking resistance command was inhibited because the maximum ON time was expired and the energy caused by regeneration (that can no longer be dissipated) has led to overvoltage.
	Possible cause	This application requires an intense use of the Braking Resistor, for example in lifting applications, where a long downstroke is required when the load is connected to the motor.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the power dissipated by the braking resistance allows for a heavier use, set **C211** with a greater ON time.

A093 Precharge: Bypass open

A093	Description	Bypass relay open.
	Event	The control board requested the closure of the bypass relay (or contactor) for the short-circuit of the DC-link capacitor precharge resistors, but no closing signal is sent (auxiliary of the relay) during functioning (precharge already closed).
	Possible cause	Failure in the relay control circuit or in the auxiliary signal circuit detecting relay closing.
	Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A094 Heatsink Overheated

A094	Description	IGBT heatsink temperature too high.
	Event	IGBT power heatsink overheated even if the cooling fan is on (see also **A096** and **A099**).
	Possible cause	• Ambient temperature exceeding 40 °C. • Motor overcurrent. • Excessive carrier frequency for the application required.
	Solution	1. Check ambient temperature. 2. Check motor current. 3. Decrease IGBT carrier frequency (see the CARRIER FREQUENCY MENU).

A095 Illegal Drive Profile Board

A095	Description	An illegal Drive Profile board is implemented.
	Event	Incorrect configuration of the optional Drive Profile board.
	Possible cause	• The Drive Profile board is configured for a different drive. • The Drive Profile board is not configured for a different drive. • Faulty Drive Profile board.
	Solution	1. Make sure that the Drive Profile board is correctly configured for the Sinus Penta drive. 2. Replace the Drive Profile board.

A096 Fan Fault

A096	Description	Fan alarm.
	Event	Power heatsink overheated with fan locked or disconnected or faulty (see also **A094** and **A099**).
	Possible cause	Fan locked or disconnected or faulty.
	Solution	Replace fan.

A097 Motor Cables KO

A097	Description	Motor not connected.
	Event	This protection trips during autotune or DC Brake if the motor is not connected to the drive or if its current value is not compatible with the drive size.
	Possible cause	• One cable of the motor is disconnected. • The motor size is too small if compared to the drive size.
	Solution	1. Check that motor cables are properly connected to terminals **U, V, W**. 2. Check the motor parameters; perform autotune procedure again (VTC and FOC controls).

A098 Illegal Motor

A098	Description	A disabled motor has been selected.
	Event	• Motor 2 is enabled, but only one motor can be enabled: **C009**=1 (see the MOTOR CONTROL MENU). • Motor 3 is enabled, but only 1 or 2 motors can be enabled: **C009**=1 or 2 (see the MOTOR CONTROL MENU).
	Possible cause	• Incorrect setting in parameter **C009**. • Incorrect setting of the digital input parameters enabling the selection functions for motor 2 (**C173**) and/or motor 3 (**C174**).
	Solution	1. Check and enter the correct value for **C009**. 2. Check and enter the correct value for **C173**, **C174**. 3. Check the status of the digital commands for terminals **C173** and **C174**. If remote command sources are selected, check the status of the commands that have been sent.

A099 Sensor 2 Fault

A099	Description	Sensor 2 fault.
	Event	Power heatsink overheated with cooling fan off (see also **A094** and **A096**).
	Possible cause	Failure in temperature control device and/or cooling system.
	Solution	Please contact ELETTRONICA SANTERNO's Customer Service.

A100 MDI6 Illegal Configuration

A100	Description	Function programmed to **MDI6** and **frequency input A** as well.
	Event	**MDI6** terminal is programmed with a digital function command and as frequency input A.
	Possible cause	Incorrect programming of a command function for **MDI6,** because frequency input A is already set in parameter **C189** (FinA) (see the DIGITAL INPUTS MENU and the ENCODER/FREQUENCY INPUTS MENU).
	Solution	Check and adjust programming of the digital input functions and of parameter **C189**.

A101 MDI8 Illegal Configuration

A101	Description	Function programmed to **MDI8** and **frequency input B** as well.
	Event	**MDI8** terminal is programmed with a digital function command and as frequency input **B**.
	Possible cause	Incorrect programming of a command function for **MDI8,** because frequency input B is already set in parameter **C189** (FinB) (see the DIGITAL INPUTS MENU and the ENCODER/FREQUENCY INPUTS MENU).
	Solution	Check and adjust programming of the digital input functions and of parameter **C189**.

A102, A103, A104, A086 Current input > 20 mA

A102 (REF) A103 (AIN1) A104 (AIN2) A086 (XAIN5)	Description	A102: REF Current input (4÷20mA or 0÷20mA) greater than 20mA A103: AIN1 Current input (4÷20mA or 0÷20mA) greater than 20mA A104: AIN2 Current input (4÷20mA or 0÷20mA) greater than 20mA A086: XAIN5 Current input (4÷20mA or 0÷20mA) greater than 20mA
	Event	A current value greater than 20mA has been detected over one input (REF, AIN1, AIN2, XAIN5) set with the following ranges: 4÷20mA or 0÷20mA.
	Possible cause	• Wrong setting of SW1 on ES821control board (except for **A069**). • Failure in the current signal source.
	Solution	1. Check setting of SW1(except for **A069**). 2. Check the current signal source.

A105, A106, A107, A108 PT100 Channel 1,2,3,4 Fault

A105 (Channel 1) A106 (Channel 2) A107 (Channel 3) A108 (Channel 4)	Description	**A105**: PT100 Channel 1 fault **A106**: PT100 Channel 2 fault **A107**: PT100 Channel 3 fault **A108**: PT100 Channel 4 fault
	Event	Hardware input out of the measure range of the drive.
	Possible cause	• Wrong setting of SW1 or SW2 on optional control board ES847 • Failure in the current signal source.
	Solution	1. Check setting of SW1 and SW2. 2. Check the current signal source.

A109 Ambient Overtemperature

A109	Description	The ambient temperature is too high.
	Event	The control board has detected a too high ambient temperature.
	Possible cause	Inverter or cabinet overheated; failure of control board NTC.
	Solution	1. Open the cabinet and check its conditions. Also check measure **M062**. 2. Reset the alarm: send a **RESET** command. 3. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

53.4. List of the DRIVECOM Alarm Codes

If a PROFIdrive expansion board is used (see PROFIDRIVE BOARD CONFIGURATION MENU), the Sinus Penta fault codes are also coded according to the DRIVECOM communication profile.
The specific code is readable @ address 947 of the specific PROFIDRIVE PARAMETERS (see PROFIdrive COMMUNICATIONS BOARD USER MANUAL).

The DRIVECOM User Group e.V. is an association of international drive manufacturers, universities, and institutes. It has set itself a goal to develop a simple integration of drives in open automation systems. The DRIVECOM User Group therefore decided to standardise the communication interface for accessing drives.

Also visit www.drivecom.org.

Table 114: List of the DRIVECOM alarm codes.

Code	Meaning	Sinus Penta Fault	#
0000	No malfunction	–	A000
1000	General malfunction	NoCurrent Fault	A060
		AutoTune Fault	A065
2000	Current		
2300	Current on device output side		
2310	Continuous overcurrent		
2311	Continuous overcurrent No. 1	SW OverCurrent	A044
2312	Continuous overcurrent No. 2	PWMA1 Fault	A051
2320	Short circuit / earth leakage	PWMA Fault	A041
		PWMA0 Fault	A050
		PWMA Not ON	A053
3000	Voltage		
3100	Mains voltage		
3130	Phase failure	Mains Loss	A064
3200	Internal voltage		
3210	Internal overvoltage	OverVoltage	A048
3220	Internal undervoltage	UnderVoltage	A047
4000	Temperature	PT100 Channel 1 Fault	A105
		PT100 Channel 2 Fault	A106
		PT100 Channel 3 Fault	A107
		PT100 Channel 4 Fault	A108
4100	Ambient		
4110	Excess ambient temperature	Amb.Overtemp.	A109
4300	Drive temperature		
4310	Excess drive temperature	Drive OverHeated	A074
		HeatSink Overheated	A094
5000	Device hardware		
5111	U1 = supply +/- 15 V	±15V Loss	A087
5200	Control		
5210	Measurement control	ADC Not Tuned	A088
5220	Computing circuit		
5300	Operating unit	Parm Lost Chk	A072
		Parm Lost COM1	A073
		MMI Trouble	A078
		KeyPad WatchDog	A081
		Parm Lost COM2	A089
		Parm Lost COM3	A090
5400	Power section	Fan Fault	A096
		2nd Sensor Fault	A099
5440	Contactors		
5441	Contactor 1 = manufacturer specific	Bypass Circuit Fault	A045
5442	Contactor 2 = manufacturer specific	Bypass Connector Fault	A046
5443	Contactor 3 = manufacturer specific	Bypass Circuit Open	A093
5500	Data storage		
5510	RAM	RAM Fault	A049

6000	Device software		
6010	Software reset (Watchdog)		
6100	Internal software	False Interrupt	A043
		Generic Motorola	A063
		1ms Interrupt OverTime	A071
6200	User software	User Fault	A040
6300	Data record		
6301	Data record No. 1	SW Version KO	A092
6302	Data record No. 2	Option Board not in	A054
6303	Data record No. 3	Illegal XMDI in DGI	A042
6304	Data record No. 4	Illegal XMDI in DGO	A052
6305	Data record No. 5	Illegal XMDI in MPL	A057
6306	Data record No. 6	FOC No Encoder	A079
6307	Data record No. 7	Illegal Encoder Cfg	A082
6308	Data record No. 8	Illegal Motor Selected	A098
6309	Data record No. 9	MDI6 Illegal Configuration	A100
630A	Data record No. 10	MDI8 Illegal Configuration	A101
7000	Supplementary modules		
7100	Power		
7110	Brake chopper	Braking Resistor Overload	A091
7120	Motor	Motor Not Connected	A097
7300	Sensor	PTC Alarm	A055
		PTC Short Circuit	A056
		REF < 4mA	A066
		AIN1 < 4mA	A067
		AIN2 < 4mA	A068
		XAIN5 < 4mA	A069
		REF > 20mA	A102
		AIN1 > 20mA	A103
		AIN2 > 20mA	A104
		XAIN5 > 20mA	A086
7301	Tacho fault		
		Tracking Error	A080
		Encoder Fault	A059
7310	Speed	Speed Alarm	A076
7500	Communication	Ser WatchDog	A061
		SR1 WatchDog	A062
		Fbs WatchDog	A070
		Illegal Drive Profile Board	A095
8000	Monitoring		
8300	Torque control		
8311	Excess torque	Motor OverHeated	A075
9000	External malfunction	External Alarm 1	A083
		External Alarm 2	A084
		External Alarm 3	A085

53.5. Warnings

Warning messages are displayed on the display/keypad. They are flashing messages that usually appear in line 1 or 2 of the first three lines of the display.

NOTE Warnings are neither protections nor alarms, and are not stored to the fault list.

Some warnings simply state what's happening or suggest what to do when using the keypad.
However, most of the warning messages are Coded warnings: they are displayed with letter "W" followed by two digits stating which warning is active at that moment. Example:

W32 OPEN ENABLE

Warning messages are detailed in the following section.

53.6. Warning List

Table 115: Warning list.

Warning	Alarm Message	Description
W03	SEARCHING…	The user interface is searching the data of the next page to display.
W04	DATA READ KO	Software warnings concerning data reading.
W06	HOME SAVED	The page displayed has been saved as the home page displayed at power on.
W07	DOWNLOADING	The keypad is **writing** to the drive the WORK zone parameters saved on its own flash memory.
W08	UPLOADING	The keypad is **reading** from the drive the WORK zone parameters that will be saved on its own flash memory.
W09	DOWNLOAD OK	Parameters were successfully downloaded (**written**) from the keypad to the drive.
W11	UPLOAD OK	Parameters were successfully uploaded (**read**) from the drive to the keypad.
W12	UPLOAD KO	The keypad interrupted parameter upload to the drive. Parameter **reading** has failed.
W13	NO DOWNLOAD	A Download procedure was queried, but no parameter is saved to the flash memory.
W16	PLEASE WAIT…	Wait until the system completes the operation required.
W17	SAVE IMPOSSIBLE	Parameter save is not allowed.
W18	PARAMETERS LOST	The keypad interrupted parameter download to the drive. Parameter **writing** has failed. As a result, not all parameters have been updated (parameter inconsistency).
W19	NO PARAMETERS LOAD	UPLOAD impossible.
W20	NOT NOW	The required function is not available at the moment.
W21	CONTROL ON	The required function is inhibited because the drive is running.
W23	DOWNLOAD VER. KO	Download failed because parameters saved to keypad memory relate to a SW version or product ID incompatible with the drive SW version or product ID.
W24	VERIFY DATA	Download preliminary operation underway, the system is checking the integrity and compatibility of the parameters saved in the keypad memory.
W28	OPEN START	Open and close the **START** (MDI1) signal to start the drive.
W31	ENCODER OK	Encoder tuning procedure finished: the encoder is correctly connected.
W32	OPEN ENABLE	Open and close the **ENABLE** (MDI2) signal to enable the drive.
W33	WRITE IMPOSSIBLE	Writing procedure impossible.
W34	ILLEGAL DATA	Illegal value entered, operation failed.
W35	NO WRITE CONTROL	Writing procedure impossible because Control is active and the drive is running.
W36	ILLEGAL ADDRESS	Illegal address entered, operation failed.
W37	ENABLE LOCKED	The drive is disabled and does not acknowledge the **ENABLE** command because it is writing a "C" parameter. **CAUTION: The drive will start up as soon as writing is over!!!**
W38	LOCKED	Editing mode cannot be accessed because parameter modification is disabled: **P000** is different from **P002**.
W39	KEYPAD DISABLED	Editing mode cannot be accessed because the keypad is disabled.
W40	FAN FAULT	Fan locked or disconnected or faulty.
W41	SW VERSION KO	Download impossible because of different SW Versions.
W42	IDP KO	Download impossible because of different IDPs (Identification Products).
W43	PIN KO	Download impossible because of different PINs (Part Identification Numbers).
W44	CURRENT CLASS KO	Download impossible because of different current classes.
W45	VOLTAGE CLASS KO	Download impossible because of different voltage classes.
W46	DOWNLOAD KO	Download impossible (generic cause).
W48	OT Time over	The preset threshold for the drive Operation Time has been exceeded.
W49	ST Time over	The preset threshold for the drive Supply Time has been exceeded.

53.7. State List

Table 116: State list.

Number	State	Description
0	ALARM!!!	Alarm tripped
1	STARTING UP	The drive is starting up
2	MAINS LOSS	Mains loss
3	TUNING	The drive is tuning
4	SPEED SEARCHING	Searching for motor speed
5	DCB at START	DC Braking at start
6	DCB at STOP	DC Braking at stop
7	DCB HOLD	DC current for Hold function
8	MANUAL DCB	DC Braking at start
9	LIMIT WHILE ACCEL.	Current/torque limit while accelerating
10	LIMIT WHILE DECEL.	Current/torque limit while decelerating
11	LIMIT AT ST. SPD	Current/torque limit at constant rpm
12	BRAKING	Braking module startup or deceleration ramp extension
13	RUN AT ST. SPEED	Drive running at speed set point
14	ACCELERATING	Drive running with motor in acceleration stage
15	DECELERATING	Drive running with motor in deceleration stage
16	INVERTER OK	Drive on Stand-by with no alarms tripped
17	FLUXING	Motor fluxing stage
18	FLUXED MOTOR	Motor fluxed
19	FIRE MODE RUN	Constant rpm in Fire Mode
20	FIRE MODE ACC.	Acceleration in Fire Mode
21	FIRE MODE DEC.	Deceleration in Fire Mode
22	INVERTER OK*	Drive on Stand-by with no alarms tripped; void warranty due to alarm trip in Fire Mode
25	SPARE	Board in Spare mode
27	WAIT NO ENABLE	Waiting for opening **ENABLE** command
28	WAIT NO START	Waiting for opening **START** command
29	PIDOUT min DISAB	Drive disabled due to PID output < Min.
30	REF min DISABLED	Drive disabled due to REF < Min.
31	IFD WAIT REF.	Drive enabled with IFD control waiting for reference in order to start
32	IFD WAIT START	Drive enabled with IFD control waiting for START in order to start
33	DISABLE NO START	When fluxing, the RUN command was not given within the max. time set in **C183**. The drive is kept disabled until the RUN command is given.

54. CUSTOM PARAMETERS

In the table below, you can write down settings that are different from the default values.

PARAMETERS	Default Values	Custom Values	PARAMETERS	Default Values	Custom Values
P00x User Level					
P001-AcsLev	0: Basic		P003-ModCmode	1:[StandBy+Fluxing]	
Product					
P263-Lang	1: ENGLISH				
P26x Display					
P264-ModNav	0: Menu		P264a-ModNavMenu	1: Yes	
P264b-ModMenu	0: Standard		P265-FirstPage	3: [Start Up]	
P266-kpd_type	1: Ref.Activated		P267-umis1_PID	0: Disable	
P267a-Custom PID units of measure	[%]				
P268-Measure n.1 on Root page	M004		P268y- Scaling of Measure n.1 on Root page	100.00%	
P268a- Measure n.2 on Root page	M000		P268z- Scaling of Measure n.2 on Root page	100.00%	
P268b-Measure n.1 on Keypad page	M006		P268c- Measure n.2 on Keypad page	M026	
P268d-Measure n.3 on Keypad page	M004		P268e- Measure n.4 on Keypad page	M000	
P269-DisabKey1	0: No		P269a-DisabKey2	0: No	
P00x-P03x Ramps					
P009-Tup1	[*]		P010-Tdn1	[*]	
P012-Tup2	[*]		P013-Tdn2	[*]	
P014-Un.Meas1-2	[*]		P015-Tup3	[*]	
P016-Tdn3	[*]		P018-Tup4	[*]	
P019-Tdn4	[*]		P020-Un.Meas3-4	[*]	
P021a-Rnd.Sel1	[*]		P021b-Rnd.Sel2	[*]	
P021c-Rnd.Sel3	[*]		P021d-Rnd.Sel4	[*]	
P022-RndStartAcc	50 %		P023-RndStopAcc.	50 %	
P024-RndStartDec	50 %		P025-RndStopDec	50 %	
P026-T Tup	5.00 s		P027-T Tdn	5.00 s	
P028-T Un.Mea	1: 0.1 s		P029-J Tup	1 s	
P030-J Tdn	1 s		P031-SpdAccReset	1: Yes	
P032-TupFireM	[*]		P033-TdnFireM	[*]	
P05x-P07x Reference					
P050-REF	3: 0-10V		P051-REFMIN	0.0 V	
P051a-REFMIN_%	100%		P052-REFMAX	10.0 V	
P052a-REFMAX_%	100%		P053-REFOFFS	0.000 V	
P054-TauFilt REF	5 ms		P055-AIN1	2: 4-20mA	
P056-AIN1MIN	4.0 mA		P056a-AIN1MIN_%	100%	
P057-AIN1MAX	20.0 mA		P057a-AIN1MAX_%	100%	
P058-AIN1OFFS	0.000 mA		P059-TauFilt AIN1	5 ms	
P060-AIN2	2: 4-20mA		P061-AIN2MIN	4.0 mA	
P061a-AIN2MIN_%	100%		P062-AIN2MAX	20.0 mA	
P062a-AIN2MAX_%	100%		P063-AIN2OFFS	0.000 mA	
P064-TauFilt AIN2	5 ms		P065-SpdDisab	0 rpm	
P066-SpdDisabTime	0 s		P067-U/D Ramp	Square	
P068-U/D Mem	1: Yes		P068a-U/D1-StopRes	0: No	
P068b-U/D2-StopRes	0: No		P068c-U/D1SwSRes	0: No	
P068d-U/D2SwSRes	0: No		P069-U/D Range	1: Unipolar	
P070-Jog Ref	0 %		P071-PulseMin	10000 Hz	
P071a-PulseMin_%	100%		P072-PulseMax	100000 Hz	
P072a-PulseMax_%	100%		P073-EncMin	-1500 rpm	
P073a-EncMin_%	100%		P074-EncMax	1500 rpm	
P074a-EncMax_%	100%				

PARAMETERS	Default Values	Custom Values	PARAMETERS	Default Values	Custom Values
P08x-P10x Multispeed					
P080-Mspd.use	0:Preset Speed		**P081**-Spd1	0.00 rpm	
P083-Spd2	0.00 rpm		**P085**-Spd3	0.00 rpm	
P087-Spd4	0.00 rpm		**P088**-Spd5	0.00 rpm	
P089-Spd6	0.00 rpm		**P090**-Spd7	0.00 rpm	
P091-Spd8	0.00 rpm		**P092**-Spd9	0.00 rpm	
P093-Spd10	0.00 rpm		**P094**-Spd11	0.00 rpm	
P095-Spd12	0.00 rpm		**P096**-Spd13	0.00 rpm	
P097-Spd14	0.00 rpm		**P098**-Spd15	0.00 rpm	
P099-FireM_Spd	750.00 rpm		**P100**-Un.Meas	0: 0.01 rpm	
P08x-P09x PID Multireference					
P080a-Mref.use PID	0:Preset Ref		**P081a**-Ref 1 PID	0.00	
P082a-Ref 2 PID	0.00		**P083a**-Ref 3 PID	0.00	
P084a-Ref 4 PID	0.00		**P085a**-Ref 5 PID	0.00	
P086a-Ref 6 PID	0.00		**P087a**-Ref 7 PID	0.00	
P099a-FireM_Ref PID	0.00				
P10x Prohibit Speeds					
P105-Velbp1	0 rpm		**P106**-Velbp2	0 rpm	
P107-Velbp3	0 rpm		**P108**-Bwbps	0 rpm	
P11x-P12x % Var. Ref.					
P115-VarPerc1	0.0 %		**P116**-VarPerc2	0.0 %	
P117-VarPerc3	0.0 %		**P118**-VarPerc4	0.0 %	
P119-VarPerc5	0.0 %		**P120**-VarPerc6	0.0 %	
P121-VarPerc7	0.0 %				
P12x-P15x Speed Loop					
P125-Ti min M1	0.500 s		**P126**-Ti max M1	0.500 s	
P128-Kp min M1	10.00		**P129**-Kp max M1	10.00	
P130-Err.min M1	1.00 %		**P131**-Err.max M1	1.00 %	
P135-Ti min M2	0.500 s		**P136**-Ti max M2	0.500 s	
P138-Kp min M2	10.00		**P139**-Kp max M2	10.00	
P140-Err.min M2	1.00 %		**P141**-Err.max M2	1.00 %	
P145-Ti min M3	0.500 s		**P146**-Ti max M3	0.500 s	
P148-Kp min M3	10.00		**P149**-Kp max M3	10.00	
P150-Err.min M3	1.00 %		**P151**-Err.max M3	1.00 %	
P152-curr_symm.	0 %				
P15x-P17x FOC Regulator					
P155-Curr_Kp M1	3.00		**P156**-Curr_Ti M1	20.0 ms	
P158-Flux_Kp M1	0.00		**P159**-Flux_Ti M1	33 ms	
P162-Curr_Kp M2	3.00		**P163**-Curr_Ti M2	20.0 ms	
P165-Flux_Kp M2	0.00		**P166**-Flux_Ti M2	33 ms	
P169-Curr_Kp M3	3.00		**P170**-Curr_Ti M3	20.0 ms	
P172-Flux_Kp M3	0.00		**P173**-Flux_Ti M3	33 ms	
P17x-P21x Analog Outputs					
P176-AO1 Mode	1: +/-10V		**P177**-AO1 Sel	1: Motor Speed	
P178-AO1 Min	-1500.000 rpm		**P179**-AO1 Max	1500.000 rpm	
P180-AO1 Offset	0.000 V		**P181**-AO1 Filt	0.000 s	
P182-AO1 Out_min	-10.0 V		**P183**-AO1 Out_max	10.0 V	
P184-AO2 Mode	1: +/-10V		**P185**-AO2 Sel	2: Speed Ref.	
P186-AO2 Min	-1500.000 rpm		**P187**-AO2 Max	1500.000 rpm	
P188-AO2 Offset	0.000 V		**P189**-AO2 Filt	0.000 s	
P190-AO2 Out_min	-10.0 V		**P191**-AO2 Out_max	10.0 V	
P192-AO3 Mode	1: +/-10V		**P193**-AO3 Sel	5:Motor Current	
P194-AO3 Min	0.000 A		**P195**-AO3 Max	36.000 A	
P196-AO3 Offset	0.000 V		**P197**-AO3 Filt	0.000 s	
P198-AO3 Out_min	-10.0 V		**P199**-AO3 Out_max	10.0 V	
P200-PulsOut Mode	0: Disabled		**P201**-PlsOut Sel	1: Motor Speed	
P202-Pls Out Min	0 rpm		**P203**-Pls Out Max	0 rpm	
P204-Pls Out Fmax	10.00 kHz		**P205**-Pls Out Fmin	100.00 kHz	
P206-Pls Out Filt	0.000 s		**P207**-AO1Gain		
P208-AO2Gain			**P209**-AO3Gain	RESERVED	
P210-AO1Address	RESERVED		**P211**-AO2Address		
P212-AO3Address			**P213**-Sin Amp	100.0 %	
P214-Sin Freq	1.00 Hz		**P215**-Saw Freq	1.000 Hz	

P21x-P22x Timers			
P216-T1 delay On 0.0 s		**P217**-T1 delay Off 0.0 s	
P218-T2 delay On 0.0 s		**P219**-T2 delay Off 0.0 s	
P220-T3 delay On 0.0 s		**P221**-T3 delay Off 0.0 s	
P222-T4 delay On 0.0 s		**P223**-T4 delay Off 0.0 s	
P224-T5 delay On 0.0 s		**P225**-T5 delay Off 0.0 s	
P226a-Timer MDI1 0		**P226b**-Timer MDI2 0	
P226c-Timer MDI3 0		**P226d**-Timer MDI4 0	
P227a-Timer MDI5 0		**P227b**-Timer MDI6 0	
P227c-Timer MDI7 0		**P227d**-Timer MDI8 0	
P228a-Timer MDO1 0		**P228b**-Timer MDO2 0	
P228c-Timer MDO3 0		**P228d**-Timer MDO4 0	
P229a-Timer MPL1 0		**P229b**-Timer MPL2 0	
P229c-Timer MPL3 0		**P229d**-Timer MPL4 0	
P23x-P26x PID Parameters			
P236-PID Out Max 100.00 %		**P237**-PID Out Min 100.00 %	
P237a-Wake Up Mode 0: Disabled		**P237b**-Wake Up Level 0.00 %	
P238-Integ Max 100.00 %		**P239**-Der Max 100.00 %	
P240-PID Kp 1.000		**P241**-PID KpMult 0: 1	
P242-PID Ti(Tc) 500 Tc		**P243**-PID Td(Tc) 0 mTc	
P244-PID Tc 5 ms		**P245**-PID Ref Min 0.00 %	
P246-PID Ref Max 100.00 %		**P247**-PID Fdbk Min 0.00 %	
P248-PID Fdbk Max 100.00 %		**P249**-PID Tup 0.00 s	
P250-PID Tdn 0.00 s		**P251**-PID U.Mea. 1: 0.1 s	
P252-Rnd start 50 %		**P253**-Rnd stop 50 %	
P254-Thresh Int 0.0 %|Refmax|		**P255**-Disab Time Disabled	
P256-Trate Lim 1 ms		**P257**-GainScale 1.000	
P260-GainAWUP 1.00			
P27x-P30x Digital Outputs			
P270-Out1Mode 3: Analog		**P271**-Out1Sel1 A61: Speed	
P272-Out1Sel2 A61: Speed		**P273**-Out1 Test1 0: >	
P274-Out1 Test2 3: ≤		**P275**-D01 ValTst1 50.000 rpm	
P276-D01 ValTst2 10.000 rpm		**P277**-Out1Func 1: (A) Set (B) Reset	
P277a-Out1Sel1 D0: Disable		**P277b**-Out1Func 0: f(A,B) OR (C)	
P278-Out1Logic 1: True		**P279**-Out2Mode 6: Brake	
P280-Out2Sel1 A71: Torque output		**P281**-Out2Sel2 A61: Speed	
P282-Out2 Test1 0: >		**P283**-Out2 Test2 3: ≤	
P284-D02 ValTst1 20.000 %		**P285**-D02 ValTst2 50.000 rpm	
P286-Out2Func 1: (A) Set (B) Reset		**P286a**-Out2Sel1 D0: Disable	
P286b-Out2Func 0: f(A,B) OR (C)		**P287**-Out2Logic 1: True	
P288-Out3Mode 1: Digital		**P289**-Out3Sel1 D3: Inverter Alarm	
P290-Out3Sel2 D3: Inverter Alarm		**P291**-Out3 Test1 0: >	
P292-Out3 Test2 0: >		**P293**-D03 ValTst1 0.000	
P294-D03 ValTst2 0.000		**P295**-Out3Func 0: (A) OR (B)	
P295a-Out3Sel1 D0: Disable		**P295b**-Out3Func 0: f(A,B) OR (C)	
P296-Out3Logic 0: False		**P297**-Out4Mode 1: Digital	
P298-Out4Sel1 D1: Inverter Run Ok		**P299**-Out4Sel2 D1: Inverter Run Ok	
P300-Out4 Test1 0: >		**P301**-Out4 Test2 0: >	
P302-D04 ValTst1 0.000		**P303**-D04 ValTst2 0.000	
P304-Out4Func 0: (A) OR (B)		**P304a**-Out4Sel1 D0: Disable	
P304b-Out4Func 0: f(A,B) OR (C)		**P305**-Out4Logic 1: True	

PARAMETERS	Default Values	Custom Values	PARAMETERS	Default Values	Custom Values
P306-P317 Aux Digital Outputs					
P306-Out1Sel	D0: Disable		**P307**-Out1Logic	1: True	
P308-Out2Sel	D0: Disable		**P309**-Out2Logic	1: True	
P310-Out3Sel	D0: Disable		**P311**-Out3Logic	1: True	
P312-Out4Sel	D0: Disable		**P313**-Out4Logic	1: True	
P314-Out5Sel	D0: Disable		**P315**-Out5Logic	1: True	
P316-Out6Sel	D0: Disable		**P317**-Out6Logic	1: True	
P32x PT100 Settings					
P320-Mea1 Type	0:Disable		**P321**-Offset Mea1	0	
P322-Mea2 Type	0:Disable		**P323**-Offset Mea2	0	
P324-Mea3 Type	0:Disable		**P325**-Offset Mea3	0	
P326-Mea4 Type	0:Disable		**P327**-Offset Mea4	0	
P33x Fieldbus Parameters					
P330-fbs_meas3	M012 Torq.Out.%		**P331**-fbs_meas4	M022 PID Out%	
P35x-P38x MPL					
P350-Out1Mode	1: Digital		**P351**-Out1Sel1	D21: MDI Enable	
P352-Out1Sel2	D0: Disable		**P353**-Out1 Test1	0: >	
P354-Out1 Test2	0: >3: ≤		**P355**-D01 ValTst1	0	
P356-D01 ValTst2	0		**P357**-Out1Func	0: (A) OR (B)	
P357a-Out1Sel1	D0: Disable		**P357b**-Out1Func	0: f(A,B) OR (C)	
P358-Out1Logic	1: True		**P359**-Out2Mode	1: Digital	
P360-Out2Sel1	A71: Torque output		**P361**-Out2Sel2	A61: Speed	
P362-Out2 Test1	0: >		**P363**-Out2 Test2	3: ≤	
P364-D02 ValTst1	20.000 %		**P365**-D02 ValTst2	50.000 rpm	
P366-Out2Func	1: (A) Set (B) Reset		**P366a**-Out2Sel1	D0: Disable	
P366b-Out2Func	0: f(A,B) OR (C)		**P367**-Out2Logic	1: True	
P368-Out3Mode	1: Digital		**P369**-Out3Sel1	D2: Inverter Ok On	
P370-Out3Sel2	D2: Inverter Ok On		**P371**-Out3 Test1	0: >	
P372-Out3 Test2	0: >		**P373**-D03 ValTst1	0.000	
P374-D03 ValTst2	0.000		**P375**-Out3Func	0: (A) OR (B)	
P375a-Out3Sel1	D0: Disable		**P375b**-Out3Func	0: f(A,B) OR (C)	
P376-Out3Logic	1: True		**P377**-Out4Mode	1: Digital	
P378-Out4Sel1	D1: Inverter Run Ok		**P379**-Out4Sel2	D1: Inverter Run Ok	
P380-Out4 Test1	0: >		**P381**-Out4 Test2	0: >	
P382-D04 ValTst1	0.000		**P383**-D04 ValTst2	0.000	
P384-Out4Func	0: (A) OR (B)		**P384a**-Out4Sel1	D0: Disable	
P384b-Out4Func	0: f(A,B) OR (C)		**P385**-Out4Logic	1: True	
P39x Auxiliary Reference					
P390-XAIN4	3: 0-10V		**P391**-XAIN4MIN	0.0 V	
P391a-XAIN4MIN_%	100%		**P392**-XAIN4MAX	10.0 V	
P392a-XAIN4MAX_%	100%		**P393**-XAIN4OFFS	0.000 V	
P394-TauFilt XAIN4	100 ms		**P395**-XAIN5	2: 4-20mA	
P396-XAIN5MIN	4.0 mA		**P396a**-XAIN5MIN_%	100%	
P397-XAIN5MAX	20.0 mA		**P397a**-XAIN5MAX_%	100%	
P398-XAIN5OFFS	0.000 mA		**P399**-TauFilt XAIN5	100 ms	
P43x-P46x PID2 Parameters					
P436-PID2 Out Max	100.00 %		**P437**-PID2 Out Min	100.00 %	
P437a-Wake Up Mode	0: Disabled		**P437b**-Wake Up Level	0.00 %	
P438-Integ Max	100.00 %		**P439**-Der Max	100.00 %	
P440-PID2 Kp	1.000		**P441**-PID2 KpMult	0: 1	
P442-PID2 Ti(Tc)	500 Tc		**P443**-PID2 Td(Tc)	0 mTc	
P444-PID2 Tc	5 ms		**P445**-PID2 Ref Min	0.00 %	
P446-PID2 Ref Max	100.00 %		**P447**-PID2 Fdbk Min	0.00 %	
P448-PID2 Fdbk Max	100.00 %		**P449**-PID2 Tup	0.00 s	
P450-PID2 Tdn	0.00 s		**P451**-PID2 U.Mea.	1: 0.1 s	
P452-Rnd start	50 %		**P453**-Rnd stop	50 %	
P454-Thresh Int	0.0 %|Refmax|		**P455**-Disab Time	Disabled	
P456-Trate Lim	1 ms		**P457**-GainScale	1.000	
P460-GainAWUP	1.00				

PARAMETERS	Default Values	Custom Values	PARAMETERS	Default Values	Custom Values
C00x-C00x Carrier Freq					
C001-Minimun Carrier	[*]		C002-Maximum Carrier	[*]	
C003- Pulse Number	1: 24		C004-Silent Modulation	[*]	
C00x-C04x Motor Control M1					
C008-VmainsNom	[**]		C009-Mot.Numb.	1	
C010-Ctrl.Type M1	0: IFD		C011-RefMode M1	0: Speed	
C012-EncEnab M1	0: No		C013-v_f_mode1	[*]	
C014-Phase Rot. Mot1	0: No		C015-Fmot M1	50.0 Hz	
C016-n mot M1	1420 rpm		C017-Pnom M1	[*]	
C018-Inom M1	[*]		C019-Vnom M1	[**]	
C020-P0 M1	0.0 %		C021-i0 M1	0 %	
C022-Rstat M1	[*]		C023-Ld M1	[*]	
C024-Lm M1	250.00 mH		C025-TauRot M1	0 ms	
C026-vdcFiltM1	0ms		C028-nmin M1	0 rpm	
C029-nmax M1	1500 rpm		C030-spddeflux M1	90 %	
C031-nsa M1	Disabled		C032-red_Trq1	30.0 %	
C033-spd_redTrq1	20 %		C034-Preboost M1	[*]	
C034a-Boost ref.pos. M1	0.0 %		C034b-Boost ref.neg. M1	0.0 %	
C035-Boost0 M1	[*]		C036-Boost M1	[*]	
C037-FrqBst	[*]		C038-AutoBst	[*]	
C039-SlipComp. M1	Disabled		C040-DV_M1	Disabled	
C041-Tfl M1	[*]		C042-Vout Sat M1	85%	
C04x-C05x Limits M1					
C043-Iacclim M1	150%		C044-Irunlim M1	150%	
C045-Ideclim M1	[*]		C046-defilimRed M1	0: Disabled	
C047-Tmin M1	0.0 %		C048-Tmax M1	120%	
C049-Tlim Ramp M1	50ms		C050-fRedLimAcc M1	0: Enabled	
C05x-C08x Motor Control M2					
C053-Ctrl.Type M2	0: IFD		C054-RefMode M2	0: Speed	
C055-EncEnab M2	0: No		C056-v_f_mode2	[*]	
C057-Phase Rot. Mot2	0: No		C058-Fmot M2	50.0 Hz	
C059-n mot M2	1420 rpm		C060-Pnom M2	[*]	
C061-Inom M2	[*]		C062-Vnom M2	[**]	
C063-P0 M2	0.0 %		C064-i0 M2	0 %	
C065-Rstat M2	[*]		C066-Ld M2	[*]	
C067-Lm M2	250.00 mH		C068-TauRot M2	0 ms	
C069-vdcFiltM2	0ms		C071-nmin M2	0 rpm	
C072-nmax M2	1500 rpm		C073-spddeflux M2	90 %	
C074-nsa M2	Disabled		C075-red_Trq2	30.0 %	
C076-spd_redTrq2	20 %		C077-Preboost M2	[*]	
C077a-Boost ref.pos. M2	0.0 %		C077b-Boost ref.neg. M2	0.0 %	
C078-Boost0 M2	[*]		C079-Boost M2	[*]	
C080-FrqBst	[*]		C081-AutoBst	[*]	
C082-SlipComp. M2	Disabled		C083-DV_M2	Disabled	
C084-Tfl M2	[*]		C085-Vout Sat M2	85%	
C08x-C09x Limits M2					
C086-Iacclim M2	150%		C087-Irunlim M2	150%	
C088-Ideclim M2	[*]		C089-defilimRed M2	0: Disabled	
C090-Tmin M2	0.0 %		C091-Tmax M2	120%	
C092-Tlim Ramp M2	50ms		C093- fRedLimAcc M2	0: Enabled	

PARAMETERS		Default Values	Custom Values	PARAMETERS	Default Values
C09x-C12x Motor Control M3					
C096-Ctrl.Type M3	0: IFD		C097-RefMode M3	0: Speed	
C098-EncEnab M3	0: No		C099-v_f_mode3	[*]	
C100-Phase Rot. Mot3	0: No		C101-Fmot M3	50.0 Hz	
C102-n mot M3	1420 rpm		C103-Pnom M3	[*]	
C104-Inom M3	[*]		C105-Vnom M3	[**]	
C106-P0 M3	0.0 %		C107-i0 M3	0 %	
C108-Rstat M3	[*]		C109-Ld M3	[*]	
C110-Lm M3	250.00 mH		C111-TauRot M3	0 ms	
C112-vdcFiltM3	0ms		C114-nmin M3	0 rpm	
C115-nmax M3	1500 rpm		C116-spddeflux M3	90 %	
C117-nsa M3	Disabled		C118-red_Trq3	30.0 %	
C119-spd_redTrq3	20 %		C120-Preboost M3	[*]	
C120a-Boost ref.pos. M3	0.0 %		C120b-Boost ref.neg. M3	0.0 %	
C121-Boost0 M3	[*]		C122-Boost M3	[*]	
C123-FrqBst	[*]		C124-AutoBst	[*]	
C125-SlipComp. M3	Disabled		C126-DV_M3	Disabled	
C127-Tfl M3	[*]		C128-Vout Sat M3	85%	
C12x-C13x Limits M3					
C129-Iacclim M3	150%		C130-Irunlim M3	150%	
C131-Ideclim M3	[*]		C132-defilimRed M3	0: Disabled	
C133-Tmin M3	0.0 %		C134-Tmax M3	120%	
C135-Tlim Ramp M3	50ms		C136-fRedLimAcc M3	0: Enabled	
C14x Control Method					
C140-Sel Comm 1	1: Terminals		C141-Sel Comm 2	1: Terminals	
C142-Sel Comm 3	0: Disabled		C143-Sel InRef 1	1: REF	
C144-Sel InRef 2	2: AIN1		C145-Sel InRef 3	0: Disabled	
C146-Sel InRef 4	0: Disabled		C147-Sel T lim	0: Disabled	
C148-RemLoc_mode	0: StandBy + Fluxing				
C15x-C18x Digital Inputs					
			C149a-StartB	0: None	
C150-Stop	0: None		C150a-StopB	0: None	
C151-Rev	0: None		C151a-RevB	0: None	
C152-Enable S	0: None		C153-Disable	0: None	
C154-DisabReset	0: No		C155-Mltsp 0	4: MDI4	
C156-Mltsp 1	5: MDI5		C157-Mltsp 2	0: None	
C158-Mltsp 3	0: None		C159-Cw-CCw	8: MDI8	
C160-DCB	0: None		C161-Up	0: None	
C162-Down	0: None		C163-U/D Reset	0: None	
C164-ExtAlrm 1	0: None		C164a-ExtAlr1Delay	0 ms	
C165-ExtAlrm 2	0: None		C165a-ExtAlr2Delay	0 ms	
C166-ExtAlrm 3	0: None		C166a-ExtAlr3Delay	0 ms	
C167-MltRmp 0	0: None		C168-MltRmp 1	0: None	
C169-Jog	0: None		C170-Master/Slave	0: None	
C171-PID disab.	0: None		C171a-PID sel. control	0: Disabled	
C172-Keypad lock	0: None		C173-2nd Mot.	0: None	
C174-3rd Mot.	0: None		C175-PercSpd 0	0: None	
C176-PercSpd 1	0: None		C177-PercSpd 2	0: None	
C178-PIDud_res	0: None		C179-SourceSel	0: MDI6	
C180-Loc/Rem	0: MDI7		C180a-Loc/RemType	2: Pushbutton+Storage	
C181-Safe Start	0: Disabled		C182-MultiProg	0: Disabled	
C183-Tflux_dis	AlwaysON		C184-StartFlux	0: No	
C185-StartFrWheel	0: Dec. Ramp		C186-FireMode	0: None	
C187-DisabExtTlim	0: None		C188a-MrefPID 1	0: None	
C188b-MrefPID 2	0: None		C188c-MrefPID 3	0: None	
C18x-C19x Encoder/Frequency Input					
C189-UseEnc	0: A / B Unused		C190-pulsEncA	1024	
C191-pulsEncB	1024		C192-SpdAlrTime	5.00 s	
C193-SpdErr	300 rpm		C194-TrackAlrEn	1: Enable	
C195-tauFiltFdbk	5.0 ms		C196-tauFiltRef	5.0 ms	
C197-nCH ENCA	0:.2Ch. Quad		C198-nCH ENCB.	0: 2Ch. Quad	
C199-EncSign	0: Fdbk.NO Ref.NO				

PARAMETERS	Default Values	Custom Values	PARAMETERS	Default Values	PARAMETERS
C21x Braking Unit					
C210-Enab/Vel BrakeO	[*]		C211-BrakeTon	2.00 s	
C212-BrkDutyCycle	10 %				
C21x-C22x DC Braking					
C215-Enab dcb stop	0: No		C216-Enab dcb start	0: No	
C217-Tdcb stop	0.5 s		C218-Tdcb start	0.5 s	
C219-dcb speed	50 rpm		C220-I dcb	100 %	
C221-I dcb hold	0 %		C222-Tdefl M1	[*]	
C223-Tdefl M2	[*]		C224-Tdefl M3	[*]	
C22x-C23x Power Down					
C225-pwd type	3: Alarm		C226-Tpdd	10 ms	
C227-Tpddec	20 s		C228-Pddecboost	0.10 %	
C229-Pddcder	1		C230-Vpddel	[**]	
C231-Kpvdclc	0.050		C232-Kivdclc	0.500s	
C234-stopmode	0: Stop		C235-stoplev	0 rpm	
C24x Speed Searching					
C245-Enab SpdSch	0: No		C246-tssd	1 s	
C247-SpsRate	10 %		C248-Is	75 %	
C249-SpsSpd	0: Last Speed				
C25x AutoReset					
C255-nPulsRes	Disable		C256-T ResCyc	300 s	
C257-PowOnRes	0: No		C258-UvMlStore	0: No	
C26x-C27x Thermal Protection					
C264-FanTemp	50 °C		C265-ThermProt M1	0: No	
C266-ThermCurr M1	120 %		C267-ThermConstM1	360s	
C268-ThermProt M2	0: No		C269-ThermCurr M2	120 %	
C270-ThermConstM2	360s		C271-ThermProt M3	0: No	
C272-ThermCurr M3	120 %		C273-ThermConstM3	360s	
C274-PTC ThermProt	0:Disable				
C27x Maintenance					
C276-Set OP Time	0h		C276-Set SP Time	0h	
C28x-C29x PID Configuration					
C285-Sel InPID 1	2: AIN1		C286-Sel InPID 2	0: Disabled	
C287-Sel InPID 3	0: Disabled		C288-Sel Fdbk 1 PID	3: AIN2/PTC	
C289-Sel Fdbk 2 PID	0: Disable		C290-Sel Fdbk 3 PID	0: Disable	
C291-PID Mode	0: Disable		C291a-PID Control mode	0: Standard SUM	
C291b-PID Mode	0: Disable		C292-Der Mode	0: Measure	
C293-PID Struct	0: No		C294-PID Act	1: Reference	
C30x Crane					
C300-StartTrq ref.pos.	0.0 %		C301-t_StartTrq ref.pos.	0 ms	
C300a-StartTrq ref.neg.	0.0 %		C301a-t_StartTrq ref.neg.	0 ms	
C302-Brk_On	0: None				
PARAMETERS	Default Values	Custom Values	PARAMETERS	Default Values	Custom Values

R00x-R01x Serial Link			
R001-com_slaveaddr 1		R002-com_answdelay 5 ms	
R003-sc0_baudrate 38400 bps		R004-com_4time_delay 2 ms	
R005-ser_wdg_time 0.0 s		R006-parity sc0 1: No , 2 Stop Bit	
R008-cm1_slaveaddr 1		R009-cm1_answdelay 5 ms	
R010-sc1_baudrate 38400 bps		R011-cm1_4time_delay 2 ms	
R012-sr1_wdg_time 0.0 s		R013-parity sc1 1: No , 2 Stop Bit	
R01x Fieldbus Configuration			
R016-fbs_wdg_time 0 ms		R017a-AO1_fb_sel 0: No	
R017b-AO2_fb_sel 0: No		R017c-AO3_fb_sel 0: No	
R02x Expansion Board Settings			
R021-Data Logger Setting 1: NO		R023- I/O Board setting 0:None	
R02x-R04x PROFIdrive Settings			
R025-SlaveAddr 1		R026-PZD3_O_Addr 1: Digital Inputs	
R027-PZD4_O_Addr 0: not used		R028-PZD5_O_Addr 0: not used	
R029-PZD6_O_Addr 0: not used		R030-PZD7_O_Addr 0: not used	
R031-PZD8_O_Addr 0: not used		R032-PZD9_O_Addr 0: not used	
R033-PZD10_O_Addr 0: not used		R034-PZD3_I_Addr 0: not used	
R035-PZD4_I_Addr 0: not used		R036-PZD5_I_Addr 0: not used	
R037-PZD6_I_Addr 0: not used		R038-PZD7_I_Addr 0: not used	
R039-PZD8_I_Addr 0: not used		R040-PZD9_I_Addr 0: not used	
R041-PZD3_I_Addr 0: not used		R044-DP com.mode 0: DP V0	
R045-DP sel. 1: VENDOR SPECIFIC 1			

Key:
[*] Parameter depending on the current size.
[**] Parameter depending on the voltage class.

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