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SINUS PENTA

MULTIFUNCTION AC DRIVE

PROGRAMMING GUIDE

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SANTERNO

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0.4.1 OVERVIEW

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

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

1) Display/keypad unit;
2) Serial link through standard port RS485 or optional board ES836.

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

Any information sent to/from the inverter through 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, table compiler including operation data log, parameter setup and data reception-transmission-storage from and to a computer, scan function for the automatic detection of the connected inverters (up to 247 inverters 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 inverter interfacing.

0.4.2 MENUS AND SUBMENUS

This User Manual (Programming Instructions) is divided into several 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:

1) Measure Mxxx (always Read Only):

<table>
<tr><td>Mxxx</td><td>Range</td><td>Inverter representation
(integer)</td><td>Display on the display/keypad and the RemoteDrive
(may be a decimal figure)
plus unit of measure</td></tr>
<tr><td rowspan="3">Measure Name</td><td>Active</td><td colspan="2">Type of control (IFD / VTC / FOC / SYN / REG) the measure is related to</td></tr>
<tr><td>Address</td><td colspan="2">ModBus address which the measure can be read from
(integer)</td></tr>
<tr><td>Function</td><td colspan="2">Measure description</td></tr>
</table>

2) Parameters Pxxx (always R/W):

<table>
<tr><td>Pxxx</td><td>Range</td><td>Inverter representation
(integer)</td><td>Display on the display/keypad and the RemoteDrive
(may be a decimal figure)
plus unit of measure</td></tr>
<tr><td rowspan="4">Parameter Name</td><td>Default</td><td>Factory-setting of the parameter
(as represented for the inverter)</td><td>Factory-setting of the parameter
(as displayed)
plus unit of measure</td></tr>
<tr><td>Level</td><td colspan="2">Access level (BASIC / ADVANCED / ENGINEERING)</td></tr>
<tr><td>Address</td><td colspan="2">ModBus address which the parameter can be read from
(integer)</td></tr>
<tr><td>Function</td><td colspan="2">Parameter description</td></tr>
</table>

3) Parameters Cxxx (Read Only with inverter in Run; R/W with inverter in Stand-by):

<table>
<tr><td>Cxxx</td><td>Range</td><td>Inverter representation
(integer)</td><td>Display on the display/keypad and the RemoteDrive
(may be a decimal figure)
plus unit of measure</td></tr>
<tr><td rowspan="4">Parameter Name</td><td>Default</td><td>Factory-setting of the parameter
(as represented for the inverter)</td><td>Factory-setting of the parameter
(as displayed)
plus unit of measure</td></tr>
<tr><td>Level</td><td colspan="2">Access Level (BASIC / ADVANCED / ENGINEERING)</td></tr>
<tr><td>Address</td><td colspan="2">ModBus address which the parameter can be read from or which the parameter can be written to
(integer)</td></tr>
<tr><td>Function</td><td colspan="2">Parameter description</td></tr>
</table>

4) Parameters Rxxx (Read Only with inverter in Run; R/W with inverter in Stand-by). **Unlike parameters Cxxx, parameters Rxxx become active only at the inverter power on.**

<table>
<tr><td>Pxxx</td><td>Range</td><td>Inverter representation
(integer)</td><td>Display on the display/keypad and the RemoteDrive
(may be a decimal figure)
plus unit of measure</td></tr>
<tr><td rowspan="4">Parameter Name</td><td>Default</td><td>Factory-setting of the parameter
(as represented for the inverter)</td><td>Factory-setting of the parameter
(as displayed)
plus unit of measure</td></tr>
<tr><td>Level</td><td colspan="2">Access Level (BASIC / ADVANCED / ENGINEERING)</td></tr>
<tr><td>Address</td><td colspan="2">ModBus address which the parameter can be read from or which the parameter can be written to
(integer)</td></tr>
<tr><td>Function</td><td colspan="2">Parameter description</td></tr>
</table>

5) Inputs Ixxx. The values assigned to these inputs are not stored to non-volatile memory. Their value is always 0 when the inverter is powered on.

<table>
<tr><td>Ixxx</td><td>Range</td><td>Inverter representation
(integer)</td><td>Display on the display/keypad and the RemoteDrive
(may be a decimal figure)
plus unit of measure</td></tr>
<tr><td rowspan="3">Input Name</td><td>Level</td><td colspan="2">Access level (BASIC / ADVANCED / ENGINEERING)</td></tr>
<tr><td>Address</td><td colspan="2">ModBus address which the input can be read from or which the input can be written to
(integer)</td></tr>
<tr><td>Function</td><td colspan="2">Input description</td></tr>
</table>

NOTE

When a parameter is modified from 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 you modify a parameter using RemoteDrive, the inverter will immediately use the new parameter value.

0.4.3 ALARMS AND WARNINGS

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

Axxx	Description	
Alarm Name	Event	
	Possible cause	
	Solution	

1 MEASURE MENU

1.1 Description

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

- Product ID

This screen contains the size and voltage class of the inverter, the type of control that has been selected and the software version of microcontrollers Texas and Motorola.

- Operation Time

This screen contains the software version of the display/keypad and the values of the Supply Time (ST) and Operation Time (OT) of the inverter.

- Menu n.1 – Torque Speed

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 inverter 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.

- Menu n.2 – PID Regulator

This menu contains the values relating to the inverter PID regulator.

- Menu n.3 – Inverter Measures

This menu contains the electric values measured by the inverter (output, mains side, DC bus side).

- Menu n.4 – Digital Inputs

This menu contains the state of the inverter digital inputs.

- Men n.5 – Local References

This menu contains the values of the analog references, the encoder input and the frequency input.

- Menu n.6 – Remote References

This menu contains the speed/torque or reference/feedback values of the PID coming from serial link or field bus.

- Menu n.7 – Outputs

This menu contains the state of the inverter digital outputs, analog outputs and frequency outputs.

- Menu n.8 – Autodiagnostics

This menu contains temperature values, mains voltage values required for Sinus Penta's operation as a regenerative device, and the inverter state.

- Menu n.9 – Preset Inputs

This menu indicates the functions programmed for the inverter digital inputs.

- Menu n.10 – Trip Log

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.

- Menu n.11 –PowerOff Log

This menu contains the value of some measures being used at the inverter power off. It also indicates the alarm tripped (if any).

1.2 Product ID

		P	E	N	T	A	_	4	T	0	0	2	0		
I	F	D		V	o	l	t	/	F	r	e	q	.		
S	w	_	V	E	r	_	T	e	X		1	.	3	0	0
S	w	_	V	E	r	_	M	o	T		1	.	3	0	9

The first line of the display/keypad states the name, the voltage class and the size of the inverter. In the example above, the inverter voltage class is 4T (400V) and the inverter size is 020.

The second line shows the control algorithm used for the selected motor. In the example above, the algorithm controlling the selected motor is IFD (V/f).

The third line shows the software version of DSP Texas. The last line shows the software version of microprocessor Motorola.

1.3 Operation Time

					M	E	A	S	U	R	E				
S	w	_	V	e	r	_	M	m	I		1	.	3	0	2
S	T		=					5	3	:	2	5	:	0	1
O	T		=					2	9	:	3	5	:	5	1

The second line shows the version of the display table in the display/keypad.

The third and fourth lines show ST and OT (supply time and operation time of the inverter, expressed in hours, minutes and seconds. The operation time is the time period when IGBTs are on.)

1.4 Menu n.1 – Torque Speed

Measures of the Torque Speed submenu [M000 ÷ M017]

This submenu contains speed values, torque values, flux reference values.

1.4.1 M000–1 Speed Reference at Constant Rpm

M000	Range	± 32000	± 32000 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	
	Function	Value of the speed reference obtained when the motor rotates at constant speed, once the preset ramp time is over.	

NOTE

In parameter M000, a speed value with two decimal figures is displayed, because it includes two separate reference values for M000 (integer) and M001 (decimal portion).

M001	Range	± 99	± 0.99 rpm
	Active	Active only when a speed reference is used for the selected motor, and other than zero only when FOC control is selected.	
	Address	1651	
	Function	Decimal portion of the speed reference value obtained when the motor rotates at constant speed.	

1.4.2 M002-3 Speed Ramp Output

M002	Range	± 32000	± 32000 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	
	Function	This is the measure of the speed value processed with respect to the ramp time.	

NOTE

In parameter M002, a speed value with two decimal figures is displayed, because it includes two separate reference values for M002 (integer) and M003 (decimal portion).

M003	Range	± 99	± 0.99 rpm
	Active	Active only when a speed reference is used for the selected motor, and other than zero only when FOC control is selected.	
	Address	1653	
	Function	This is the decimal portion of the speed reference measure processed with respect to the ramp time.	

1.4.3 M004–5 Motor Speed

M004	Range	± 32000	± 32000 rpm
	Active	Always active.	
	Address	1654	
	Function	Motor speed value.	

NOTE

In parameter M004, a speed value with two decimal figures is displayed, because it includes two separate reference values for M004 (integer) and M005 (decimal portion).

M005	Range	± 99	± 0.99 rpm
	Active	Other than zero only when FOC control is selected.	
	Address	1655	
	Function	This is the decimal portion of the motor speed measure.	

1.4.4 M006 Inverter Output Frequency

M006	Range	± 10000	± 1000.0 Hz
	Active	Always active.	
	Address	1656	
	Function	This is the measure of the voltage frequency output of the inverter.	

1.4.5 M007 Torque Reference at Constant Rpm

M007	Range	± 32000	± 32000 Nm Note: The actual range depends on the rated torque and the limit torque 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 when the motor rotates at constant speed.	

1.4.6 M008 Torque Demand

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.	

1.4.7 M009 Motor Torque

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.	

1.4.8 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.	

1.4.9 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.	

1.4.10 M012 Motor Torque (%)

M012	Range	± 32000	± 32000 Nm
	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.	

1.4.11 M013 Torque Limit Reference at Constant Rpm

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 inverter, this value is the actual torque limit expressed in Nm.	

1.4.12 M014 Torque Limit Value Being Used

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.	

1.4.13 M015 Torque Limit Reference at Constant RPM (%)

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 inverter, this value is the actual torque limit.	

1.4.14 M016 Torque Limit Value (%) Being Used

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.	

1.4.15 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 Wb.	

1.5 Menu n.2 – PID Regulator

Measures of the PID Regulator submenu [M018 ÷ M025]

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

1.5.1 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 the following parameters: P245–P246
	Active	Always active.	
	Address	1668	
	Function	This is the measure of the PID reference expressed as a value percent. Please refer to the PID Parameters and PID Configuration Menus for the scaling of the PID input.	

1.5.2 M019 Reference of the PID Being Used

M019	Range	±10000	±100.00 % Note: The actual range depends on the max. value and the min. value of the PID reference set in the following parameters: P245–P246
	Active	Always active.	
	Address	1669	
	Function	This is the measure of the PID reference expressed as a value percent. Please refer to the PID Parameters and PID Configuration Menus for the scaling of the PID input.	

1.5.3 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 the following parameters: P247–P248
	Active	Always active.	
	Address	1670	
	Function	This is the measure of the PID feedback expressed as a value percent. Please refer to the PID Parameters and PID Configuration Menus for the feedback scaling of the PID input.	

1.5.4 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 the following parameters: P245–P246 (reference) P247–P248 (feedback)
	Active	Always active.	
	Address	1671	
	Function	This is the measure of the PID input error expressed as a value percent. See also **PID Parameters and PID Configuration Menus.**	

1.5.5 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 the following 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 value percent. Please refer to the **PID Parameters and PID Configuration Menus** for the scaling of the PID output.	

1.5.6 M023 PID Reference Being Used

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 being used for the PID regulator, as M019 but multiplied by the gain level set in P257 (see also **PID Parameters and PID Configuration Menus).** For the display/keypad, the unit of measure can be programmed in the Code parameter in the **Display Menu.**	

1.5.7 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 on.	
	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 PID Parameters and PID Configuration Menus). For the display/keypad, the unit of measure can be programmed in the Code parameter in the Display Menu.	

1.5.8 M025 PID OUTPUT

M025	Range	±32000	Note: The actual range depends on the max. value and the min. value of the PID output set in parameters P236–P237, and on the gain level set in P257.
	Active	Always on.	
	Address	1675	
	Function	This is the measure of the PID regulator output, as M022 but multiplied by the gain level set in P257 (see also PID Parameters and PID Configuration Menus). For the display/keypad, the unit of measure can be programmed in the Code parameter in the Display Menu.	

1.6 Menu n.3 – Inverter Measures

Measures of the Inverter Measure submenu [M026 ÷ M030]

This submenu contains the electric values detected by the inverter (output, mains side, DC bus side).

1.6.1 M026 Output Current

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

1.6.2 M027 Output Voltage

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

1.6.3 M028 Output Power

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

1.6.4 M029 DC-Bus Voltage

M029	Range	0÷1000	0÷1000 V
	Active	Always active.	
	Address	1679	
	Function	Measure of the voltage in the inverter DC-link.	

1.6.5 M030 Supply Voltage

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

1.7 Menu n.4 – Digital Inputs

Measures of the Digital Inputs submenu [M031 ÷ M035]

In this submenu you can check the state of the command sources for the digital inputs (local terminals, serial link and field bus), the terminal board resulting from their combination and the terminals which are actually used for the inverter control. The terminals which are actually used to control the inverter also consider any timers applied to the digital inputs.

1.7.1 M031 Delayed Digital inputs

M031	Range	Bit-controlled measure	*See codification.
	Active	Always active.	
	Address	1681	
	Function	State of the virtual control terminal board used by the inverter. This is the terminal board resulting from the combination of the preset command sources (local terminal board, serial link and DC bus), where the Enable command is given by the AND of all the Enable commands; for the other inputs, the OR between the different command sources is applicable. See also Control Method and Timers Menus.	

Table 1: Codification of Measure M031.

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

1.7.2 M032 Instant Digital Inputs

M032	Range	Bit-controlled measure	*See codification.
	Active	Always active.	
	Address	1682	
	Function	State of the virtual control terminal board after application of 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 DC bus), where the Enable command is given by the AND of all the Enable commands; for the other inputs, the OR between the different command sources is applicable. See also Control Method Menu.	

Table 2: Codification of Measure M032.

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

1.7.3 M033 Local Control Terminal Board

M033	Range	Bit-controlled measure	*See codification.
	Active	Always active.	
	Address	1683	
	Function	State of the digital inputs in the inverter terminal board.	

Table 3: Codification of Measure M033.

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

1.7.4 M034 Control Terminals from Serial Link

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

Table 4: Codification of Measure M034.

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

1.7.5 M035 Control Terminal Board from Field Bus

M035	Range	Bit-controlled measure	*See codification.
	Active	Always active.	
	Address	1685	
	Function	State of the digital inputs in the terminal board controlled from field bus.	

Table 5: Codification of Measure M035.

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

1.8 Menu n.5 – Local References

Measures of the Local References submenu {[M037 ÷ M039] ; [M050 ÷ M051] }

This submenu contains the measures of the possible reference sources available in the terminal board (analog inputs, frequency inputs and encoder input).

1.8.1 M037 Analog Reference REF

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 inverter in analog input REF.	

1.8.2 M038 Analog Reference AIN1

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 inverter in analog input AIN1.	

1.8.3 M039 Analog Reference AIN2

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 inverter in analog input AIN2.	

1.8.4 M050 Encoder Reference

M050	Range	± 32000	± 32000 rpm.
	Active	Always active.	
	Address	1700	
	Function	Reading of the encoder set as a reference source (see Encoder/Frequency Input and Control Method Menus).	

1.8.5 M051 Frequency 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 read in the digital input set as a reference source (see Encoder/Frequency Input and Control Method Menus).	

1.9 Menu n.6 – Remote References

Measures of the Remote References submenu [M040 ÷ M049]

This submenu contains the measures (via serial link or field bus) of the speed references or the torque references, or of the PID reference and the PID feedback.

1.9.1 M040–1 Speed Reference from Serial Link

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

NOTE

In parameter M040, a speed value with two decimal figures is displayed, because it includes two separate reference values for M040 (integer) and M041 (decimal portion).

M041	Range	± 99	± 0.99 rpm
	Active	Other than zero only if FOC control is selected.	
	Address	1691	
	Function	This is the decimal portion of the speed reference set via serial link.	

1.9.2 M042–3 Speed Reference from Field Bus

M042	Range	± 32000	± 32000 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 C072–C073 Motor 2 C114–C115 Motor 3
	Active	Always active.	
	Address	1692	
	Function	This is the measure of the speed reference set by the field bus.	

NOTE

In parameter M042, a speed value with two decimal figures is displayed, because it includes two separate reference values for M042 (integer) and M043 (decimal portion).

M043	Range	± 99	± 0.99 rpm
	Active	Other than zero only if FOC control is selected.	
	Address	1693	
	Function	This is the decimal portion of the speed reference set by the field bus.	

1.9.3 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.	

1.9.4 M045 Torque Reference from Field Bus

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 field bus and expressed as a percentage of the rated torque of the selected motor.	

1.9.5 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 value percent.	

1.9.6 M047 PID Reference from Field Bus

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 field bus and expressed as a value percent.	

1.9.7 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 value percent.	

1.9.8 M049 PID Feedback from Field Bus

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 via field bus and expressed as a value percent.	

1.10 Menu n.7 – Outputs

Measures of the Outputs submenu [M056 ÷ M060]

In this submenu you can check the state of the digital inputs, the analog inputs and the frequency inputs available in the terminal board.

1.10.1 M056 Digital Outputs

M056	Range	Bit-controlled measure	*See codification.
	Active	Always active.	
	Address	1706	
	Function	State of digital inputs MDO1÷4.	

Table 6: Codification of Measure M056

Bit n.	Digital Output
0	MDO1/FOUT
1	MDO2
2	MDO3
3	MDO4

1.10.2 M057 Frequency Output

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

1.10.3 M058 Analog Output AO1

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 References Menu).	

1.10.4 M059 Analog Output AO2

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

1.10.5 M060 Analog Output AO3

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

1.11 Menu n.8 – Autodiagnostics

Measures of the Autodiagnostics submenu [M061 ÷ M090]

In this submenu you can check the reading of the analog channels used for temperature sensors and the relevant temperature values.

1.11.1 M061 A/D Converter Voltage, Ambient Temperature Measurement

M061	Range	0 ÷ 3300	0 ÷ 3.30 V
	Active	Always active.	
	Address	1711	
	Function	Voltage detected by A/D converter for ambient temperature measurement.	

1.11.2 M062 Ambient Temperature Measurement

M062	Range	± 32000	± 320.0 °C
	Active	Always active.	
	Address	1711	
	Function	Ambient temperature measured on the surface of the control board.	

1.11.3 M063 A/D Converter Voltage, IGBT Temperature Measurement

M063	Range	0 ÷ 3300	0 ÷ 3.30 V
	Active	Always active.	
	Address	1713	
	Function	Voltage measured on A/D converter used to measure IGBT temperature. Note: Not all inverter sizes are provided with this sensor.	

1.11.4 M064 IGBT Temperature Measurement

M064	Range	± 32000	± 320.0 °C
	Active	Always active.	
	Address	1714	
	Function	Measure of the temperature in IGBTs. Note: Not all inverter sizes are provided with this sensor.	

1.11.5 M089 Inverter State

M089	Range	See codification	See codification
	Active	Always active.	
	Address	1739	
	Function	Describes the current condition of the inverter.	

Table 7: Codification of the Inverter State

Value	Codification	Description
0	Alarm !!!	An alarm tripped (inverter in emergency condition)
1	Starting Up	The inverter is starting up.
2	Mains Loss	Mains loss condition detected.
3	Tuning	Tuning.
4	Speed Search	Motor speed searching.
5	DCB at Start	DC braking at start.
6	DCB at Stop	DC braking at stop.
7	DCB Thermoswitch	DCB for anticondensation.
8	Manual DCB	Braking from Manual command.
9	Limit. While Acc.	Torque/Current limit while accelerating.
10	Limit. While Dec.	Torque/Current limit while decelerating.
11	Limit. at Constant Rpm	Torque/Current limit at constant Rpm.
12	Braking	Enabling external braking resistor command.
13	Run at Constant Rpm	Constant Rpm attained.
14	Accelerating	Motor is accelerating.
15	Decelerating	Motor is decelerating.
16	Inverter OK	Inverter in Stand–by (no alarm tripped).
17	Fluxing	Motor ramp fluxing (VTC and FOC).
18	Fluxed Motor	Fluxing motor waiting for Start command (VTC and FOC only).
27	Waiting NO Enable	Waiting for Enable command disabling.
28	Waiting NO Run	Waiting for Start command disabling.
29	Min. PID Out Disab.	Inverter disabling due to PID output dropped below preset value.
30	Min. Ref. Disab.	Inverter disabling due to speed reference dropped below preset value.
31	IFD Ref Waiting	IFD control waiting for speed reference.
32	IFD Start Waiting	IFD control waiting for Start command.
33	Disable NO RUN	With fluxed motor, no Run command was sent within the time period set in C183.

1.11.6 M090 Active Alarm

M090			
	Range	See Alarm Menu	See Alarm Menu
	Active	Always active	
	Address	1740	
	Function	Alarm tripped.	

1.11.7 Hardware Status

Hardware Status			
	Range	See codification	See codification
	Active	Always active.	
	Address	1523	
	Function	Status of the inverter hardware.	

Significant bits (bits 15–8) — Non-significant bits (bits 7–0)

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
Fault3		Fault2		Fault1		Fault0									

Table 8: Codification of the Inverter Hardware Status.

Fault n.	Type of Fault	Description of each bit (1 = True; 0 = False)
0	IGBT Power Converter Fault	Bit 8: Indication of fault signal rising edge
		Bit 9: Current state of the fault signal
1	Hardware OverCurrent (OC) Function	Bit 10: Indication of fault signal rising edge
		Bit 11: Current state of the fault signal
2	Fan Fault	Bit 12: Indication of fault signal rising edge
		Bit 13: Current state of the fault signal
3	PWMENA; return of IGBT drive command.	Bit 14: Command returned.
		Bit 15: Current state of IGBT command return.

1.12 Menu n.9 – Preset Inputs

In this submenu you can check the functions assigned to the digital inputs.

Table 9: Codification of the Functions Assigned to the Digital Inputs.

Display Items	Function Assigned to the Digital Inputs
STOP	Stop function
REV	Startup with negative speed
EN –S	Enable in safety condition
DIS	Inverter disabling
MVel0	Multispeed 0
MVel1	Multispeed 1
MVel2	Multispeed 2
MVel3	Multispeed 3
CwCCw	Reversal of the direction of rotation
DCB	DC Braking
UP	Reference increase
DOWN	Reference decrease
UDRes	Reset of speed setpoint due to UP/DOWN command
Alr1	Auxiliary trip 1
Alr2	Auxiliary trip 2
Alr3	Auxiliary trip 3
MRmp0	Multiramp 0
MRmp1	Multiramp 1
JOG	Jog mode
SLAVE	Selection of Slave Mode
PIDDs	PID Disabling
KpdLk	Display/keypad unit
Mot2	Selection of Motor 2
Mot3	Selection of Motor 3
Var0	Reference Variation 0
Var1	Reference Variation 1
Var2	Reference Variation 2
PdUDR	PID Reference Reset due to UP/DOWN commands
LOCAL	Selection of Local mode
START	Start function
ENA	Enable
RESET	Alarm reset
EncA	Encoder A Input
EncB	Encoder B Input
FinA	Frequency input FINA
FinB	Frequency input FINB
OVER!	Incompatibility between input settings

1.13 Menu n.10 – Trip Log

This submenu contains the trip log of the last eight alarms stored by the inverter. It also includes the values of some characteristic variables detected exactly when each alarm tripped.

Scroll the Trip Log Menu to display the codes of the last eight alarms tripped.

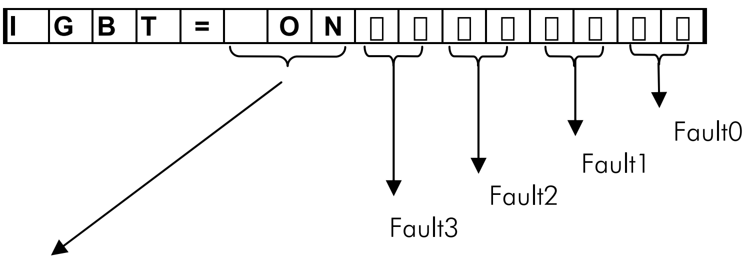
Press the PROG key to access the alarm submenu and navigate to each value measured by the inverter when the alarm tripped.

The next page shows a navigation example for the Trip Log Menu (relating to alarm A1 in particular). Note that A1 is the last alarm tripped and A8 is the first alarm tripped.

The measures marked with Mxxx are the same measures used in this section.

The following measures are not identified by their code:

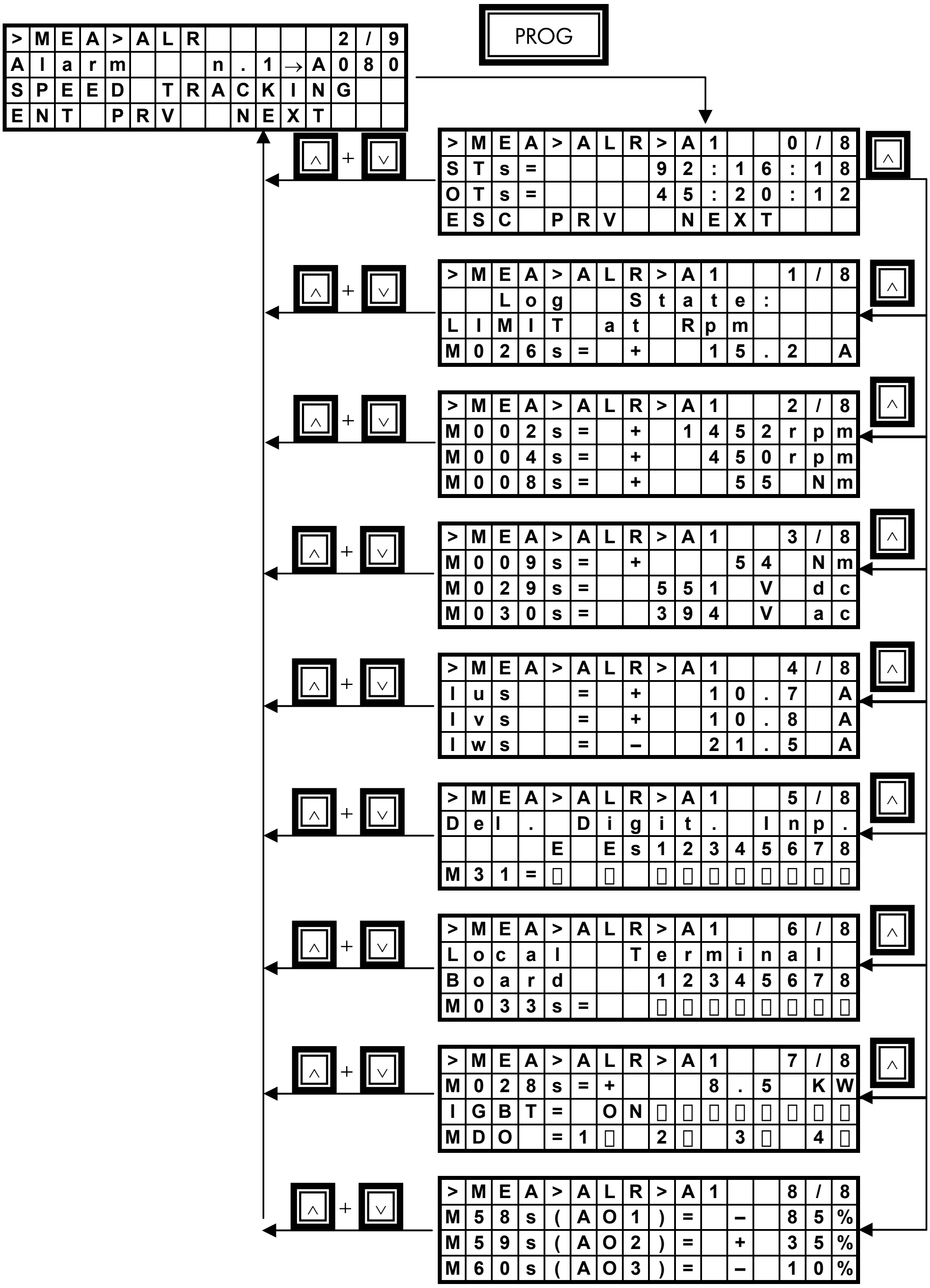
Ius = current value for phase U,
Ivs = current value for phase V ,
Iws = current value for phase W,
IGBT is as follows:



IGBT state when an alarm trips.

For the description of each fault, please refer to Hardware Status in the Autodiagnostics Menu.
When an alarm trips, the state of IGBTs may be one of the following:
ON: IGBTs were on.
OFF: IGBTs were off.
ALR: IGBTs were in alarm mode.

Navigation Example – Trip Log Menu



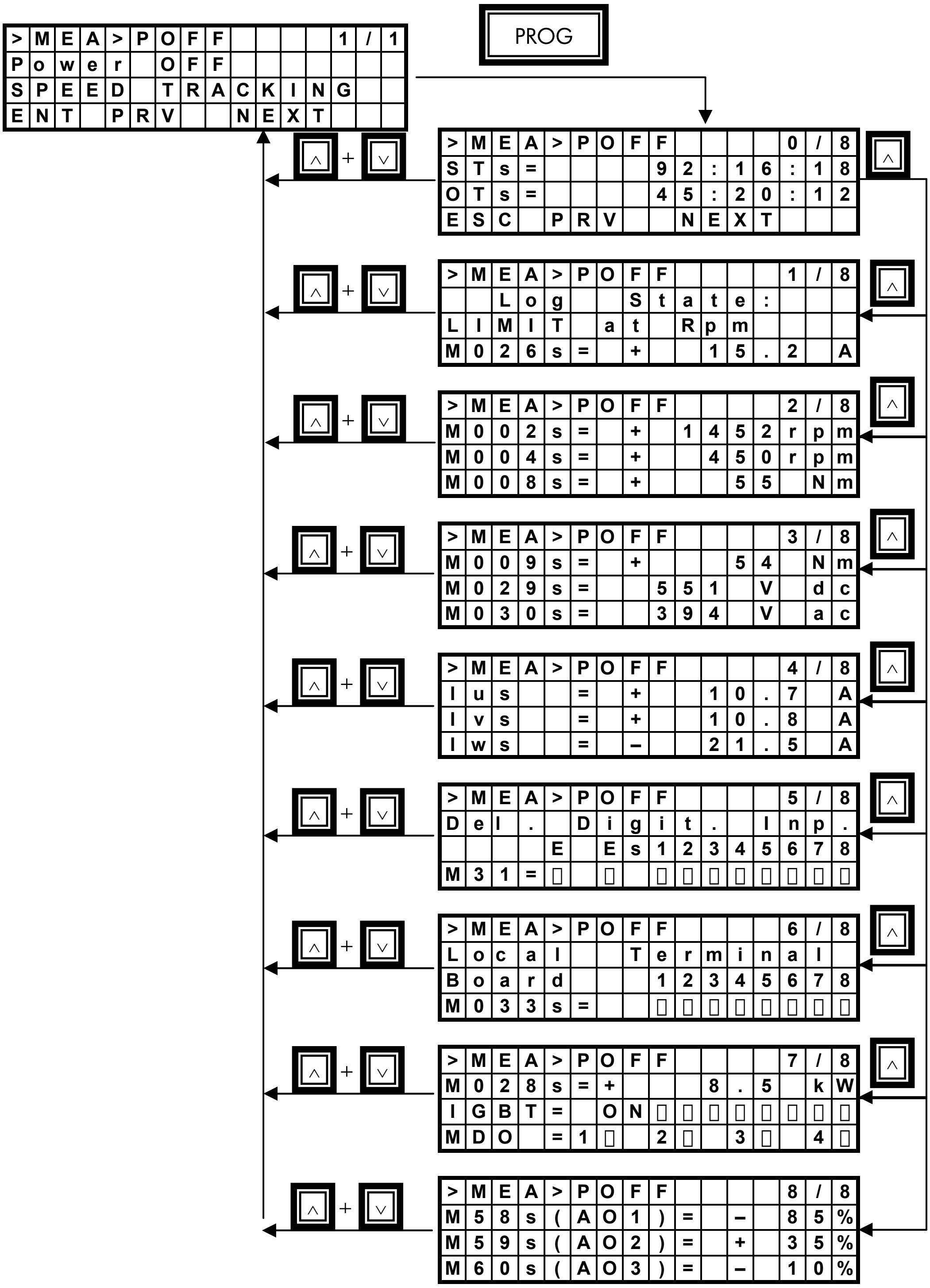
1.14 Menu n.11 – PowerOff Log

This submenu contains the measures of some characteristic variables detected at the inverter power off, in conjunction with the alarm (if any) tripped at that moment.

Press PROG to access the submenu and navigate to the measures detected by the inverter when it came off. Measures and codes are the same as the ones shown in the Trip Log Menu (see Trip Log Menu).

The next page shows a navigation example for the PowerOff Log Menu.

Navigation Example – PowerOff Log Menu



2 RAMPS MENU

2.1 Overview

An acceleration/deceleration ramp is a function allowing a linear variation 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; using other two parameters, you can set the start rounding off and the end rounding off for the deceleration ramps. A fifth parameter allows to select the ramps for the preset rounding off.

2.1.1 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 unit of measure, in order to increase the programmable time range.

P009 Ramp Up Time 1
P010 Ramp Down Time 1
P011 Unit of Measure for Ramp Time 1

P012 Ramp Up Time 2
P013 Ramp Down Time 2
P014 Unit of Measure for Ramp Time 2

P015 Ramp Up Time 3
P016 Ramp Down Time 3
P017 Unit of Measure for Ramp Time 3

P018 Ramp Up Time 4
P019 Ramp Down Time 4
P020 Unit of Measure for Ramp Time 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 the first motor, and so on). The time unit of measure may have the following values:

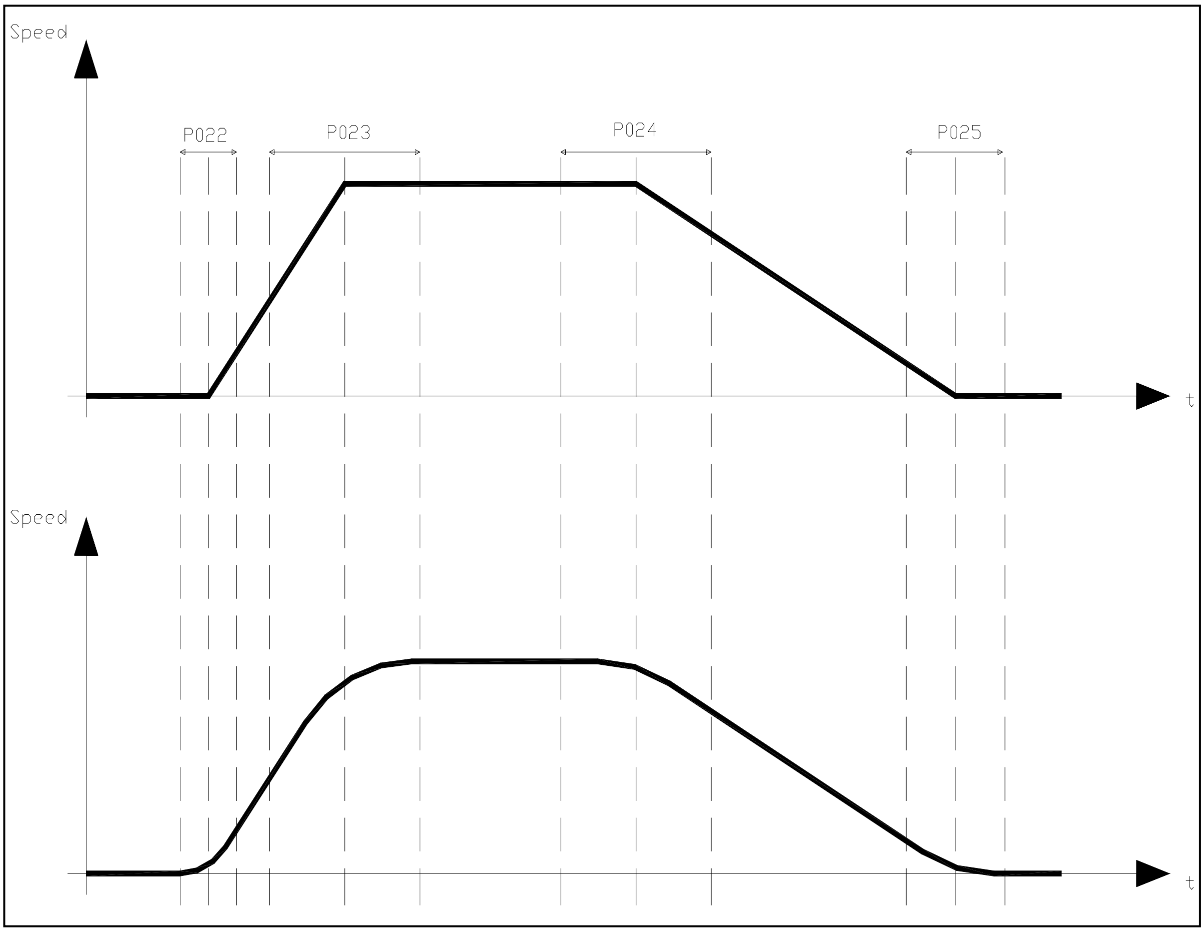
0–> 10 ms
1–> 100 ms
2–> 1000 ms
3–> 10000 ms

The programmable range may be 0s – 327000s.

Example of a speed ramp:

Table 10: Example of a Speed Ramp

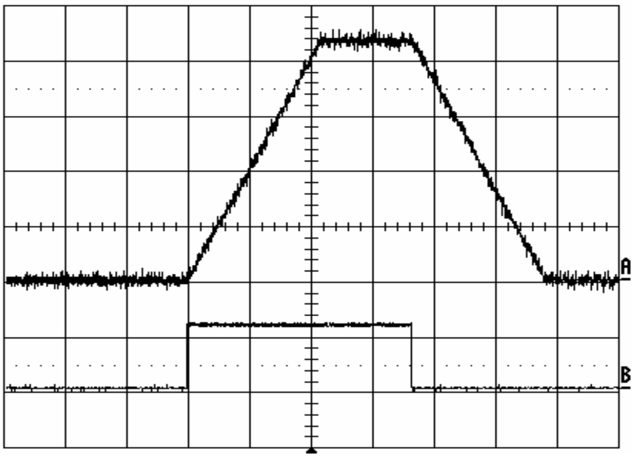
P011		Range P009 – P010	
Value	Codification	Min.	Max.
0	10ms	0	327.00 s
1	100ms	0	3270.0 s
2	1000ms	0	32700 s
3	10000ms	0	327000 s



The factory-setting for the unit of measure is 100ms; the ramp time is 10 sec.
You can also select the rounding off and the rounding off percentage for the starting ramp up and the starting ramp down, and for the end ramp up and the end ramp down. The ramp rounding off allows to reach the reference end value with a null 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 to increase 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 = 1111binary (rounding off selected for all four ramps) ; P022 = 50% ; P023 = 50%
The ramp up time is:
P009 + ((P009* (P022+P023)/2)/100) = 10 + ((10* (50+50)/2)/100) = 15 sec

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



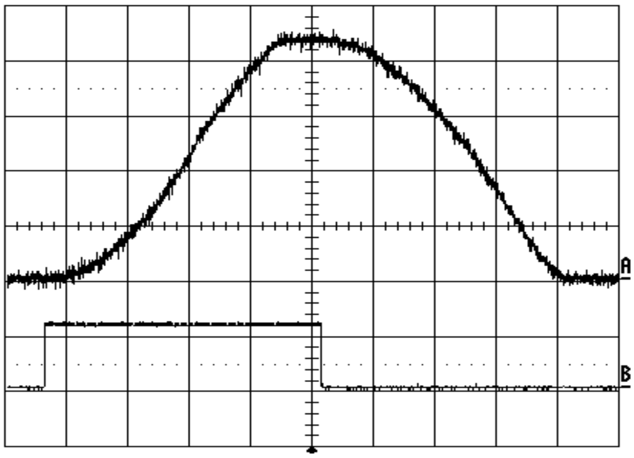


Fig.2 Fig.3

Figures 2 and 3 show the speed reference trends for an acceleration ramp (ramp up) of 5 seconds from the time when the inverter stops (high level of the second signal) up to constant rpm with different rounding off configurations. Rounding off is suppressed in Figure 2; in Figure 3, start/end ramp up rounding off values (P022 and P023 respectively) are equal to 50% and to 30%, whereas start/end ramp down rounding off values (P024 and P025 respectively) are equal to 50% and 30%. Note that the time the reference takes to reach constant rpm depends on the ramp times but also on the rounding off values you have defined.

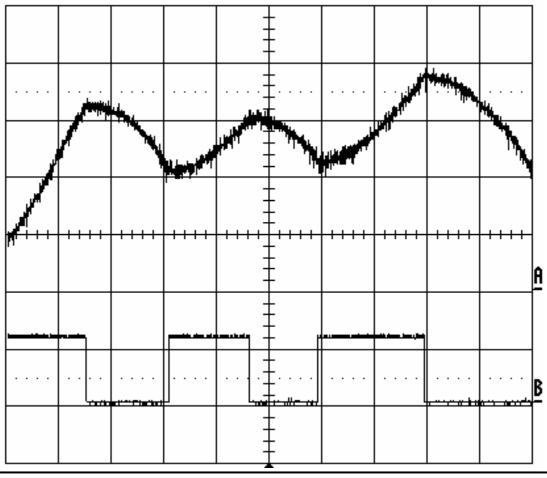
Acceleration RESET function.

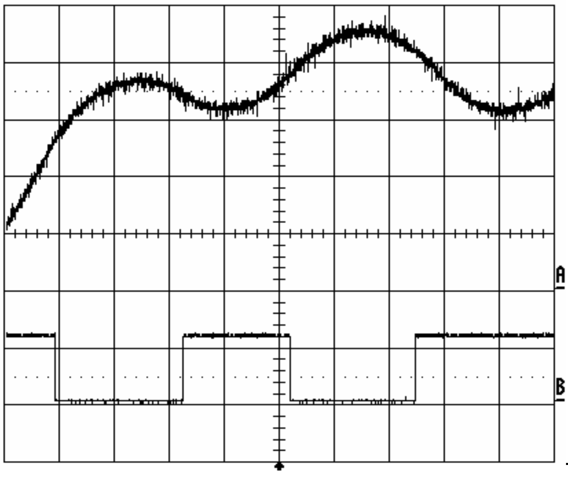
This parameter has effect only if rounded off ramps are used. Parameter P031 enables to reset acceleration when reference trends change.

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 Fig.4). The figure shows the instant when deceleration begins; the rounding off value assigned to the speed reference when the trend 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 curve (see Figure 5).

Fig. 4 and Fig. 5 *Trends of the speed reference when shifting from the acceleration stage to the deceleration stage if P031 (Gradient Variation Acceleration Reset) is set to [Yes] and [No] respectively.*





2.1.2 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).

2.2 Parameter List

Table 11: List of Parameters P009 ÷ P031

Parameter	FUNCTION	Access Level	MODBUS Address
P009	Speed ramp 1: acceleration time	BASIC	609
P010	Speed ramp 1: deceleration time	BASIC	610
P011	Speed ramp 1: time unit of measure	BASIC	611
P012	Speed ramp 2: acceleration time	ADVANCED	612
P013	Speed ramp 2: deceleration time	ADVANCED	613
P014	Speed ramp 2: time unit of measure	ADVANCED	614
P015	Speed ramp 3: acceleration time	ADVANCED	615
P016	Speed ramp 3: deceleration time	ADVANCED	616
P017	Speed ramp 3: time unit of measure	ADVANCED	617
P018	Speed ramp 4: acceleration time	ADVANCED	618
P019	Speed ramp 4: deceleration time	ADVANCED	619
P020	Speed ramp 4: time unit of measure	ADVANCED	620
P021	Selection for ramp rounding off	ADVANCED	621
P022	Acceleration ramp: start rounding off time	ADVANCED	622
P023	Acceleration ramp: end rounding off time	ADVANCED	623
P024	Deceleration ramp: start rounding off time	ADVANCED	624
P025	Deceleration ramp: end rounding off time	ADVANCED	625
P026	Torque ramp time: up	ADVANCED	626
P027	Torque ramp time: down	ADVANCED	627
P028	Unit of measure for torque ramp time	ADVANCED	628
P029	Jog ramp acceleration time	ADVANCED	629
P030	Jog ramp deceleration time	ADVANCED	629
P031	Gradient variation acceleration reset	ADVANCED	631

2.2.1 P009 Speed Ramp 1: Acceleration Time

P009	Range	0 ÷ 32700	*Function of P011*
Speed ramp 1: acceleration time	Default	100	10 sec
	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 rounded off ramps are used, the actual time the reference takes to reach constant rpm exceeds the time set in P009 of a value percent equal to (P022+P023)/2.	

2.2.2 P010 Speed Ramp 1: Deceleration Time

P010	Range	0 ÷ 32700	*Function of P011*
Speed ramp 1: deceleration time	Default	100	10 sec
	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 rounded off ramps are used, the actual time the reference takes to reach 0speed exceeds the time set in P010 of a value percent equal to (P024+P025)/2.	

2.2.3 P011 Speed Ramp 1: Time Unit of Measure

P011	Range	0 ÷ 3	0: 10 ms 1: 100 ms 2: 1000 ms 3: 10000 ms
Speed ramp 1: time unit of measure	Default	1	1: 100 ms
	Level	BASIC	
	Address	611	
	Function	Defines the unit of measure for speed ramp times P009 and P010. The allowable programmable range is 0s – 327000s. Example: P011=1 *then* P009=100 meaning P009 = 100x100ms = 10 sec P011=0 *then* P009=100 meaning P009 = 100x10ms = 1 sec P011=3 *then* P009=100 meaning P009 = 100x10000ms = 1000 sec	

2.2.4 P012 Speed Ramp 2: Acceleration Time

P012			
Speed ramp 2: acceleration time	Range	0 ÷ 32700	*Function of P014*
	Default	100	10 sec
	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 Digital Inputs Menu).

2.2.5 P013 Speed Ramp 2: Deceleration Time

P013			
Speed ramp 2: deceleration time	Range	0 ÷ 32700	*Function of P014*
	Default	100	10 sec
	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 Digital Inputs Menu).

2.2.6 P014 Speed Ramp 2: Time Unit of Measure

P014			
Speed ramp 2: time unit of measure	Range	0 ÷ 3	0: 10 ms 1: 100 ms 2: 1000 ms 3: 10000 ms
	Default	1	1: 100 ms
	Level	ADVANCED	
	Address	614	
	Function	Defines the unit of measure for speed ramp times P012 and P013. The allowable programmable range is 0s – 327000s. See time unit of measure for ramp 1 (par. P011).	

2.2.7 P015 Speed Ramp 3: Acceleration Time

P015	Range	0 ÷ 32700	*Function of P017*
Speed ramp 3: acceleration time	Default	100	10 sec
	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 Digital Inputs Menu).

2.2.8 P016 Speed Ramp 3: Deceleration Time

P016	Range	0 ÷ 32700	*Function of P017*
Speed ramp 3: deceleration time	Default	100	10 sec
	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 Digital Inputs Menu).

2.2.9 P017 Speed Ramp 3: Time Unit of Measure

P017	Range	0 ÷ 3	0: 10 ms 1: 100 ms 2: 1000 ms 3: 10000 ms
Speed ramp 3: time unit of measure	Default	1	1: 100 ms
	Level	ADVANCED	
	Address	617	
	Function	Defines the unit of measure for speed ramp times P015 and P016. The allowable programmable range is 0s – 327000s. See time unit of measure for ramp 1 (par. P011).	

2.2.10 P018 Speed Ramp 4: Acceleration Time

P018	Range	0 ÷ 32700	*Function of P020*
Speed ramp 4: acceleration time	Default	100	10 sec
	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 Digital Inputs Menu).

2.2.11 P019 Speed Ramp 4: Deceleration Time

P019	Range	0 ÷ 32700	*Function of P020*
Speed ramp 4: deceleration time	Default	100	10 sec
	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 Digital Inputs Menu).

2.2.12 P020 Speed Ramp 4: Time Unit of Measure

P020	Range	0 ÷ 3	0: 10 ms 1: 100 ms 2: 1000 ms 3: 10000 ms
Speed ramp 4: time unit of measure	Default	1	1: 100 ms
	Level	ADVANCED	
	Address	620	
	Function	Defines the unit of measure for speed ramp times P018 and P019. The allowable programmable range is 0s – 327000s. See time unit of measure for ramp 1 (par. P011).	

2.2.13 P021 Selection for Ramp Rounding Off

P021	Range	0000b ÷ 1111b *binary* 0x0000 ÷ 0x000F *hexadecimal* 0 ÷ 15	0000b (no ramp is rounded off); 1111b (all ramps are rounded off)
Selection for ramp rounding off	Default	1111b = 0x000F = 15	1111b (all ramps are rounded off)
	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 to reach the reference end value with a null tangent, both while accelerating and while decelerating, thus suppressing torque peaks that could damage mechanical couplings.	

2.2.14 P022 Acceleration Ramp: Start Rounding off Time

P022	Range	0 ÷ 100	0 ÷ 100 %
Acceleration ramp: start rounding off time	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

2.2.15 P023 Acceleration Ramp: End Rounding off Time

P023	Range	0 ÷ 100	0 ÷ 100 %
Acceleration ramp: end rounding off time	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

2.2.16 P024 Deceleration Ramp: Start Rounding off Time

P024	Range	0 ÷ 100	0 ÷ 100 %
Deceleration ramp: start rounding off time	Default	50	50%
	Level	ADVANCED	
	Address	624	
	Function	See 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

2.2.17 P025 Deceleration Ramp: End Rounding off Time

P025	Range	0 ÷ 100	0 ÷ 100 %
Deceleration ramp: end rounding off time	Default	50	50%
	Level	ADVANCED	
	Address	625	
	Function	See 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

2.2.18 P026 Torque Ramp Time: Up

P026	Range	0 ÷ 32700	*Function of P028*
Torque ramp time: up	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).	

2.2.19 P027 Torque Ramp Time: Down

P027	Range	0 ÷ 32700	*Function of P028*
Torque ramp time: down	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).	

2.2.20 P028 Unit of Measure for Torque Ramp Time

P028	Range	0 ÷ 3	0: 10 ms 1: 100 ms 2: 1000 ms 3: 10000 ms
Unit of measure for torque ramp time	Default	1	1: 100 ms
	Level	ADVANCED	
	Address	628	
	Function	Defines the unit of measure for the torque ramp times. See unit of measure for ramp 1 (par. P011).	

2.2.21 P029 Jog Ramp Acceleration Time

P029	Range	0 ÷ 6500	0 ÷ 6500 sec
JOG ramp acceleration time	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).	

2.2.22 P030 Jog Ramp Deceleration Time

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

2.2.23 P031 Gradient Variation Acceleration Reset

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

3 REFERENCES MENU

3.1 Overview

3.1.1 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 inverter.

This reference is acquired by the inverter only if the START command is active and the inverter is RUNNING, otherwise, it is ignored.

The main reference is the reference at constant rpm: when the inverter is RUNNING, it will increment the speed or torque set–point which will reach the main reference with a timed ramp (see Ramp Menu).

The factory-setting for the inverter operating mode is MASTER with a speed reference. In SLAVE mode, the reference is a torque reference; this operating mode may be configured only for VTC control (vectorial control) and FOC control (Field Oriented Control).

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:

- C011 (motor 1)
- C054 (motor 2)
- C097 (motor 3)

The SLAVE mode may also be selected through a digital input (see Digital Inputs Menu).

When the main reference is acquired by the inverter (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 12: Parameters Used for References Menu

Parameters	Menu	Contents
P050 ÷ P074	Reference	Scaling parameters for references sent from analog inputs REF, AIN1, AIN2. Scaling parameters for references sent from encoder and frequency input. Parameters for modifications using UP and DOWN keys. Parameter for JOG reference set up. Parameter for inverter disabling in case of reference at min. value.
P080 ÷ P098	Preset Speed	Parameters setting preset speed values to be selected through digital inputs.
P105 ÷ P108	Prohibit Speed	Parameters setting prohibit speed values.
P115 ÷ P121	Slow Down	Parameters setting slowing down values percent to be selected through digital inputs.
C143 ÷ C146	Control Method	Parameters setting the reference source.
C011, C028, C029	Motor 1	Parameter setting Master (speed) mode or Slave (torque) mode. Parameters setting min. speed and max. speed. *For motor n.1*
C054, C071, C072	Motor 2	Parameter setting Master (speed) mode or Slave (torque) mode. Parameters setting min. speed and max. speed. *For motor n.2*
C097, C114, C115	Motor 3	Parameter setting Master (speed) mode or Slave (torque) mode. Parameters setting min. speed and max. speed. *For motor n.3*
C047, C048	Current Limit n.1	Parameters setting min. torque and max. torque. *For motor n.1*
C090, C091	Current Limit n.2	Parameters setting min. torque and max. torque. *For motor n.2*
C133, C134	Current Limit n.3	Parameters setting min. torque and max. torque. *For motor n.3*

The following pages contain block diagrams illustrating speed reference processing (Figure 1) and torque reference processing (Figure 2). Menus and parameters used are also stated.

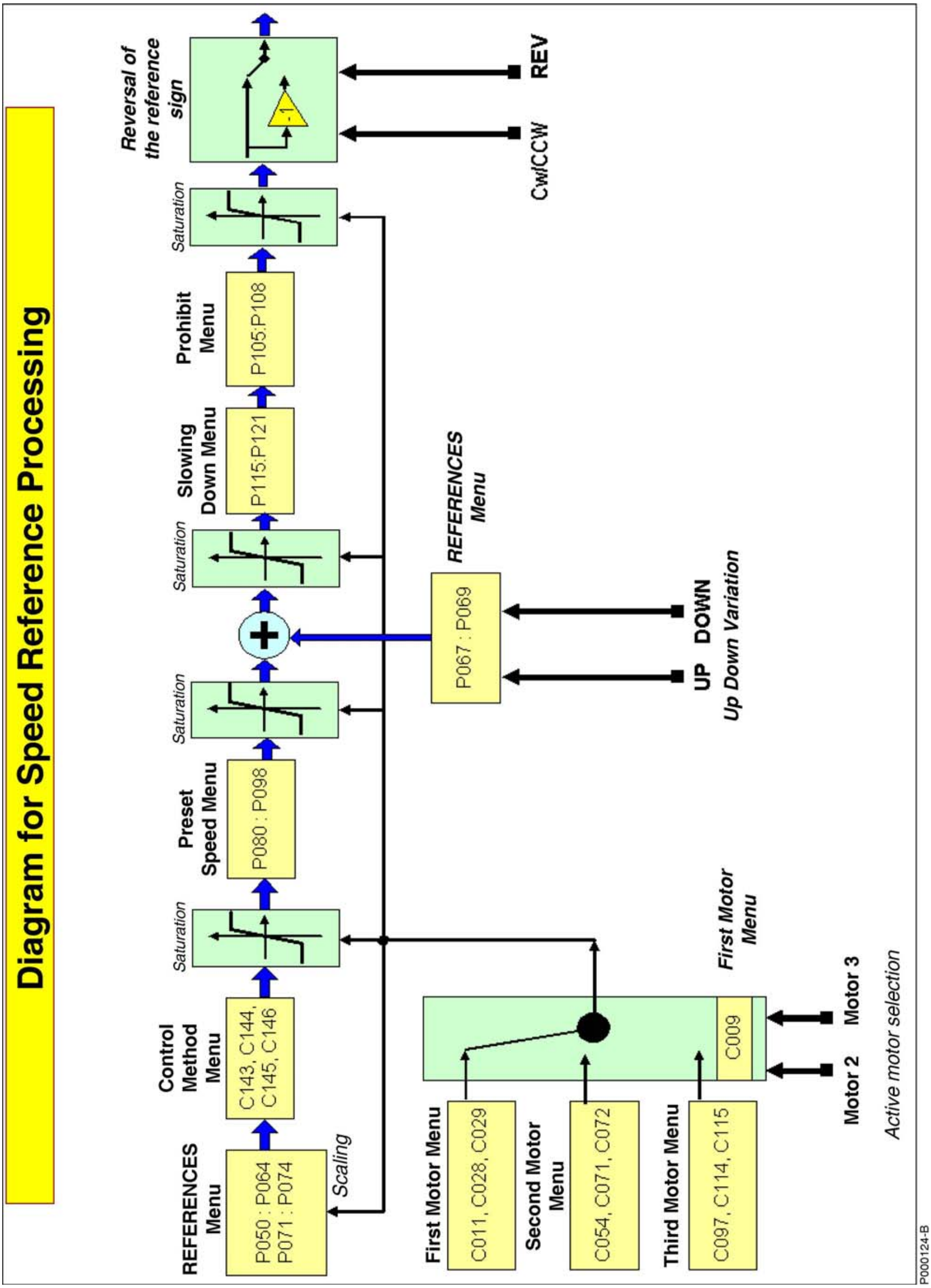


Figure 1: Speed Reference Processing

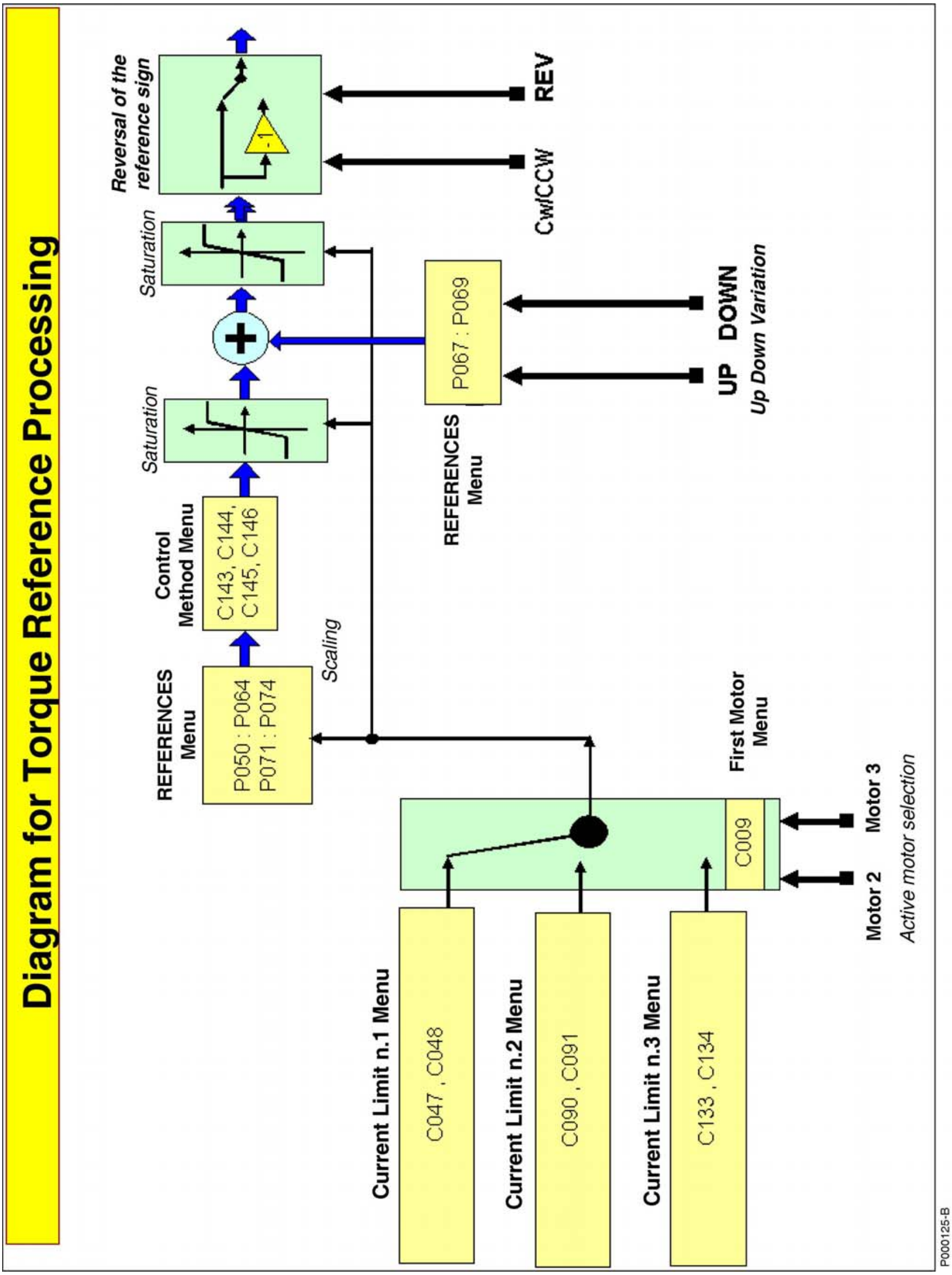


Figure 2: Torque Reference Processing

3.1.2 Scaling Analog Inputs REF, AIN1, AIN2

NOTE — Please refer to the Installation Manual for hardware details concerning 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; inputs AIN1 and AIN2 are differential inputs.

Factory setting is as follows: the main speed reference is given by analog input REF, mode 0V ÷ +10V; 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 to set 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 null), while parameter P054 defines the filtering time constant (factory setting: P054 = 5ms).

Type of input: for each analog input, Dip–Switch SW1 allows to set 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 with a minimum offset (4mA ÷ 20mA).

The user will set each analog input mode in parameters P050, P055, P060.

Table 13: Analog Input Hardware Mode

Type	Name	Type	Dip–Switch	Full-scale	Parameter
Single-ended input	REF	Input ±10V	SW1–A off	±10.66V	P050
		Input 0–20mA	SW1–A on	±42.81mA	
Differential input	AIN1	Input ±10V	SW1–B off	±10,66V	P055
		Input 0–20mA	SW1–B on	±42.81mA	
Differential input	AIN2	Input ±10V	SW1–C off, SW1–D E off	±10.66V	P060
		Input 0–20mA	SW1–C on, SW1–D E off	±42.81mA	
		Input PTC	SW1–C off, SW1–D E on	1.857V over10V *	

CAUTION — For each analog input (REF, AIN1, AIN2), check that the “mode” parameter setting (P050, P055, P060) matches with the setting of the relevant Dip–Switches SW1.

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 abscissa, and the speed/torque reference values in the ordinate.

Each point is detected through its two coordinates.

The ordinates of the two points are the following:

the value of Vel_Min (or Trq_Min for the torque reference) for the first point; the value of Vel_Max (or Trq_Max for the torque reference) for the second point.

- Vel_Min depends on the selected motor: this is the value of parameter C028 (motor 1), C071 (motor 2), or C114 (motor 3).
- Trq_Min depends on the selected motor: this is the value of parameter C047 (motor 1), C090 (motor 2) or C133 (motor 3).
- Vel_Max depends on the selected motor: this is the value of parameter C029 (motor 1), C072 (motor 2) or C115 (motor 3).
- Trq_Max depends on the selected motor: this is the value of parameter C048 (motor 1), C091 (motor 2), or C134 (motor 3).

The abscissas of the two points depend on the analog input:

Input REF:
Parameter P051 is the abscissa of the first point; parameter P052 is the abscissa of the second point.

Input AIN1:
Parameter P056 is the abscissa of the first point; parameter P057 is the abscissa of the second point.

Input AIN2:
Parameter P061 is the abscissa of the first point; parameter P062 is the abscissa of the second point.

Figures 3, 4, and 5 illustrate how parameters set processing the signals for speed (or torque) analog reference.

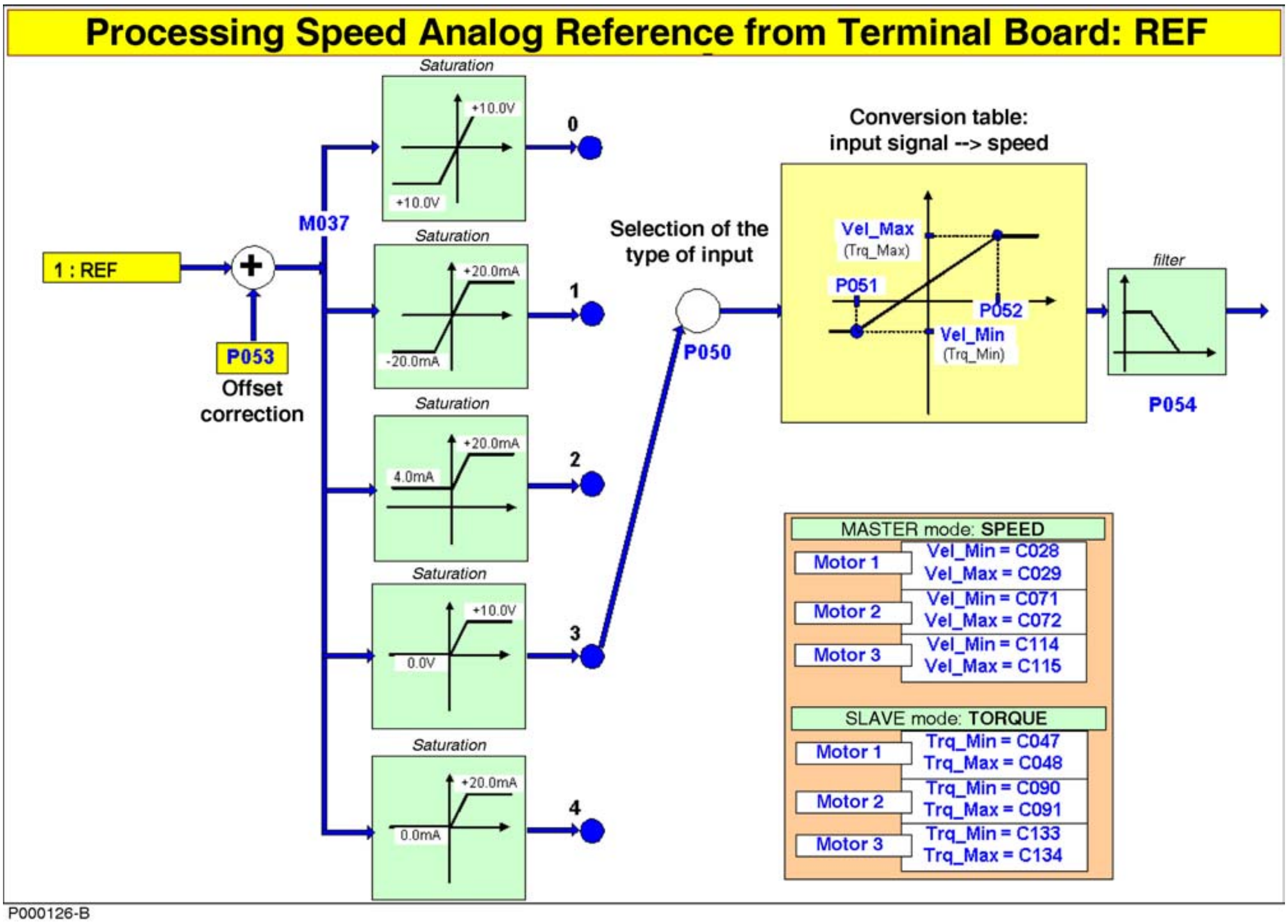


Figure 3: Processing Speed Analog Reference from Terminal Board: REF

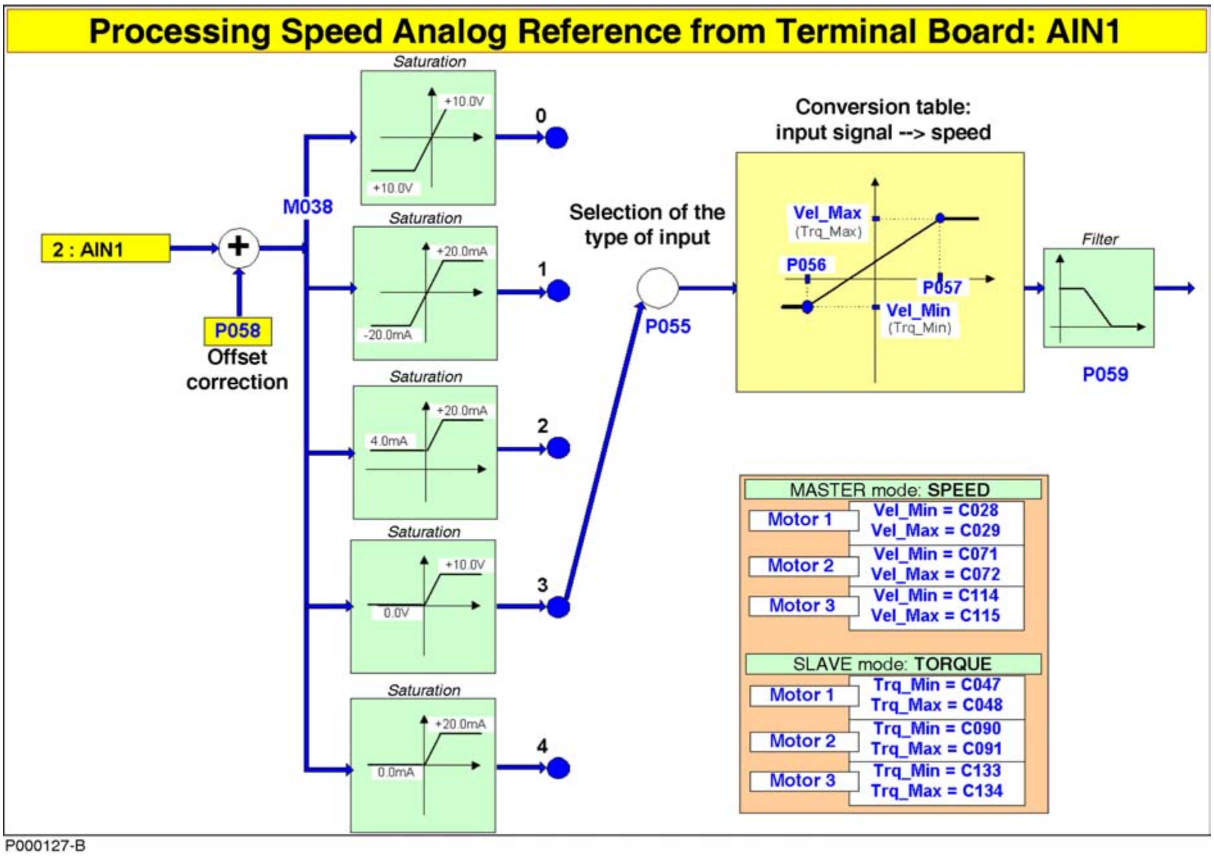


Figure 4: Processing Speed Analog Reference from Terminal Board: AIN1

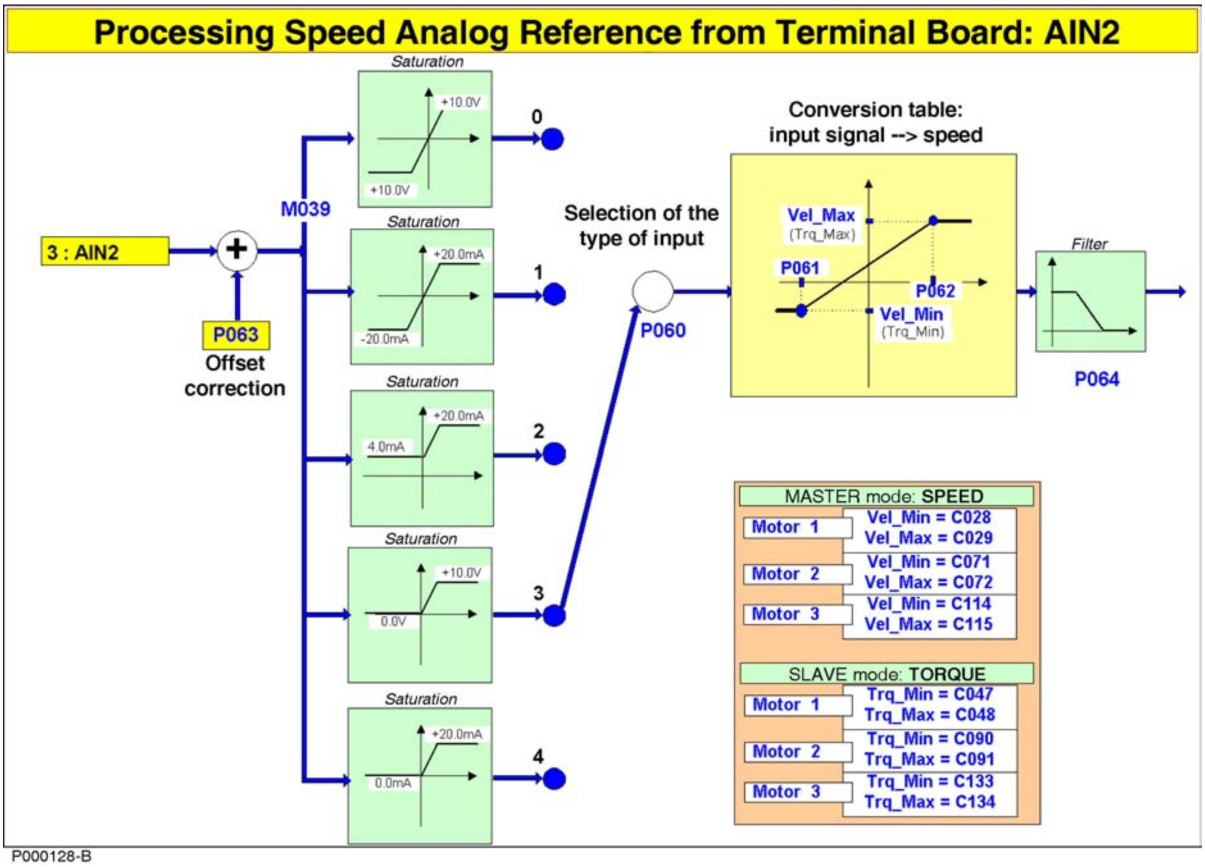


Figure 5: Processing Speed Analog Reference from Terminal Board: AIN2

The figures below are programming examples for analog input REF; motor 1 is selected in MASTER mode: speed reference.

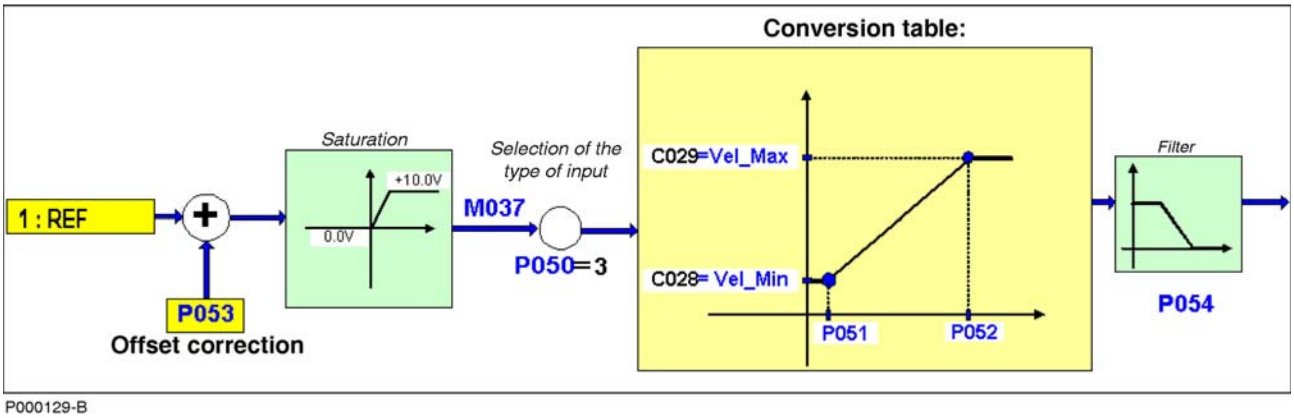


Figure 6: Example of Input REF Processing (1)

Setting in Figure 6 is as follows:
P050 = 3
P051 = 1V; P052 = 10V;
Vel_Min = C028 = 100 rpm ; Vel_Max = C029 = 1100 rpm

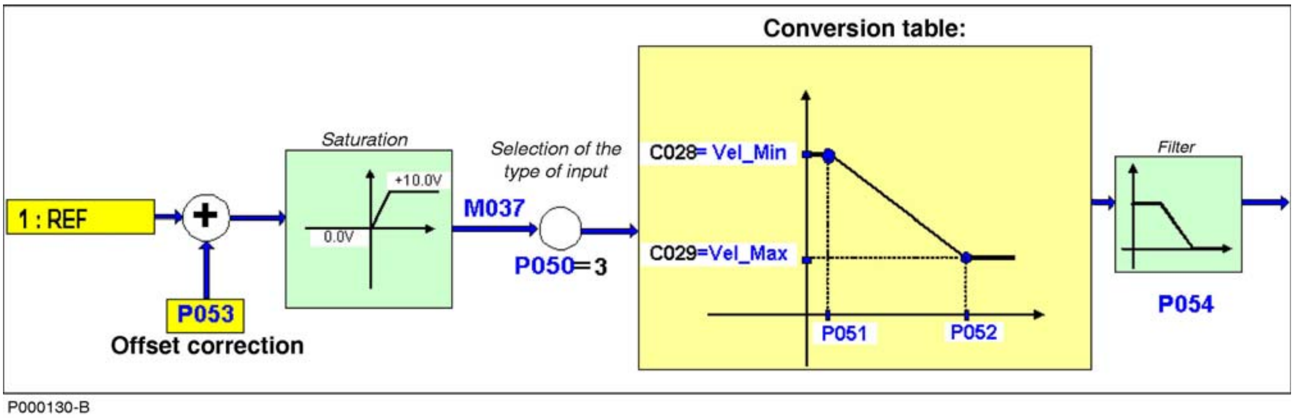


Figure 7: Example of Input REF Processing (2)

Setting in figure 7 is as follows:
P050 = 3
P051 = 1V; P052 = 10V;
Vel_Min = C028 = 1200 rpm; Vel_Max = C029 = 400 rpm

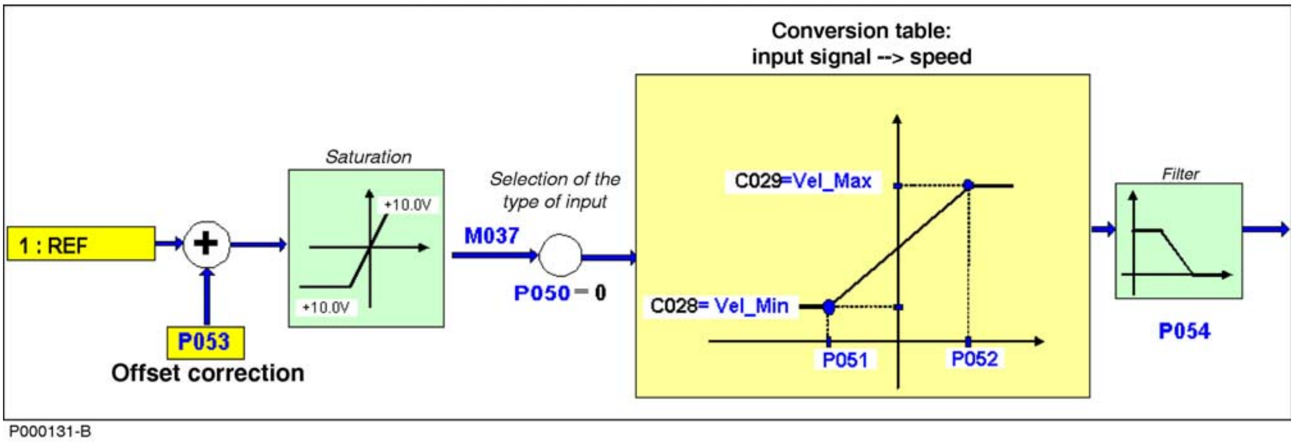


Figure 8: Example of Input REF Processing (3)

Setting in Figure 8 is as follows:
P050 = 0
P051 = –5V; P052 = +8V;
Vel_Min = C028 = 1450 rpm; Vel_Max = C029 = 300 rpm

3.2 Parameter List

Table 14: List of Parameters P050 ÷ P074

Parameter	FUNCTION	Access Level	MODBUS Address
P050	Type of signal over input REF	ADVANCED	650
P051	Value of input REF for Reference Vel_Min (or Trq_Min)	ADVANCED	651
P052	Value of input REF for Reference Vel_Max (or Trq_Max)	ADVANCED	652
P053	Value of Offset correction over input REF	ADVANCED	653
P054	Filtering time constant over input REF	ADVANCED	654
P055	Type of signal over input AIN1	ADVANCED	655
P056	Value of input AIN1 for Reference Vel_Min (or Trq_Min)	ADVANCED	656
P057	Value of input AIN1 for Reference Vel_Max (or Trq_Max)	ADVANCED	657
P058	Value of Offset correction over input AIN1	ADVANCED	658
P059	Filter time constant over input AIN1	ADVANCED	659
P060	Type of signal over input AIN2	ADVANCED	660
P061	Value of input AIN2 for Reference Vel_Min (or Trq_Min)	ADVANCED	661
P062	Value of input AIN2 for Reference Vel_Max (or Trq_Max)	ADVANCED	662
P063	Value of Offset correction over input AIN2	ADVANCED	663
P064	Filter time constant over input AIN2	ADVANCED	664
P065	INVERTER disabling when reference is at its min. value	ADVANCED	665
P066	INVERTER disabling time when reference is at its min. value	ADVANCED	666
P067	Time for ramp UP/DOWN	ADVANCED	667
P068	Storage of UP/DOWN quantity added to reference	ADVANCED	668
P069	Range of UP/DOWN quantity added to reference	ADVANCED	669
P070	JOG reference (Speed/Torque)	ADVANCED	670
P071	Value of Frequency reference for Reference Vel_Min (or Trq_Min)	ADVANCED	671
P072	Value of Frequency reference for Reference Vel_Max (or Trq_Max)	ADVANCED	672
P073	Value of Encoder input for Reference Vel_Min (or Trq_Min)	ADVANCED	673
P074	Value of Encoder input for Reference Vel_Max (or Trq_Max)	ADVANCED	674

3.2.1 P050 Type of Signal over Input REF

P050	Range	0 ÷ 4	0: ± 10 V 1: ± 20 mA 2: 4 ÷ 20 mA 3: 0 ÷ 10 V 4: 0 ÷ 20 mA
Type of signal over input REF	Default	3	3: 0 ÷ 10 V
	Level	ADVANCED	
	Address	650	
	Function	This parameter selects the type of single–ended, analog signal over terminal REF 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 when the inverter is running, alarm A066 trips. 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 switch SW1–A allowing to select the proper electric circuit for the analog signal processing (voltage signal or current signal).

3.2.2 P051 Value of Input REF for Min. Reference

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
Value of input REF for reference Vel_Min orTrq_min.	Default	0	0 V
	Level	ADVANCED	
	Address	651	
	Function	This parameter selects the value for input REF signal for minimum reference, or better the reference set in **C028** (Master mode) or in **C047** (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.	

3.2.3 P052 Value of Input REF for Max. Reference

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
Value of input REF for reference Vel_Max or Trq_max.	Default	100	10,0 V
	Level	ADVANCED	
	Address	652	
	Function	This parameter selects the value for input REF signal for minimum reference, or better the reference set in **C029** (Master mode) or in **C048** (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.	

3.2.4 P053 Value for Offset Correction over Input REF

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
Value for offset correction over input REF	Default	0	0 V
	Level	ADVANCED	
	Address	653	
	Function	This parameter selects the offset correction value of the analog signal REF that has been measured. The value set is added to the signal measured before saturation or conversion (see relevant table).	

3.2.5 P054 Filter Time Constant over Input REF

P054	Range	0 ÷ +65000	0 ÷ +65000ms
Filter time constant over input REF	Default	5	5 ms
	Level	ADVANCED	
	Address	653	
	Function	This parameter selects the value of the filter time constant of the first command applied to the input REF signal when the signal saturation and conversion is over.	

3.2.6 P055 TYPE OF SIGNAL OVER INPUT AIN1

P055	Range	0 ÷ 4	0: ± 10 V 1: ± 20 mA 2: 4 ÷ 20 mA 3: 0 ÷ 10 V 4: 0 ÷ 20 mA
Type of signal over input AIN1	Default	3	3: 0 ÷ 10 V
	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 when the inverter is running, alarm A067 trips. 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–B allowing to select the proper electric circuit for the analog signal processing (voltage signal or current signal).

3.2.7 P056 VALUE OF INPUT AIN1 FOR MIN. REFERENCE

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
Value of input AIN1 for reference Vel_Min or Trq_min.	Default	0	0 V
	Level	ADVANCED	
	Address	656	
	Function	This parameter selects the value for input AIN1 signal for minimum reference, or better the reference set in C028 (Master mode) or in C047 (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.	

3.2.8 P057 Value of Input AIN1 for Max. Reference

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 , *ifP055* = 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
Value of input AIN1 for reference Vel_Max or Trq_max.	Default	100	10,0 V
	Level	ADVANCED	
	Address	657	
	Function	This parameter selects the value for input AIN1 signal for maximum reference, or better the reference set in C029 (Master mode) or in C048 (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.	

3.2.9 P058 Value for Offset Correction over Input AIN1

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
Value for offset correction over input AIN1	Default	0	0 V
	Level	ADVANCED	
	Address	658	
	Function	This parameter selects the offset correction value of the analog signal AIN1 that has been measured. The value set is added to the signal measured before saturation or conversion (see relevant table).	

3.2.10 P059 Filter Time Constant over Input AIN1

P059	Range	0 ÷ +65000	0 ÷ +65000ms
Filter time constant over input AIN1	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 the input AIN1 signal when the signal saturation and conversion is over.	

3.2.11 P060 Type of Signal over Input AIN2

P060	Range	0 ÷ 4	0: ± 10 V 1: ± 20 mA 2: 4 ÷ 20 mA 3: 0 ÷ 10 V 4: 0 ÷ 20 mA
Type of signal over input AIN2	Default	3	3: 0 ÷ 10 V
	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 when the inverter is running, alarm A068 trips. 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–C and SW1-E allowing to select the proper electric circuit for the analog signal processing (voltage signal or current signal).

3.2.12 P061 Value of Input AIN2 for Min. Reference

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
Value of input AIN2 for reference Vel_Min or Trq_min.	Default	0	0 V
	Level	ADVANCED	
	Address	661	
	Function	This parameter selects the value for input AIN2 signal for minimum reference, or better the reference set in C028 (Master mode) or in C047 (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.	

3.2.13 P062 Value of Input AIN2 for Max. Reference

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
Value of input AIN2 for reference Vel_Max or Trq_max.	Default	100	10,0 V
	Level	ADVANCED	
	Address	662	
	Function	This parameter selects the value for input AIN1 signal for maximum reference, or better the reference set in C029 (Master mode) or in C048 (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.	

3.2.14 P063 Value for Offset Correction over Input AIN2

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
Value for offset correction over input AIN2	Default	0	0 V
	Level	ADVANCED	
	Address	663	
	Function	This parameter selects the offset correction value of the analog signal AIN2 that has been measured. The value set is added to the signal measured before saturation or conversion (see relevant table).	

3.2.15 P064 Filter Time Constant over Input AIN2

P064	Range	0 ÷ +65000	0 ÷ +65000ms
Filter time constant over input AIN2	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 the input AIN2 signal when the signal saturation and conversion is over.	

3.2.16 P065 Inverter Disabling and Minimum Reference

P065			
Inverter disabling when the speed reference is at its min. value	Range	0 ÷ +32000	0: Disabled 1 ÷ +32000 rpm
	Default	0	0: Disabled
	Level	ADVANCED	
	Address	665	
	Function	If this parameter is other than zero, the current speed reference computed when processing of all active source reference 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 reaching+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 **inverter 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 inverter will automatically deactivate. **The inverter 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. with a speed reference.

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

3.2.17 P066 Inverter Disabling Time with Minimum Reference

P066			
Inverter disabling time when reference is at its min. speed	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 **inverter 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 inverter will automatically deactivate. *(See description of parameter P065.)*	

3.2.18 P067 Time for Ramp Up–Down

P067	Range	0 ÷ 6500	0 ÷ 6500 sec
Time for ramp Up–Down	Default	5	5 sec
	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 Vel_Min and Vel_Max (or Trq_Min and Trq_Max). *If motor 1 is active, Vel_Min=C028, Vel_Max=C029, Trq_Min=C047, Trq_Max=C048.*	

3.2.19 P068 Storage of Up–Down Quantity

P068	Range	0 ÷ 1	0: Disabled, 1: Enabled
Storage of Up–Down quantity	Default	1	1: Enabled
	Level	ADVANCED	
	Address	668	
	Function	If P068=1, the quantity added through input digital signals UP and DOWN or with the INC and DEC keys (local mode), is stored at the inverter power off and is added to the start reference when the inverter is restarted. This function allows to store the reference value obtained with UP and DOWN signals.	

3.2.20 P069 Range of Up–Down Quantity

P069	Range	0 ÷ 1	0: Bipolar, 1: Unipolar
Range of Up–Down quantity	Default	1	1: Unipolar
	Level	ADVANCED	
	Address	669	
	Function	If P069=1, the quantity added through input digital signals UP and DOWN or with the INC and DEC 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.	

3.2.21 P070 JOG Reference (Speed/Torque)

P070			
Jog Reference (Speed/Torque)	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 torque max. value of the selected motor (max. value as an absolute value between min. and max. torque limit).	

3.2.22 P071 Value of the Frequency Reference for Min. Reference

P071			
Value of frequency reference for reference Vel_Min or Trq_min.	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 **C028** (Master mode) or in **C047** (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.	

3.2.23 P072 Value of the Frequency Reference for Max. Reference

P072			
Value of frequency reference for reference Vel_Max or Trq_max.	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 **C029** (Master mode) or in **C048** (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.	

3.2.24 P073 Value of Encoder Input for Min. Reference

P073			
Value of Encoder input for Vel_Min or Trq_min.	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 **C028** (Master mode) or in **C047** (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.	

3.2.25 P074 Value of Encoder Input for Max. Reference

P074	Range	–32000 ÷ 32000	± 32000 rpm
Value of Encoder input for reference Vel_Max or Trq_max.	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 **C028** (Master mode) or in **C047** (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.	

4 PRESET SPEED MENU

4.1 Overview

NOTE See also References Menu and Digital Inputs Menu in this manual.

The Preset Speed menu allows to define the values for 15 preset speed (or multispeed) references set in parameters P081÷ 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 programmable reference range is ± 32000 rpm. In case FOC control is used, for the first three programmable speed values, the decimal portion can also be set (±0.99 rpm).
(*This is possible with FOC control only because this control method allows a better resolution for speed regulation, which can reach 1/100 of rpm if a special encoder is used*).

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 ÷ 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; speed reference is null.

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.

4.2 Parameter List

Table 15: List of Parameters P080 ÷ P098

Parameter	FUNCTION	Access Level	MODBUS Address
P080	Multispeed function	ENGINEERING	680
P081	Output speed Mspd1	BASIC	681
P082	Decimal portion Mspd1	BASIC	682
P083	Output speed Mspd2	BASIC	683
P084	Decimal portion Mspd2	BASIC	684
P085	Output speed Mspd3	BASIC	685
P086	Decimal portion Mspd3	BASIC	686
P087	Output speed Mspd4	ADVANCED	687
P088	Output speed Mspd5	ADVANCED	688
P089	Output speed Mspd6	ADVANCED	689
P090	Output speed Mspd7	ADVANCED	690
P091	Output speed Mspd8	ADVANCED	691
P092	Output speed Mspd9	ADVANCED	692
P093	Output speed Mspd10	ADVANCED	693
P094	Output speed Mspd11	ADVANCED	694
P095	Output speed Mspd12	ADVANCED	695
P096	Output speed Mspd13	ADVANCED	696
P097	Output speed Mspd14	ADVANCED	697
P098	Output speed Mspd15	ADVANCED	698

4.2.1 P080 MULTISPEED FUNCTION

P080	Range	0 ÷ 2	0: Preset Speed, 1: Sum Speed, 2: Exclusive Preset Speed
Multispeed function	Default	0	0: Preset Speed
	Level	ENGINEERING	
	Address	680	
	Function	Defines the functionality of the preset speed values for the global speed reference. Three functions are available: • 0: [Preset Speed] → the selected **multispeed** is the actual rpm value (upon limitation 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 null**.	

4.2.2 P081 OUTPUT SPEED 1 (MSPD1)

P081	Range	–32000 ÷ 32000	±32000 rpm
Output speed 1 (integer)	Default	0	0 rpm
	Level	BASIC	
	Address	681	
	Function	Determines the value of the output speed for the selection of multispeed 1; this value will be processed based on setting in P080.	

4.2.3 P082 Decimal Portion Mspd1

P082			
Output speed 1 (decimal portion)	Range	–99 ÷ 99	±0.99 rpm
	Default	0	0 rpm
	Level	BASIC	
	Address	682	
	Function	Determines the value of the decimal portion of the reference for the selection of multispeed 1. The decimal portion is considered for active control FOC only, allowing a better resolution of the speed control.	

4.2.4 P083 Output Speed 2 (Mspd2)

P083			
Output speed 2 (integer)	Range	–32000 ÷ 32000	±32000 rpm
	Default	0	0 rpm
	Level	BASIC	
	Address	683	
	Function	Determines the value of the output speed for the selection of multispeed 2; this value will be processed based on setting in P080.	

4.2.5 P084 Decimal Portion Mspd2

P084			
Output speed 2 (decimal portion)	Range	–99 ÷ 99	±0.99 rpm
	Default	0	0 rpm
	Level	BASIC	
	Address	684	
	Function	Determines the value of the decimal portion of the reference for the selection of multispeed 2. The decimal portion is considered for active control FOC only, allowing a better resolution of the speed control.	

4.2.6 P085 Output Speed 3 (Mspd3)

P085			
Output speed 3 (integer)	Range	–32000 ÷ 32000	±32000 rpm
	Default	0	0 rpm
	Level	BASIC	
	Address	685	
	Function	Determines the value of the output speed for the selection of multispeed 3; this value will be processed based on setting in P080.	

4.2.7 P086 Decimal Portion Mspd3

P084	Range	–99 ÷ 99	±0.99 rpm
Output speed 3 (decimal portion)	Default	0	0 rpm
	Level	BASIC	
	Address	686	
	Function	Determines the value of the decimal portion of the reference for the selection of multispeed 3. The decimal portion is considered for active control FOC only, allowing a better resolution of the speed control.	

4.2.8 P087 Output Speed 4 (Mspd4)

P087	Range	–32000 ÷ 32000	±32000 rpm
Output speed 4	Default	0	0 rpm
	Level	BASIC	
	Address	687	
	Function	Determines the value of the output speed for the selection of multispeed 4; this value will be processed based on setting in P080.	

4.2.9 P088 Output Speed 5 (Mspd5)

P088	Range	–32000 ÷ 32000	±32000 rpm
Output speed 5	Default	0	0 rpm
	Level	BASIC	
	Address	688	
	Function	Determines the value of the output speed for the selection of multispeed 5; this value will be processed based on setting in P080.	

4.2.10 P089 Output Speed 6 (Mspd6)

P089	Range	–32000 ÷ 32000	±32000 rpm
Output speed 6	Default	0	0 rpm
	Level	BASIC	
	Address	689	
	Function	Determines the value of the output speed for the selection of multispeed 6; this value will be processed based on setting in P080.	

4.2.11 P090 Output Speed 7 (Mspd7)

P090	Range	–32000 ÷ 32000	±32000 rpm
Output speed 7	Default	0	0 rpm
	Level	BASIC	
	Address	690	
	Function	Determines the value of the output speed for the selection of multispeed 7; this value will be processed based on setting in P080.	

4.2.12 P091 Output Speed 8 (Mspd8)

P090	Range	–32000 ÷ 32000	±32000 rpm
Output speed 8	Default	0	0 rpm
	Level	BASIC	
	Address	691	
	Function	Determines the value of the output speed for the selection of multispeed 8; this value will be processed based on setting in P080.	

4.2.13 P092 Output Speed 9 (Mspd9)

P092	Range	–32000 ÷ 32000	±32000 rpm
Output speed 9	Default	0	0 rpm
	Level	BASIC	
	Address	692	
	Function	Determines the value of the output speed for the selection of multispeed 7; this value will be processed based on setting in P080.	

4.2.14 P093 Output Speed 10 (Mspd10)

P093	Range	–32000 ÷ 32000	±32000 rpm
Output speed 10	Default	0	0 rpm
	Level	BASIC	
	Address	693	
	Function	Determines the value of the output speed for the selection of multispeed 10; this value will be processed based on setting in P080.	

4.2.15 P094 Output Speed 11 (Mspd11)

P094	Range	–32000 ÷ 32000	±32000 rpm
Output speed 11	Default	0	0 rpm
	Level	BASIC	
	Address	694	
	Function	Determines the value of the output speed for the selection of multispeed 11; this value will be processed based on setting in P080.	

4.2.16 P095 Output Speed 12 (Mspd12)

P095	Range	–32000 ÷ 32000	±32000 rpm
Output speed 12	Default	0	0 rpm
	Level	BASIC	
	Address	695	
	Function	Determines the value of the output speed for the selection of multispeed 12; this value will be processed based on setting in P080.	

4.2.17 P096 Output Speed 13 (Mspd13)

P096	Range	–32000 ÷ 32000	±32000 rpm
Output speed 13	Default	0	0 rpm
	Level	BASIC	
	Address	696	
	Function	Determines the value of the output speed for the selection of multispeed 13; this value will be processed based on setting in P080.	

4.2.18 P097 Output Speed 14 (Mspd14)

P097	Range	–32000 ÷ 32000	±32000 rpm
Output speed 14	Default	0	0 rpm
	Level	BASIC	
	Address	697	
	Function	Determines the value of the output speed for the selection of multispeed 14; this value will be processed based on setting in P080.	

4.2.19 P098 Output Speed 15 (Mspd15)

P098	Range	–32000 ÷ 32000	±32000 rpm
Output speed 15	Default	0	0 rpm
	Level	BASIC	
	Address	698	
	Function	Determines the value of the output speed for the selection of multispeed 15; this value will be processed based on setting in P080.	

5 PROHIBIT SPEED MENU

5.1 Overview

This menu allows to set prohibit speed ranges due to mechanical resonance.

Three prohibit speed ranges are available: 3 intermediate values of the speed range and their semiamplitude (one for all ranges).
In that 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 viceversa when the reference is increasing.

The discontinuity of the speed reference has no effect on the actual speed of the connected motor, because it 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, +/-).

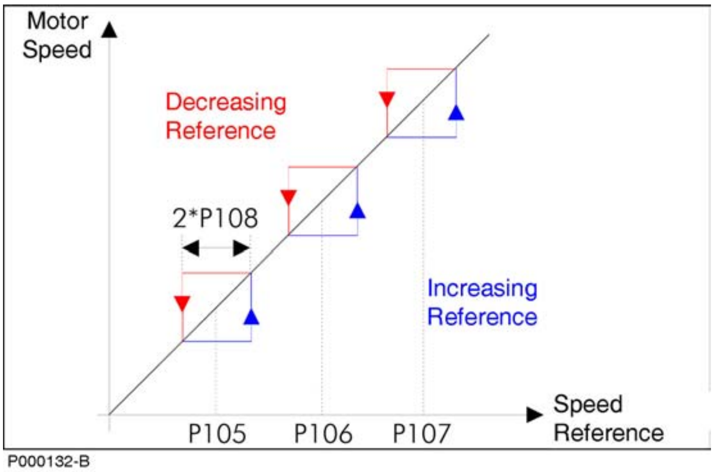


Figure 9: Prohibit Speed Ranges

Figure 9 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 Semiamplitude 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 that case, the second and third prohibit ranges partially match, because the min. allowable value of the second range (700 rpm) is higher than the min. allowable value of the third range (650 rpm); they form one prohibit speed range ranging from 600 rpm to 750 rpm.

5.2 Parameter List

Table 16: List of Parameters P105 ÷ P108

Parameter	FUNCTION	Access Level	MODBUS Address
P105	Prohibit speed 1	ADVANCED	705
P106	Prohibit speed 2	ADVANCED	706
P107	Prohibit speed 3	ADVANCED	707
P108	Semiamplitude of prohibit speed ranges	ADVANCED	708

5.2.1 P105 Prohibit Speed 1

P105			
Prohibit speed 1	Range	0 ÷ 32000	0 ÷ 32000 rpm
	Default	0	0 rpm
	Level	ADVANCED	
	Address	705	
	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 (+/-).	

5.2.2 P106 Prohibit Speed 2

P106			
Prohibit speed 2	Range	0 ÷ 32000	0 ÷ 32000 rpm
	Default	0	0 rpm
	Level	ADVANCED	
	Address	706	
	Function	Determines the intermediate value of the second prohibit speed range. This value is to be considered as an absolute value, i.e. independent of the speed reference sign (+/-).	

5.2.3 P107 Prohibit Speed 3

P107			
Prohibit speed 3	Range	0 ÷ 32000	0 ÷ 32000 rpm
	Default	0	0 rpm
	Level	ADVANCED	
	Address	707	
	Function	Determines the intermediate value of the third prohibit speed range. This value is to be considered as an absolute value, i.e. independent of the speed reference sign (+/-).	

5.2.4 P108 Semiamplitude of Prohibit Speed Ranges

P108			
Semiamplitude of prohibit speed ranges	Range	0 ÷ 5000	0 ÷ 5000 rpm
	Default	0	0 rpm
	Level	ADVANCED	
	Address	708	
	Function	Determines the semiamplitude of prohibit speed ranges.	

6 VARIATION PERCENT MENU

6.1 Overview

In the Variation Percent menu, you can define the variation values of the speed/torque instant reference to be entered through digital inputs that have been properly programmed.

As per the selection of the variation percent forced 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 variation possibilities 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 selected sources (measure M00).
Example:

P155	=	0.0%	Variation percent of reference 1
P156	=	50.0%	Variation percent of reference 2
P157	=	–80.0%	Variation percent of reference 3

Based on the speed/torque variation selected through digital inputs, the speed reference at constant speed will be the following:

Variation 1: the whole current reference.
Variation 2: the current reference increased by 50.0%.
Variation 3: the current reference decreased by 80.0%.

Speed control (example)

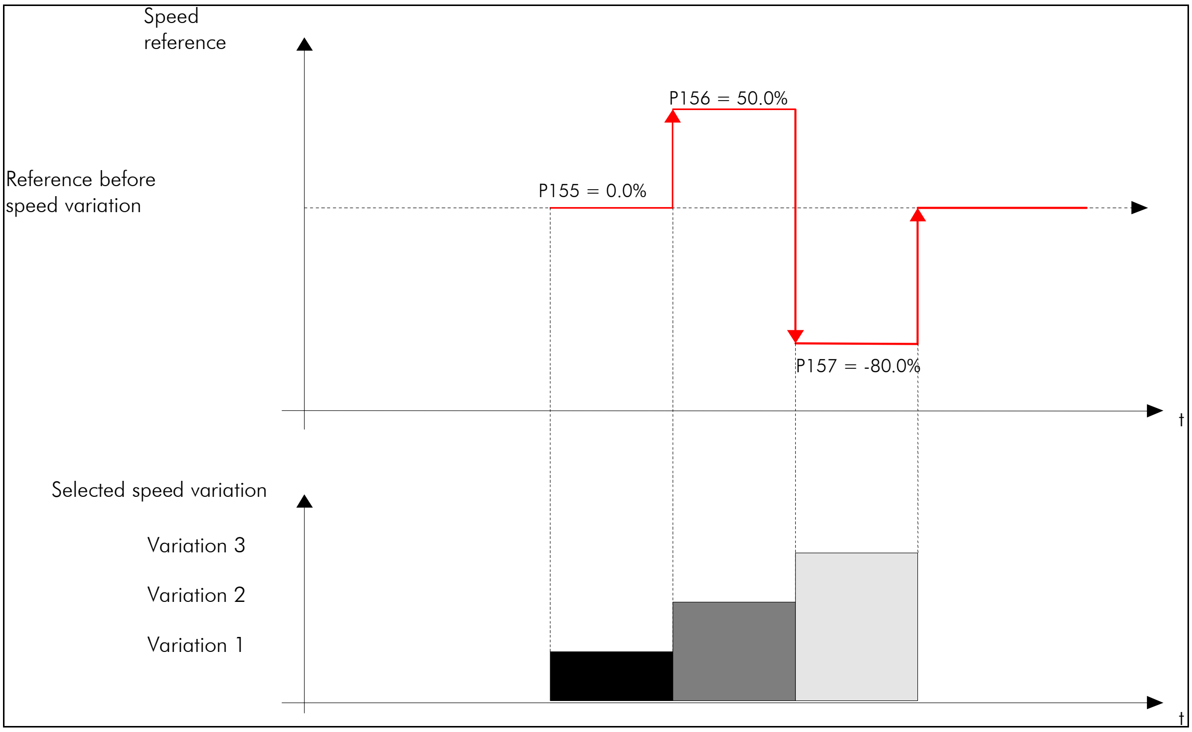


Figure 10: Example of Speed Control

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.

6.2 Parameter List

Table 17: List of Parameters P115 ÷ P121

Parameter	FUNCTION	Access Level	MODBUS Address
P115	Variation percent of reference 1	ENGINEERING	715
P116	Variation percent of reference 2	ENGINEERING	716
P117	Variation percent of reference 3	ENGINEERING	717
P118	Variation percent of reference 4	ENGINEERING	718
P119	Variation percent of reference 5	ENGINEERING	719
P120	Variation percent of reference 6	ENGINEERING	720
P121	Variation percent of reference 7	ENGINEERING	721

6.2.1 P115 Variation Percent of Reference 1

P115	Range	±1000	±100.0%
Variation percent of reference n.1	Default	0	0.0%
	Level	ENGINEERING	
	Address	715	
	Function	This parameter defines the variation percent of the current reference (M00 for speed control, M007 for torque control) to be considered as a ramp reference if variation percent 1 is selected.	

6.2.2 P116 Variation Percent of Reference 2

P116	Range	±1000	±100.0%
Variation percent of reference n.2	Default	0	0.0%
	Level	ENGINEERING	
	Address	716	
	Function	This parameter defines the variation percent of the current reference (M00 for speed control, M007 for torque control) to be considered as a ramp reference if variation percent 2 is selected.	

6.2.3 P117 Variation Percent of Reference 3

P117	Range	±1000	±100.0%
Variation percent of reference n.3	Default	0	0.0%
	Level	ENGINEERING	
	Address	717	
	Function	This parameter defines the variation percent of the current reference (M00 for speed control, M007 for torque control) to be considered as a ramp reference if variation percent 3 is selected.	

6.2.4 P118 Variation Percent of Reference 4

P117	Range	±1000	±100.0%
Variation percent of reference n.4	Default	0	0.0%
	Level	ENGINEERING	
	Address	718	
	Function	This parameter defines the variation percent of the current reference (M00 for speed control, M007 for torque control) to be considered as a ramp reference if variation percent 4 is selected.	

6.2.5 P119 Variation Percent of Reference 5

P119	Range	±1000	±100.0%
Variation percent of reference n.5	Default	0	0.0%
	Level	ENGINEERING	
	Address	719	
	Function	This parameter defines the variation percent of the current reference (M00 for speed control, M007 for torque control) to be considered as a ramp reference if variation percent 5 is selected.	

6.2.6 P120 Variation Percent of Reference 6

P119	Range	±1000	±100.0%
Variation percent of reference n.6	Default	0	0.0%
	Level	ENGINEERING	
	Address	720	
	Function	This parameter defines the variation percent of the current reference (M00 for speed control, M007 for torque control) to be considered as a ramp reference if variation percent 6 is selected.	

6.2.7 P121 Variation Percent of Reference 7

P119	Range	±1000	±100.0%
Variation percent of reference n.7	Default	0	0.0%
	Level	ENGINEERING	
	Address	721	
	Function	This parameter defines the variation percent of the current reference (M00 for speed control, M007 for torque control) to be considered as a ramp reference if variation percent 7 is selected.	

7 SPEED ADJUSTMENT MENU

7.1 Overview

In the Speed Adjustment menu, for VTC and FOC controls, you can set the parameter values of the speed regulators for the three connected motors.

The speed regulator for each motor has two parameterization functions: two integral terms, two proportional terms and two speed error thresholds.
The response of the speed regulator can be dynamically linked with the speed error; in that 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	0.02	[sec]	Minimum integral time
P126	0.2	[sec]	Maximum integral time
P128	5		Minimum proportional constant
P129	15		Maximum proportional constant
P130	2	[rpm]	Minimum error threshold
P131	20	[rpm]	Maximum error threshold

Error <= P130
For speed errors lower than or equal to 2 rpm, 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)]

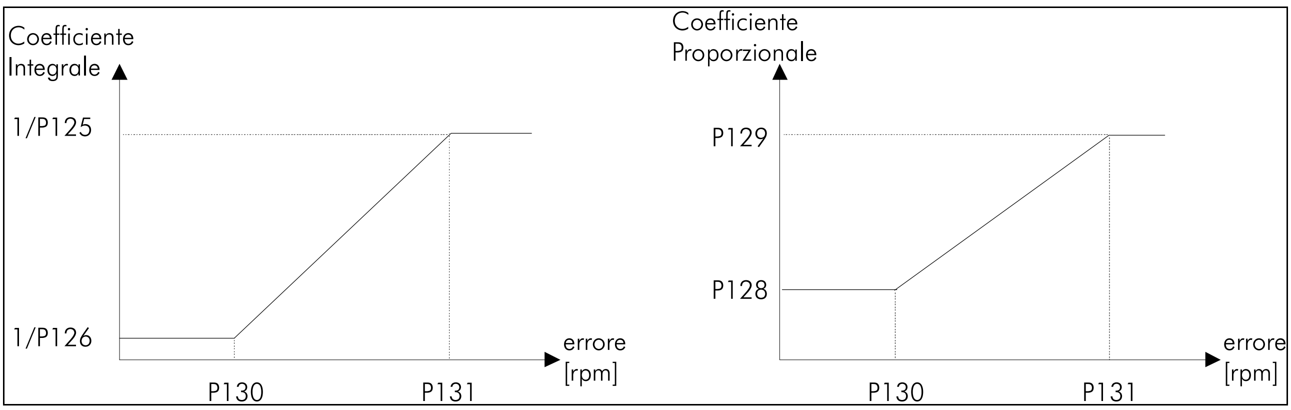


Figure 11: Dual Parameterization Function (Example)

7.2 Parameter List

Table 18: List of Parameters P125 ÷ P151

Parameter	FUNCTION	Access Level	MODBUS Address
P125	Mot1 Min. integral time	BASIC	725
P126	Mot1 Max. integral time	BASIC	726
P128	Mot1 Min. prop. coefficient	BASIC	728
P129	Mot1 Max. prop. coefficient	BASIC	729
P130	Mot1 Min. error threshold	BASIC	730
P131	Mot1 Max. error threshold	BASIC	731
P135	Mot2 Min. integral time	BASIC	735
P136	Mot2 Max. integral time	BASIC	736
P138	Mot2 Min. prop. coefficient	BASIC	738
P139	Mot2 Max. prop. coefficient	BASIC	739
P140	Mot2 Min. error threshold	BASIC	740
P141	Mot2 Max. error threshold	BASIC	741
P145	Mot3 Min. integral time	BASIC	745
P146	Mot3 Max. integral time	BASIC	746
P148	Mot3 Min. prop. coefficient	BASIC	748
P149	Mot3 Max. prop. coefficient	BASIC	749
P150	Mot3 Min. error threshold	BASIC	750
P151	Mot3 Max. error threshold	BASIC	751

7.2.1 P125 Mot 1 Min. Integral Time

P125			
Mot1 Min. integral time	Range	1÷ 32000	0.0001÷ 3.2000 [Disable] sec
	Default	2000	0.2000 sec
	Level	BASIC	
	Address	725	
	Function	VTC and FOC only. This parameter determines the min. integral time for the speed regulator. It may be accessed only if the min. and max. error thresholds are different (P130≠P131).	

7.2.2 P126 Mot 1 Max. Integral Time

P126			
Mot1 Max. integral time	Range	1÷ 32000	0.0001÷ 3.2000 [Disable] sec
	Default	2000	0.2000 sec
	Level	BASIC	
	Address	726	
	Function	VTC and FOC only. This parameter determines the max. integral time for the speed regulator.	

7.2.3 P128 Mot 1 Min. Proportional Coefficient

P126			
Mot1 Min. Proportional Coefficient	Range	0 ÷ 65000	000.00 ÷ 650.00
	Default	800	8.00
	Level	BASIC	
	Address	728	
	Function	VTC and FOC only. This parameter determines the min. proportional coefficient for the speed regulator.	

7.2.4 P129 Mot 1 Max. Proportional coefficient

P129			
Mot1 Max. Proportional Coefficient	Range	0 ÷ 65000	000.00 ÷ 650.00
	Default	800	8.00
	Level	BASIC	
	Address	729	
	Function	VTC and FOC only. This parameter determines the max. proportional coefficient for the speed regulator. It may be accessed only if the min. and max. error thresholds are different (P130≠P131).	

7.2.5 P130 Mot 1 Min. Error Threshold

P130			
Mot1 Min. Error Threshold	Range	0 ÷ 1000	0.0 ÷ 100.0
	Default	10	1.0
	Level	BASIC	
	Address	730	
	Function	VTC and FOC only. This parameter determines the min. error threshold. If P130 = P131 or in case of speed errors lower than or equal to the max. threshold, parameters P126 and P128 will be used.	

7.2.6 P131 Mot 1 Max. Error Threshold

P131			
Mot1 Max. Error Threshold	Range	0 ÷ 1000	0.0 ÷ 100.0
	Default	10	1.0
	Level	BASIC	
	Address	731	
	Function	VTC and FOC only. This parameter determines the max. error threshold. If P130 = P131 or in case of speed errors lower than or equal to the max. threshold, parameters P125 and P129 will be used.	

7.2.7 P135 Mot 2 Min. Integral Time

P135			
Mot2 Min. Integral Time	Range	1÷ 32000	0.0001÷ 3.2000 [Disable] sec
	Default	2000	0.2000 sec
	Level	BASIC	
	Address	735	
	Function	VTC and FOC only. This parameter determines the min. integral time for the speed regulator. It may be accessed only if the min. and max. error thresholds are different (P140≠P141).	

7.2.8 P136 Mot 2 Max. Integral Time

P136			
Mot2 Max. Integral Time	Range	1÷ 32000	0.0001÷ 3.2000 [Disable] sec
	Default	2000	0.2000 sec
	Level	BASIC	
	Address	736	
	Function	VTC and FOC only. This parameter determines the max. integral time for the speed regulator.	

7.2.9 P138 Mot 2 Min. Proportional Coefficient

P138	Range	0 ÷ 65000	000.00 ÷ 650.00
Mot2 Min. Proportional Coefficient	Default	800	8.00
	Level	BASIC	
	Address	738	
	Function	VTC and FOC only. This parameter determines the min. proportional coefficient for the speed regulator.	

7.2.10 P139 Mot 2 Max. Proportional Coefficient

P139	Range	0 ÷ 65000	000.00 ÷ 650.00
Mot2 Min. Proportional Coefficient	Default	800	8.00
	Level	BASIC	
	Address	739	
	Function	VTC and FOC only. This parameter determines the max. proportional coefficient for the speed regulator. It may be accessed only if min. and max. error thresholds are different (P140≠P141).	

7.2.11 P140 Mot 2 Min. Error Threshold

P140	Range	0 ÷ 1000	0.0 ÷ 100.0
Mot2 Min. Error Threshold	Default	10	1.0
	Level	BASIC	
	Address	740	
	Function	VTC and FOC only. This parameter determines the min. error threshold. If P140 = P141 or in case of speed errors lower than or equal to the max. threshold, parameters P136 and P138 will be used.	

7.2.12 P141 Mot 2 Max. Error Threshold

P140	Range	0 ÷ 1000	0.0 ÷ 100.0
Mot2 Max. Error Threshold	Default	10	1.0
	Level	BASIC	
	Address	741	
	Function	VTC and FOC only. This parameter determines the max. error threshold. If P140 = P141 or in case of speed errors lower than or equal to the max. threshold, parameters P135 and P139 will be used.	

7.2.13 P145 Mot 3 Min. Integral Time

P145	Range	1÷ 32000	0.0001÷ 3.2000 [Disable] sec
Mot3 Min. Integral Time	Default	2000	0.2000 sec
	Level	BASIC	
	Address	745	
	Function	VTC and FOC only. This parameter determines the min. integral time for the speed regulator. It may be accessed only if the min. and max. error thresholds are different (P150≠P151).	

7.2.14 P146 Mot 3 Max. Integral Time

P146	Range	1÷ 32000	0.0001÷ 3.2000 [Disable] sec
Mot3 Max. Integral Time	Default	2000	0.2000 sec
	Level	BASIC	
	Address	746	
	Function	VTC and FOC only. This parameter determines the max. integral time for the speed regulator.	

7.2.15 P148 Mot 3 Min. Proportional Coefficient

P148	Range	0 ÷ 65000	000.00 ÷ 650.00
Mot3 Min. Proportional Coefficient	Default	800	8.00
	Level	BASIC	
	Address	748	
	Function	VTC and FOC only. This parameter determines the min. proportional coefficient for the speed regulator.	

7.2.16 P149 Mot 3 Max. Proportional Coefficient

P149	Range	0 ÷ 65000	000.00 ÷ 650.00
Mot3 Max. Proportional Coefficient	Default	800	8.00
	Level	BASIC	
	Address	749	
	Function	VTC and FOC only. This parameter determines the max. proportional coefficient for the speed regulator. It may be accessed only if min. and max. error thresholds are different (P150≠P151).	

7.2.17 P150 Mot3 Min. Error Threshold

P150	Range	0 ÷ 1000	0.0 ÷ 100.0
Mot3 Min. Error Threshold	Default	10	1.0
	Level	BASIC	
	Address	750	
	Function	VTC and FOC only. This parameter determines the min. error threshold. If P150 = P151 or in case of speed errors lower than or equal to the max. threshold, parameters P146 and P148 will be used.	

7.2.18 P151 Mot3 Max. Error Threshold

P151	Range	0 ÷ 1000	0.0 ÷ 100.0
Mot3 Min. Error Threshold	Default	10	1.0
	Level	BASIC	
	Address	751	
	Function	VTC and FOC only. This parameter determines the max. error threshold. If P150 = P151 or in case of speed errors lower than or equal to the max. threshold, parameters P145 and P149 will be used.	

8 FOC REGULATORS MENU

8.1 Overview

NOTE Please refer to **Autotune** 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 inner loops of FOC control are **two current regulators PI** having the same parameters.
The first regulator controls **torque current Iq**; the second regulator controls **flux current Id**.

Torque current Iq 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 **Speed Adjustment Menu**) for the regulation of the motor speed.

Flux current Id is given by the output of the **flux regulator**, ensuring that the connected motor is always properly fluxed.

This menu allows to access the current PI regulators and flux regulators for FOC control.

8.2 Parameter List

Table 19: List of Parameters P155 ÷ P173

Parameter	FUNCTION	Access Level	MODBUS Address
P155	Current Regulator Proportional Constant, Mot n.1	ENGINEERING	755
P156	Current Regulator Integral Time, Mot n.1	ENGINEERING	756
P158	Flux Regulator Proportional Constant, Mot n.1	ENGINEERING	758
P159	Flux Regulator Integral Time, Mot n.1	ENGINEERING	759
P162	Current Regulator Proportional Constant, Mot n.2	ENGINEERING	762
P163	Current Regulator Integral Time, Mot n.2	ENGINEERING	763
P165	Flux Regulator Proportional Constant, Mot n.2	ENGINEERING	765
P166	Flux Regulator Integral Time, Mot n.2	ENGINEERING	766
P169	Current Regulator Proportional Constant, Mot n.3	ENGINEERING	769
P170	Current Regulator Integral Time, Mot n.3	ENGINEERING	770
P172	Flux Regulator Proportional Constant, Mot n.3	ENGINEERING	772
P173	Flux Regulator Integral Time, Mot n.3	ENGINEERING	773

8.2.1 P155 (P162,P169) CURRENT REGULATOR PROPORTIONAL CONSTANT FOR FOC

P155 P162 (motor n.2) P169 (motor n.3)	Range	0 ÷ 65000	0,00 ÷ 650,00
Current regulator PI proportional constant	Default	300	3,00
	Level	ENGINEERING	
	Address	755 762 (motor n.2) 769 (motor n.3)	
	Function	In FOC control (Field Oriented Control): P155 is the proportional coefficient Kp of current regulator PI Id and Iq in field rotary reference for motor n.1 (P162 and P169 relate to motors 2 and 3). The regulator's structure is as follows: error = *Set_Point – Measure;* *integral_status* = *integral_status + error* *Ki*Ts; *Output* = Kp**error + integral_status;* where Kp is the proportional coefficient Ki is the integral coefficient = 1/Ti , where Ti is the integral time Ts is the regulator operating time (ranging from 200 to 400 microseconds based on carrier frequency).	

NOTE This parameter is automatically computed and saved with the Autotuning procedure. See Autotune Menu.

8.2.2 P156 (P163,P170) Current Regulator Integral Time for FOC

P156 P163 (motor n.2) P170 (motor n.3)	Range	1 ÷ 32000	Ti = 0,1 ÷ 3199,9 ms If P156=32000 ⇒ Integral Disabled: Ki = 0,00. *otherwise:* Ki = 1/Ti = 1/(P156*0.0001)
Current regulator PI integral time	Default	200	20,0 ms
	Level	ENGINEERING	
	Address	756 763 (motor n.2) 770 (motor n.3)	
	Function	In FOC control (Field Oriented Control): P156 is integral time Ti of current regulator PI 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> with the Autotuning procedure. See Autotune Menu.

8.2.3 P158 (P165,P172) Flux Regulator Proportional Constant for FOC

P158 P165 (motor n.2) P172 (motor n.3)	Range	0 ÷ 65000	0,00 ÷ 650,00
Flux regulator PI proportional constant	Default	300	3,00
	Level	ENGINEERING	
	Address	758 765 (motor n.2) 772 (motor n.3)	
	Function	In FOC control (Field Oriented Control): P158 is the proportional coefficient Kp of flux regulator PI 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).	

NOTE

This parameter is <u>automatically recomputed and saved</u> whenever the Rotor Time Constant parameter (C025) is modified.

8.2.4 P159 (P166,P173) Flux Regulator Integral Time for FOC

P159 P166 (motor n.2) P173 (motor n.3)	Range	1 ÷ 32000	Ti = 1,0 ÷ 31999,0 ms If P156=32000 ⇒ Integral Disabled: Ki = 0,00. *otherwise:* Ki = 1/Ti = 1/(P159*0.001)
Flux regulator PI integral time	Default	200	200 ms
	Level	ENGINEERING	
	Address	759 766 (motor n.2) 773 (motor n.3)	
	Function	In FOC control (Field Oriented Control): P156 is integral time Ti of flux regulator PI for motor n.1 (P166 and P173 relate to parameters 2 and 3). The regulator's structure is as follows: error = *Set_Point – Measure;* *integral_status* = *integral_status* + *error* *Ki*Ts; *Output* = Kp**error* + *integral_status;* where Kp is the proportional coefficient Ki is the integral coefficient = 1/Ti , where Ti is the integral time Ts is the regulator operating time (ranging from 200 to 400 microseconds based on carrier frequency).	

NOTE

This parameter is <u>automatically computed and saved</u> with the Autotuning procedure, see Autotune Menu.

9 ANALOG OUTPUTS MENU

9.1 Overview

NOTE

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

NOTE

Enable the frequency output (P200 different from "Disable") to use digital output MDO1. Any configuration set in the Digital Outputs menu will have no effect.

The Sinus Penta inverter allows to configure three programmable analog outputs as voltage outputs or current outputs, as well as a frequency output. Analog outputs are factory-set as voltage outputs ranging from +10V to –10V; the following variables are selected:

AO1: Motor Speed (speed of the connected motor)
AO2: Speed Reference (speed reference at constant speed)
AO3: Ramp Out (output speed from ramp block)

9.1.1 DESCRIPTION OF THE ANALOG OUTPUTS

The parameters of this menu allow to select the variable to be represented, its range, its acquisition mode (with sign +/- or as an absolute value), the type of analog output (voltage/current output) and the output values corresponding to the min. value and the max. value of the selected variable. An offset value and a filter may also be applied to the analog outputs. As per the frequency output, this menu contains the parameters for the selection of the represented variable, its acquisition mode (with sign +/- or as an absolute value), its min. value and max. value and the corresponding output frequency value, and a filter. The figure below shows the general structure of the analog outputs; in particular, analog output AO1 and its parameter set are illustrated.

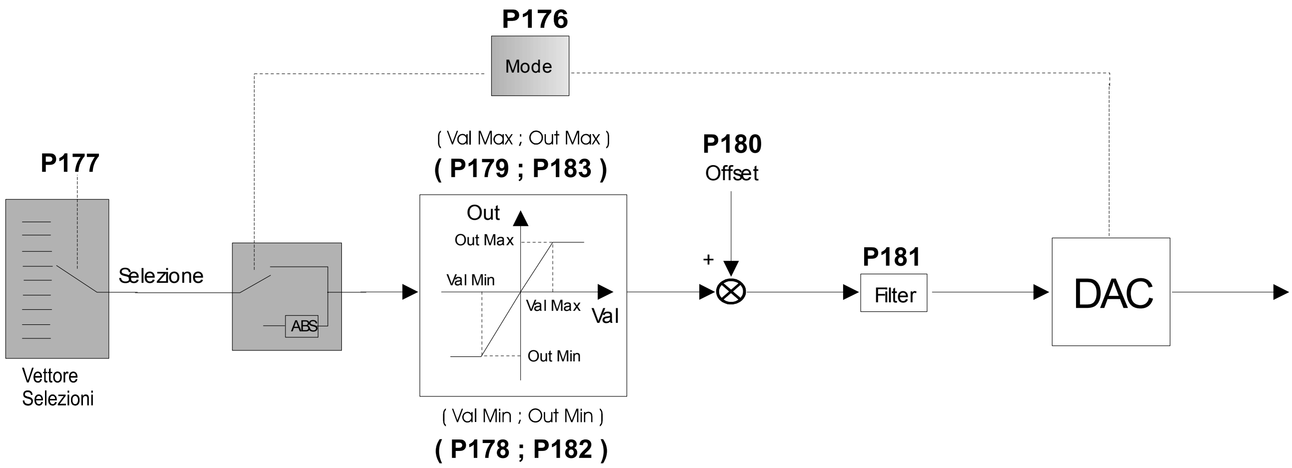


Figure 12: General Structure of the ANALOG Outputs

- Vector Selections Selects the variable to be represented through the digital analog converter (DAC): P177 for analog output AO1; P185 and P193 for AO2 and AO3 respectively.

- Mode Determines the acquisition mode of the selected variable (with sign +/- or as an absolute value) and the type (voltage/current) of analog output. If Mode = Disable, a different operating mode is selected for the analog output for which the represented variable is determined by the MODBUS address set in Address; 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) Define the minimum saturation value of the variable to be represented and the relevant 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) Define the maximum saturation value of the variable to be represented and the relevant 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 analog output AO1, in parameters P188, P196 for AO2 and AO3 respectively.

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

9.1.2 DESCRIPTION OF THE 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. For the parameter description, see section above relating to the analog outputs.

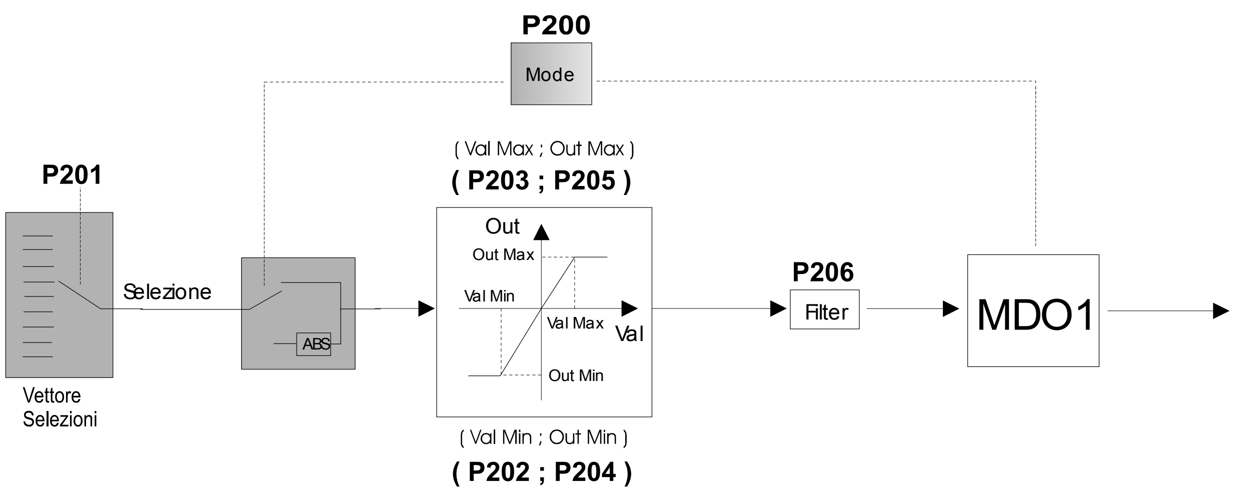


Figure 13: Structure of the FREQUENCY Output

9.2 Variables

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

Table 20: Variables to be SELECTED for the Analog Outputs and the Frequency Output

SELECTION CODE			
Selection Value	Ref. FS value	Kri	Description
0: Disable	100.00%	100	Disabled output
1: Motor Speed	10000 rpm	1	Speed of the connected motor
2: Speed Reference	10000 rpm	1	Speed reference at constant speed
3: Ramp Out	10000 rpm	1	"Ramped" speed reference
4: Motor Frequency	1000.0 Hz	10	Frequency produced by the inverter
5: Motor Current	1000.0 A	10	Current RMS
6: Output Voltage	1000.0 V	10	Output voltage RMS
7: Output Power	1000.0 kW	10	Output power
8: V bus DC	1000.0 V	10	DC-link voltage
9: Torque Reference	100.00%	100	Torque reference at constant speed
10: Torque Demand	100.00%	100	Demanded torque
11: Output Torque	100.00%	100	Evaluation of the output torque
12: Torque Limit Set Point	100.00%	100	Setpoint of the torque limit
13: PID Reference	100.00%	100	PID reference at constant speed
14: PID Set Point	100.00%	100	"Ramped" PID reference
15: PID Error	100.00%	100	Error between PID reference and feedback
16: PID Feedback	100.00%	100	Feedback to the PID
17: PID Output	100.00%	100	Output of the PID
18: REF	100.00%	100	Analog input REF
19: AIN1	100.00%	100	Analog input AIN1
20: AIN2	100.00%	100	Analog input AIN2
21: Enc. In	10000 rpm	1	Speed read by the encoder used as a reference
22: PulseIn	100.00 kHz	100	Frequency input
23: Flux Ref	1.0000 Wb	1	Flux reference at constant speed
24: Flux	1.0000 Wb	1	Current flux reference
25: iq ref.	1000.0 A	10	Current reference in axis q
26: id ref.	1000.0 A	10	Current reference in axis d
27: iq	1000.0 A	10	Current measure in axis q
28: id	1000.0 A	10	Current measure in axis d
29: vq	1000.0 V	10	Voltage in axis q
30: vd	1000.0 V	10	Voltage in axis d
31: Cosine	100.00%	10	Cosine waveform
32: Sine	100.00%	100	Sine waveform
33: Angle	1.0000 rad	10000	Electric angle of delivered Vu
34: Plus 10	10.000 V	1000	Voltage level +10V
35: Minus 10	10.000 V	1000	Voltage level –10V
36: Reserved			
37: Square Wave	100.00%	100	Square wave
38: Saw Wave	100.00%	100	Saw wave
39: Heatsink Temp.	100.00 °C	100	Temperature of the heatsink
40: Ambient Temp.	100.00 °C	100	Ambient temperature

Table 20 includes a brief description of each variable, its full-scale value and the representation coefficient required for the scaling of the min. values and the max. values selected in case of serial programming.

9.2.1 OPERATING MODE OF ANALOG OUTPUTS AND FREQUENCY OUTPUT

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

0: Disable Standard programming of the disabled analog output. Switches to +/– 10V; the variable and gain applied for its representation through the digital analog converter depend on the parameters for the MODBUS address and the gain as described in section 9.2.1. (see description of Mode).

1: +/– 10V The analog output is set as a voltage output; the allowable min. and max. output values range from +10V to – 10V. The selected variable has a positive or negative sign.

2: 0÷10V The analog output is set as a voltage output; the allowable min. and max. output values range from 0 ÷ 10V. The selected variable has a positive or negative sign.

3: 0÷20mA The analog output is set as a current output; the allowable min. and max. output values range from 0 ÷ 20mA. The selected variable has a positive or negative sign.

4: 4÷20mA The analog output is set as a current output; the allowable min. and max. output values range from 4 ÷ 20mA. The selected variable has a positive or negative sign.

5: ABS 0÷10V As output mode 0 ÷ 10V; the selected variable is considered as an absolute value.

6:ABS 0÷20mA As output mode 0 ÷ 20mA; the selected variable is considered as an absolute value.

7:ABS 4÷20mA As output mode 4 ÷ 20mA; 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.

Frequency output: three operating modes can be selected:

0: Disable The output frequency is disabled.

1: Pulse Out Digital output MDO1 is programmed as a frequency output. The selected variable has a positive or negative sign.

2: ABS Pulse Out As Pulse Out; the selected variable has a positive or negative sign.

NOTE When P200 is not set to DISABLE, digital output MDO1 is used as a frequency reference. Its settings in the Digital Outputs menu are ignored.

9.2.2 ANALOG OUTPUT PROGRAMMING EXAMPLES

This section describes some operation examples of the analog outputs obtained with different programming modes.

EXAMPLE 1:

Table 21: Example 1: Programming AO1 (0 ÷ 10V)

Parameterization of Analog Output AO1		
Parameter	Value	Description
P176	0÷10V	Analog output 1 mode
P177	1: Motor Speed	Selected variable
P178	–500 rpm	Min. value of the selected variable
P179	+500 rpm	Max. value of the selected variable
P180	0.000 V	Analog output offset
P181	0.000 sec	Filter time constant
P182	0.0 V	Output min. value
P183	10.0 V	Output max. value

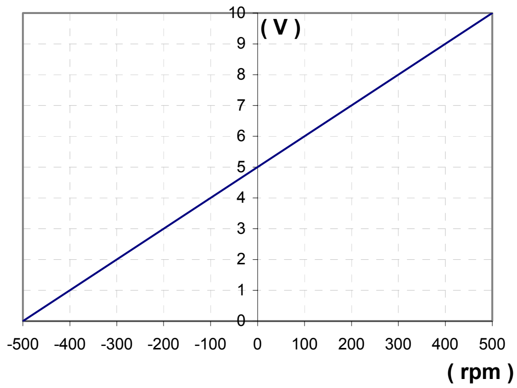


Figure 14: Example 1: Curve (Voltage; Speed) Obtained with AO1

EXAMPLE 2:

Table 22: Example 2: Programming AO1 (ABS 0 ÷ 10V)

Parameterization of Analog Output AO1		
Parameter	Value	Description
P176	ABS 0÷10V	Analog output 1 mode
P177	1: Motor Speed	Selected variable
P178	0 rpm	Min. value of the selected variable
P179	+500 rpm	Max. value of the selected variable
P180	0.000 V	Analog output offset
P181	0.000 sec	Filter time constant
P182	0.0 V	Output min. value
P183	10.0 V	Output max. value

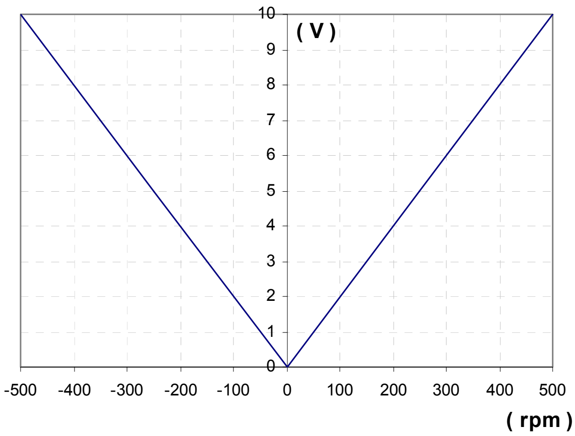


Figure 15: Example 2: Curve (Voltage; Speed) Obtained with AO1

EXAMPLE 3:

Table 23: Example 3: Programming AO1 (ABS 0 ÷ 10V)

Parameterization of Analog Output AO1		
Parameter	Value	Description
P176	ABS 0÷10V	Analog output 1 mode
P177	1: Motor Speed	Selected variable
P178	–500 rpm	Min. value of the selected variable
P179	+500 rpm	Max. value of the selected variable
P180	0.000 V	Analog output offset
P181	0.000 sec	Filter time constant
P182	0.0 V	Output min. value
P183	10.0 V	Output max. value

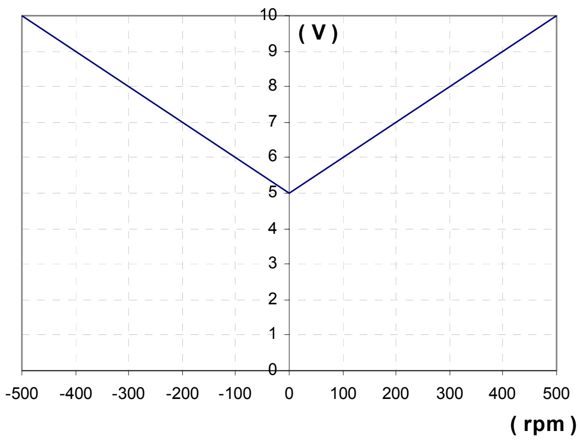


Figure 16: Example 3: Curve (Voltage; Speed) Obtained with AO1

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

EXAMPLE 4:

Table 24: Example 4: Programming AO1 (ABS 0 ÷ 10V)

Parameterization of Analog Output AO1		
Parameter	**Value**	**Description**
P176	ABS 0÷10V	Analog output 1 mode
P177	1: Motor Speed	Selected variable
P178	+100 rpm	Min. value of the selected variable
P179	+500 rpm	Max. value of the selected variable
P180	0.000 V	Analog output offset
P181	0.000 sec	Filter time constant
P182	0.0 V	Output min. value
P183	10.0 V	Output max. value

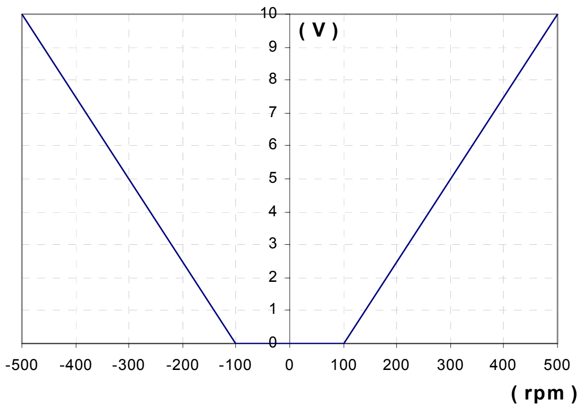


Figure 17: Example 4: Curve (Voltage; Speed) Obtained with AO1

EXAMPLE 5:

Table 25: Example 5: Programming AO1 (+/– 10V)

Parameterization of Analog Output AO1		
Parameter	**Value**	**Description**
P176	+/–10V	Analog output 1 mode
P177	1: Motor Speed	Selected variable
P178	+500 rpm	Min. value of the selected variable
P179	–500 rpm	Max. value of the selected variable
P180	0.000 V	Analog output offset
P181	0.000 sec	Filter time constant
P182	–10.0 V	Output min. value
P183	+10.0 V	Output max. value

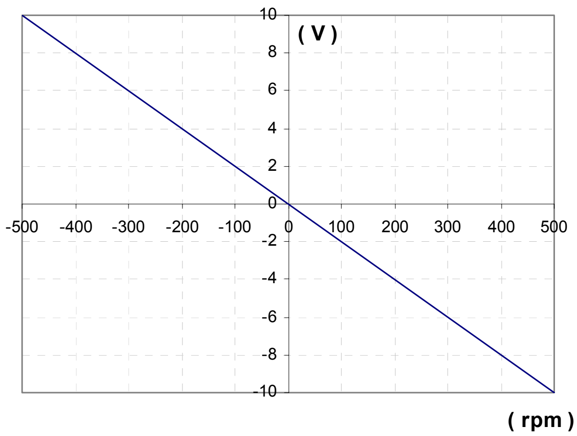


Figure 18: Example 5: Curve (Voltage; Speed) Obtained with AO1

9.3 Parameter List

Table 26: List of Parameters P176 ÷ P215

Parameter	FUNCTION	Access Level	MODBUS Address
P176	AO1: Mode selection	ADVANCED	776
P177	AO1: Variable selection	ADVANCED	777
P178	AO1: Min. value of selected variable	ADVANCED	778
P179	AO1: Max. value of selected variable	ADVANCED	779
P180	AO1: Offset	ADVANCED	780
P181	AO1: Filter time constant	ADVANCED	781
P182	AO1: Output min. value	ADVANCED	782
P183	AO1: Output max. value	ADVANCED	783
P184	AO2: Mode selection	ADVANCED	784
P185	AO2: Variable selection	ADVANCED	785
P186	AO2: Min. value of selected variable	ADVANCED	786
P187	AO2: Max. value of selected variable	ADVANCED	787
P188	AO2: Offset	ADVANCED	788
P189	AO2: Filter time constant	ADVANCED	789
P190	AO2: Output min. value	ADVANCED	790
P191	AO2: Output max. value	ADVANCED	791
P192	AO3: Mode selection	ADVANCED	792
P193	AO3: Variable selection	ADVANCED	793
P194	AO3: Min. value of selected variable	ADVANCED	794
P195	AO3: Max. value of selected variable	ADVANCED	795
P196	AO3: Offset	ADVANCED	796
P197	AO3: Filter time constant	ADVANCED	797
P198	AO3: Output min. value	ADVANCED	798
P199	AO3: Output max. value	ADVANCED	799
P200	PulseOut: Mode selection	ADVANCED	800
P201	PulseOut: Variable selection	ADVANCED	801
P202	PulseOut: Min. value of selected variable	ADVANCED	802
P203	PulseOut: Max. value of selected variable	ADVANCED	803
P204	PulseOut: Min. frequency	ADVANCED	804
P205	PulseOut: Max. frequency	ADVANCED	805
P206	PulseOut: Filter time constant	ADVANCED	806
P207	AO1: Gain	ADVANCED	807
P208	AO2: Gain	ADVANCED	808
P209	AO3: Gain	ADVANCED	809
P210	AO1: MODBUS address of the selected variable	ADVANCED	810
P211	AO2: MODBUS address of the selected variable	ADVANCED	811
P212	AO3: MODBUS address of the selected variable	ADVANCED	812
P213	Amplitude of sinusoidal signal	ENGINEERING	813
P214	Frequency of sinusoidal signal	ENGINEERING	814
P215	Frequency of saw signal	ENGINEERING	815

9.3.1 P176 AO1: Mode Selection

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.
AO1: Mode selection	Default	1	1: +/– 10V
	Level	ADVANCED	
	Address	776	
	Function	Selects the operating mode of analog output AO1.	

NOTE Analog outputs are set as voltage outputs by default; to switch to the current configuration, see configuration of the dip–switch in Sinus Penta's Installation Manual.

9.3.2 P177 AO1: Variable Selection

P177	Range	0 ÷ 40	*See section 9.2.3*
AO1: Variable selection	Default	1	Motor speed
	Level	ADVANCED	
	Address	777	
	Function	Selection of the variable to be represented to analog output AO1.	

9.3.3 P178 AO1: Min. Value of Selected Variable

P178	Range	–32000 ÷ +32000 Function of the variable selected with P177	–320,00 % ÷ +320, 00 % of full-scale value *See section 9.2.3*
AO1: Min. value of selected variable	Default	–1500	–15,00% of 10000 rpm = –1500 rpm
	Level	ADVANCED	
	Address	778	
	Function	Min. value of the motor speed corresponding to the output min. value of AO1 set in P182.	

9.3.4 P179 AO1: Max. Value of Selected Variable

P179	Range	–32000 ÷ +32000 Function of the variable selected with P177	–320,00 % ÷ +320, 00 % of full-scale value *See section 9.2.3*
AO1: Max. value of selected variable	Default	+1500	+15,00% di 10000 rpm = +1500 rpm
	Level	ADVANCED	
	Address	779	
	Function	Max. value of the motor speed corresponding to the output min. value of AO1 set in P183.	

9.3.5 P180 AO1: Offset

P180	Range	−9999 ÷ +9999 Function of the variable selected with P176	−9,999 ÷ +9,999
AO1: Offset	Default	0	0,000 V
	Level	ADVANCED	
	Address	780	
	Function	Value of the offset applied to analog output AO1.	

9.3.6 P181 AO1: Filter Time Constant

P181	Range	0 ÷ 65000	0,000 ÷ 65,000 sec.
AO1: Filter time constant	Default	0	0,000 sec.
	Level	ADVANCED	
	Address	781	
	Function	Value of the filter time constant applied to analog output AO1.	

9.3.7 P182 AO1: Output Min. Value

P182	Range	−100 ÷ +100 −200 ÷ +200 Function of the variable selected with P176.	−10,0 ÷ +10,0 V −20,0 ÷ +20,0 mA
AO1: Output min. value	Default	−100	−10,0 V
	Level	ADVANCED	
	Address	782	
	Function	Output minimum value corresponding to the minimum value of variable P178.	

9.3.8 P183 AO1: Output Max. Value

P183	Range	−100 ÷ +100 −200 ÷ +200 Function of the variable selected with P176.	−10,0 ÷ +10,0 V −20,0 ÷ +20,0 mA
AO1: Output max. value	Default	+100	+10,0 V
	Level	ADVANCED	
	Address	783	
	Function	Output maximum value corresponding to the maximum value of variable P179.	

9.3.9 P184 AO2: Mode Selection

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.
AO2: Mode selection	Default	1	1: +/− 10V
	Level	ADVANCED	
	Address	784	
	Function	Selects the operating mode of analog output AO2.	

NOTE

Analog outputs are set as voltage outputs by default; to switch to the current configuration, see configuration of the dip–switch in Sinus Penta's Installation Manual.

9.3.10 P185 AO2: Variable Selection

P185	Range	0 ÷ 40	*See section 9.2.3*
AO2: Variable selection	Default	2	Speed reference at constant speed
	Level	ADVANCED	
	Address	785	
	Function	Selection of the variable to be represented to analog output AO2.	

9.3.11 P186 AO2: Min. Value of Selected Variable

P186	Range	Function of the variable selected with P185	*See section 9.2.3*
AO2: Min. value of selected variable	Default	−1500	−1500 rpm
	Level	ADVANCED	
	Address	786	
	Function	Min. value of the motor speed corresponding to the output min. value of AO2 set in P190.	

9.3.12 P179 AO2: Max. Value of Selected Variable

P187	Range	Function of the variable selected with P185	*See section 9.2.3*
AO2: Max. value of selected variable	Default	+1500	+1500 rpm
	Level	ADVANCED	
	Address	787	
	Function	Max. value of the motor speed corresponding to the output max. value of AO2 set in P191.	

9.3.13 P180 AO2: Offset

P188	Range	Function of the variable selected with P185	
AO2: Offset selection	Default	0	0,000 V
	Level	ADVANCED	
	Address	788	
	Function	Value of the offset applied to analog output AO2.	

9.3.14 P181 AO2: Filter Time Constant

P189	Range	0 ÷ 65000	0,000÷65,000 sec.
AO2: Filter time constant	Default	0	0,000 sec.
	Level	ADVANCED	
	Address	789	
	Function	Value of the filter time constant applied to analog output AO2.	

9.3.15 P182 AO2: Output Min. Value

P190	Range	Function of the mode selected with P185.	
AO2: Output min. value	Default	–100	–10,0 V
	Level	ADVANCED	
	Address	790	
	Function	Output minimum value corresponding to the minimum value of variable P186.	

9.3.16 P183 AO2: Output Max. Value

P191	Range	Function of the mode selected with P185.	
AO2: Output max. value	Default	+100	+10,0 V
	Level	ADVANCED	
	Address	791	
	Function	Output maximum value corresponding to the maximum value of variable P187.	

9.3.17 P192 AO3: Mode Selection

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.
AO3: Mode selection	Default	1	1: +/– 10V
	Level	ADVANCED	
	Address	792	
	Function	Selects the operating mode of analog output AO3.	

NOTE

Analog outputs are set as voltage outputs by default; to switch to the current configuration, see configuration of the dip–switch in Sinus Penta's **Installation** Manual.

9.3.18 P193 AO3: Variable Selection

P193	Range	0 ÷ 40	*See section 9.2.3*
AO3: Variable selection	Default	1	"Ramped" speed reference of the connected motor
	Level	ADVANCED	
	Address	793	
	Function	Selects the variable to be represented to analog output AO3.	

9.3.19 P194 AO3: Min. Value of Selected Variable

P194	Range	Function of the variable selected with P193	*See section 9.2.3*
AO3: Min. value of selected variable	Default	–1500	–1500 rpm
	Level	ADVANCED	
	Address	794	
	Function	Min. value of the motor speed corresponding to the output min. value of AO3 set in P198.	

9.3.20 P179 AO3: Max. Value of Selected Variable

P195	Range	Function of the variable selected with P193	*See section 9.2.3*
AO3: Max. value of selected variable	Default	+1500	+1500 rpm
	Level	ADVANCED	
	Address	795	
	Function	Max. value of the motor speed corresponding to the output max. value of AO3 set in P199.	

9.3.21 P196 AO3: Offset

P196	Range	Function of the variable selected with P192	
AO3: Offset	Default	0	0,000 V
	Level	ADVANCED	
	Address	796	
	Function	Value of the offset applied to analog output AO3.	

9.3.22 P197 AO3: Filter Time Constant

P197	Range	0 ÷ 65000 sec.	0,000 ÷ 65,000 sec.
AO3: Filter time constant	Default	0	0,000 sec.
	Level	ADVANCED	
	Address	797	
	Function	Value of the filter time constant applied to analog output AO3.	

9.3.23 P198 AO3: Output Min. Value

P198	Range	Function of the mode selected with P192.	
AO3: Output min. value	Default	–100	–10,0 V
	Level	ADVANCED	
	Address	798	
	Function	Output minimum value corresponding to the minimum value of variable P194.	

9.3.24 P199 AO3: Output Max. Value

P199	Range	Function of the mode selected with P192.	
AO3: Output max. value	Default	+100	+10,0 V
	Level	ADVANCED	
	Address	799	
	Function	Output maximum value corresponding to the maximum value of variable P195.	

9.3.25 P200 PULSE OUT: MODE SELECTION

P200	Range	0 ÷ 2	0: Disabled, 1: Pulse Out, 2: ABS Pulse Out.
PULSE OUT: Mode selection	Default	0	0: Disabled
	Level	ADVANCED	
	Address	800	
	Function	Selects the operating mode of analog output PULSE OUT.	

NOTE If different from DISABLE, digital output MDO1 is used as a frequency output. Its settings in the Digital Outputs menu are ignored.

9.3.26 P201 PULSE OUT: VARIABLE SELECTION

P201	Range	0 ÷ 40	*See section 9.2.3*
PULSE OUT: Variable selection	Default	0	No selection
	Level	ADVANCED	
	Address	801	
	Function	Selection of the quantity to be represented to analog output PULSE OUT.	

9.3.27 P202 PULSE OUT: MIN. VALUE OF SELECTED VARIABLE

P202	Range	Function of the variable selected with P201	*See section 9.2.3*
PULSE OUT: Min. value of selected variable	Default	0	0
	Level	ADVANCED	
	Address	802	
	Function	Minimum value of the selected variable.	

9.3.28 P203 PULSE OUT: MAX. VALUE OF SELECTED VARIABLE

P203	Range	Function of the variable selected with P201	*See section 9.2.3*
PULSE OUT: Max. value of selected variable	Default	0	0
	Level	ADVANCED	
	Address	803	
	Function	Maximum value of the selected variable.	

9.3.29 P204 PULSE OUT: Output Min. Value

P204	Range	1000÷10000	10,00÷100,00 kHz
PULSE OUT: Output min. value	Default	1000	10,00kHz
	Level	ADVANCED	
	Address	804	
	Function	Output minimum value corresponding to the minimum value of variable P202.	

9.3.30 P205 PULSE OUT: Output Max. Value

P205	Range	1000÷10000	10,00÷100,00 kHz
PULSE OUT: Output max. value	Default	10000	100,00kHz
	Level	ADVANCED	
	Address	805	
	Function	Output maximum value corresponding to the maximum value of variable P203.	

9.3.31 P206 PULSE OUT: Filter Time Constant

P206	Range	0 ÷ 65000	0,000 ÷ 65,000 sec
PULSE OUT: Filter time constant	Default	0	0,000 sec.
	Level	ADVANCED	
	Address	806	
	Function	Value of the filter time constant applied to analog output PULSE OUT.	

9.3.32 P207 AO1: Gain

P207	Range	0 ÷ 65000	0,00 ÷ 650,00
AO1 Gain	Default	100	1,00
	Level	ADVANCED	
	Address	807	
	Function	Gain applied to the variable selected with P210 for analog output AO1 when P176 is set to DISABLE.	

9.3.33 P208 AO2: Gain

P208	Range	0 ÷ 65000	0,00 ÷ 650,00
AO2 Gain	Default	100	1,00
	Level	ADVANCED	
	Address	808	
	Function	Gain applied to the variable selected with P211 for analog output AO2 when P184 is set to DISABLE.	

9.3.34 P209 AO3: Gain

P209	Range	0 ÷ 65000	0,00 ÷ 650,00
AO3 Gain	Default	100	1,00
	Level	ADVANCED	
	Address	809	
	Function	Gain applied to the variable selected with P212 for analog output AO3 when P192 is set to DISABLE.	

9.3.35 P210 AO1: MODBUS Address of the Selected Variable

P210	Range	0 ÷ 65000	0 ÷ 65000
AO1 MODBUS address of the selected variable	Default	2639	2639
	Level	ADVANCED	
	Address	810	
	Function	MODBUS address of the variable to be represented to analog output AO1 when P176 is set to DISABLE.	

9.3.36 P211 AO2: MODBUS Address of the Selected Variable

P211	Range	0 ÷ 65000	0 ÷ 65000
AO2 MODBUS address of the selected variable	Default	2639	2639
	Level	ADVANCED	
	Address	811	
	Function	MODBUS address of the variable to be represented to analog output AO2 when P184 is set to DISABLE.	

9.3.37 P212 AO3: MODBUS Address of the Selected Variable

P212	Range	0 ÷ 65000	0 ÷ 65000
AO3 MODBUS address of the selected variable	Default	2639	2639
	Level	ADVANCED	
	Address	812	
	Function	MODBUS address of the variable to be represented to analog output AO3 when P192 is set to DISABLE.	

9.3.38 P213 Amplitude of Sinusoidal Signal

P213	Range	0 ÷ 1000	0 ÷ 100,0%
Amplitude of sinusoidal signal	Default	1000	100,0%
	Level	ENGINEERING	
	Address	813	
	Function	Amplitude of the sinusoidal signal generated from the analog output when Sine or Cosine is selected.	

9.3.39 P214 Frequency of Sinusoidal Signal

P214			
Frequency of sinusoidal signal	Range	0 ÷ 20000	0 ÷ 200,00Hz
	Default	100	1,00Hz
	Level	ENGINEERING	
	Address	814	
	Function	Frequency of the sinusoidal signal generated from the analog output when Sine or Cosine is selected.	

9.3.40 P215 Frequency of Saw Signal

P215			
Frequency of saw signal	Range	0 ÷ 20000	0 ÷ 200,00Hz
	Default	100	1,00Hz
	Level	ENGINEERING	
	Address	815	
	Function	Frequency of the saw signal generated from the analog output when Sine or Cosine is selected. It can be used as carrier frequency if MDO1 or MDO2 is to be selected with PWM mode. See example in the Digital Outputs Menu.	

10 TIMERS MENU

10.1 Overview

In the Timers menu, you can set enabling and disabling delay times for digital inputs/outputs.

NOTE: For Enable digital input MDI2, no disabling delay is allowed, because the logic status of the ENABLE command is used directly by the hardware activating IGBT commutation; when no ENABLE command is sent, the output power stage is instantly deactivated.

	NOTE	The reset function for the alarms in MDI3 is not delayed.
	NOTE	Any auxiliary alarm set to the digital inputs is not delayed.
	NOTE	Five timers are available; for each timer, you can set an enabling/disabling delay. The same timer may be assigned to multiple digital inputs/outputs.
	NOTE	The Enable–S function cannot be delayed.

Example 1:
The inverter enabling (MDI1 Start) depends on a signal coming from a different equipment. The inverter enabling is to be delayed of 2 seconds with respect to activation, and of 5 seconds with respect to deactivation. To do so, set two delay times for activation and deactivation to the same timer and assign it to Start digital input MDI1. In the example below, timer 1 is used.

P216	2.00 sec	Activation delay T1
P217	5.00 sec	Deactivation delay T1
P226a	1	Timer assigned to MDI1 (Start)

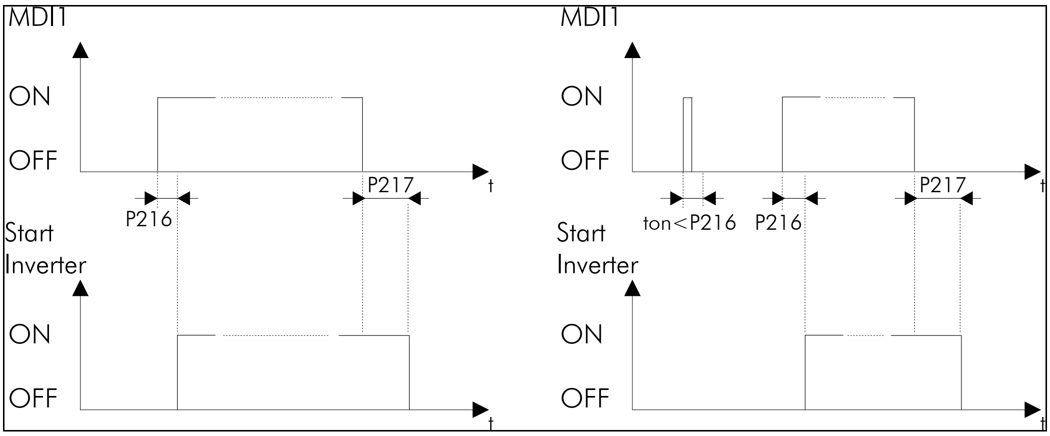


Figure 19: Example 1: Using Timers

Figure 19 shows two possible operating modes:
- On the left: application of the delay times set for the inverter enabling/disabling.
- On the right: the start signal persists for a time shorter than the delay set for enabling. In that case, the Start function is not enabled. The Start function will be enabled only when digital input MDI1 is ON for a time longer than the time set in P216.

10.2 Parameter List

Table 27: List of Parameters P216 ÷ P228

Parameter	FUNCTION	Access Level	MODBUS Address
P216	T 1 Enabling delay	ENGINEERING	816
P217	T 1 Disabling delay	ENGINEERING	817
P218	T 2 Enabling delay	ENGINEERING	818
P219	T 2 Disabling delay	ENGINEERING	819
P220	T 3 Enabling delay	ENGINEERING	820
P221	T 3 Disabling delay	ENGINEERING	821
P222	T 4 Enabling delay	ENGINEERING	822
P223	T 4 Disabling delay	ENGINEERING	823
P224	T 5 Enabling delay	ENGINEERING	824
P225	T 5 Disabling delay	ENGINEERING	825
P226	Timer assignment to inputs MDI1÷4	ENGINEERING	826
P227	Timer assignment to inputs MDI5÷4	ENGINEERING	827
P228	Timer assignment to outputs MDO1÷4	ENGINEERING	828

10.2.1 P216 T1 Enabling Delay

P216	Range	0 ÷ 60000	0.00 ÷ 600.00 sec
T1 Enabling delay	Default	0	0.00
	Level	ENGINEERING	
	Address	816	
	Function	This parameter determines enabling time T1. With **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 closing and the function activation. Use **P228** to assign timer 1 to a digital input; in that case, the digital input energizing will be delayed of the time set in **P216**.	

10.2.2 P217 T1 Disabling Delay

P217	Range	0 ÷ 60000	0.00 ÷ 600.00 sec
T1 Disabling delay	Default	0	0.00
	Level	ENGINEERING	
	Address	817	
	Function	This parameter determines disabling time T1. With **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 closing and the function deactivation. Use **P228** to assign timer 1 to a digital input; in that case, the digital input deenergizing will be delayed of the time set in **P217**.	

10.2.3 P218 T2 Enabling Delay

P218	Range	0 ÷ 60000	0.00 ÷ 600.00 sec
T2 Enabling delay	Default	0	0.00
	Level	ENGINEERING	
	Address	818	
	Function	This parameter determines enabling time T2. With **P226** or **P227**, if **timer T2** is assigned to a digital input having a particular function, this parameter represents the delay occurring between the input closing and the function activation. Use **P228** to assign timer 2 to a digital input; in that case, the digital input energizing will be delayed of the time set in **P218**.	

10.2.4 P219 T2 Disabling Delay

P219	Range	0 ÷ 60000	0.00 ÷ 600.00 sec
T2 Disabling delay	Default	0	0.00
	Level	ENGINEERING	
	Address	819	
	Function	This parameter determines disabling time T2. With P226 or P227, if timer T2 is assigned to a digital input having a particular function, this parameter represents the delay occurring between the input closing and the function deactivation. Use P228 to assign timer 2 to a digital input; in that case, the digital input deenergizing will be delayed of the time set in P219.	

10.2.5 P220 T3 Enabling Delay

P220	Range	0 ÷ 60000	0.00 ÷ 600.00 sec
T3 Enabling Delay	Default	0	0.00
	Level	ENGINEERING	
	Address	820	
	Function	This parameter determines enabling time T3. With P226 or P227, if timer T3 is assigned to a digital input having a particular function, this parameter represents the delay occurring between the input closing and the function activation. Use P228 to assign timer 3 to a digital input; in that case, the digital input energizing will be delayed of the time set in P220.	

10.2.6 P221 T3 Disabling Delay

P221	Range	0 ÷ 60000	0.00 ÷ 600.00 sec
T3 Disabling delay	Default	0	0.00
	Level	ENGINEERING	
	Address	821	
	Function	This parameter determines disabling time T3. With P226 or P227, if timer T3 is assigned to a digital input having a particular function, this parameter represents the delay occurring between the input closing and the function deactivation. Use P228 to assign timer 3 to a digital input; in that case, the digital input deenergizing will be delayed of the time set in P221.	

10.2.7 P222 T4 Enabling Delay

P222	Range	0 ÷ 60000	0.00 ÷ 600.00 sec
T4 Enabling delay	Default	0	0.00
	Level	ENGINEERING	
	Address	822	
	Function	This parameter determines enabling time T4. With P226 or P227, if **timer T4** is assigned to a digital input having a particular function, this parameter represents the delay occurring between the input closing and the function activation. Use P228 to assign timer 4 to a digital input; in that case, the digital input energizing will be delayed of the time set in P222.	

10.2.8 P223 T4 Disabling Delay

P223	Range	0 ÷ 60000	0.00 ÷ 600.00 sec
T4 Disabling delay	Default	0	0.00
	Level	ENGINEERING	
	Address	823	
	Function	This parameter determines disabling time T4. With P226 or P227, if **timer T4** is assigned to a digital input having a particular function, this parameter represents the delay occurring between the input closing and the function deactivation. Use P228 to assign timer 4 to a digital input; in that case, the digital input deenergizing will be delayed of the time set in P223.	

10.2.9 P224 T5 Enabling Delay

P224	Range	0 ÷ 60000	0.00 ÷ 600.00 sec
T5 Enabling delay	Default	0	0.00
	Level	ENGINEERING	
	Address	824	
	Function	This parameter determines enabling time T5. With P226 or P227, if **timer T5** is assigned to a digital input having a particular function, this parameter represents the delay occurring between the input closing and the function activation. Use P228 to assign timer 5 to a digital input; in that case, the digital input energizing will be delayed of the time set in P224.	

<<

10.2.10 P225 T5 Disabling Delay

P225	Range	0 ÷ 60000	0.00 ÷ 600.00 sec
T5 Disabling delay	Default	0	0.00
	Level	ENGINEERING	
	Address	825	
	Function	This parameter determines disabling time T5. With P226 or P227, if timer T5 is assigned to a digital input having a particular function, this parameter represents the delay occurring between the input closing and the function deactivation. Use P228 to assign timer 5 to a digital input; in that case, the digital input deenergizing will be delayed of the time set in P225.	

10.2.11 P226 Timers Assigned to Inputs MDI 1÷4

P226	Range	[0 ; 0 ; 0 ; 0] ÷ [5 ; 5 ; 5 ; 5]	
Timers assigned to inputs MDI 1÷4	Default	[0 ; 0 ; 0 ; 0]	No timer assigned to inputs MDI 1 ÷ 4
	Level	ENGINEERING	
	Address	826	
	Function	The first group of 4 digital inputs may be assigned to any timer; the same timer may be assigned to multiple inputs. Select “zero” to avoid delaying the digital inputs. Setting via serial link: see encoding below.	

Table 28: Encoding P226: Timers Assigned to Digital Inputs

Input	Timer	Bit Set	Binary	Decimal
MDI1	2	BIT0–BIT2	010	2
MDI2	5	BIT3–BIT5	101	5
MDI3	3	BIT6–BIT8	011	3
MDI4	5	BIT9–BIT11	101	5
Value in P226 101 011 101 010bin –>2794dec				

10.2.12 P227 Timers Assigned to Inputs MDI 5÷8

P227	Range	[0 ; 0 ; 0 ; 0] ÷ [5 ; 5 ; 5 ; 5]	
Timers assigned to inputs MDI 5÷8	Default	[0 ; 0 ; 0 ; 0]	No timer assigned to inputs MDI 5 ÷ 8
	Level	ENGINEERING	
	Address	827	
	Function	The second group of 4 digital inputs may be assigned to any timer; the same timer may be assigned to multiple inputs. Select “zero” to avoid delaying the digital inputs. Setting via serial link: see encoding in **P226**.	

10.2.13 P228 Timers Assigned to Digital Outputs MDO 1÷4

P228	Range	[0 ; 0 ; 0 ; 0] ÷ [5 ; 5 ; 5 ; 5]	
Timers assigned to digital outputs MDO 1÷4	Default	[0 ; 0 ; 0 ; 0]	No timer assigned to digital outputs MDO 1 ÷ 4
	Level	ENGINEERING	
	Address	828	
	Function	The digital outputs may be assigned to any timer; the same timer may be assigned to multiple outputs. Select “zero” to avoid delaying the digital outputs. Setting via serial link: see encoding in **P226**.	

11 PID PARAMETERS MENU

11.1 Overview

This menu defines the parameters for the digital PID regulator integrated in the inverter.
The PID regulator may be used to control a physical variable external to the inverter; 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 PID regulator.
The weight of these three terms may be defined by the user with the parameters below.

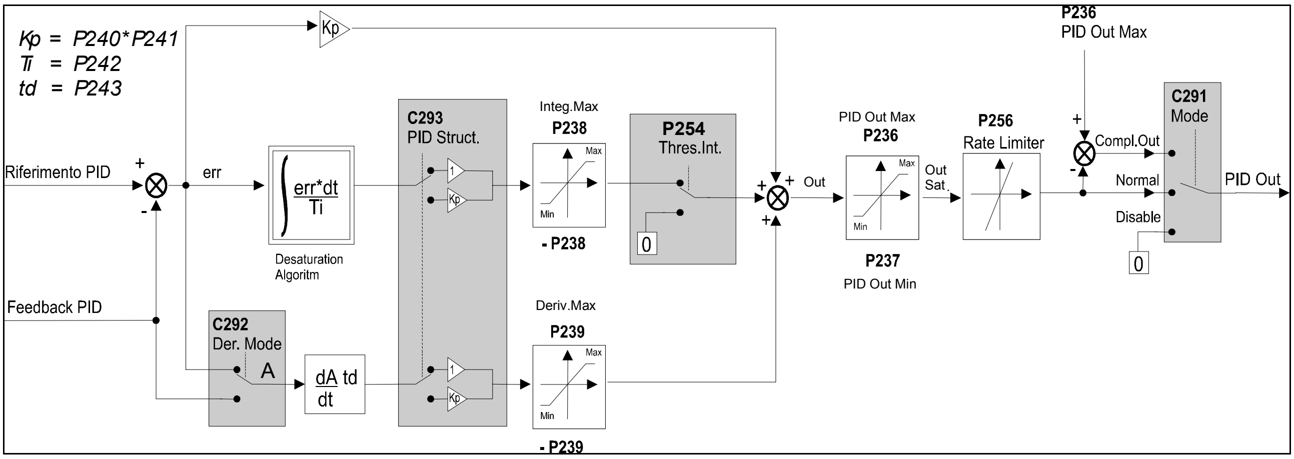


Figure 20: PID Block Diagram

NOTE

In Local mode, the PID regulator is disabled, unless it is used as an external output (C294 = 0: External Output).

11.2 Parameter List

Table 29: List of Parameters P236 ÷ P257

Parameter	FUNCTION	Access Level	MODBUS Address
P236	Max. value of PID output	ENGINEERING	836
P237	Min. value of PID output	ENGINEERING	837
P238	Max. value of integral term	ENGINEERING	838
P239	Max. value of derivative term	ENGINEERING	839
P240	Coefficient of proportional term Kp	ENGINEERING	840
P241	Multiplicative factor of proportional term Kp	ENGINEERING	841
P242	Integral time (multiples of Ts)	ENGINEERING	842
P243	Derivative time (multiples of Ts)	ENGINEERING	843
P244	Cycle time of PID regulator: Ts	ENGINEERING	844
P245	Min. value of PID reference	ENGINEERING	845
P246	Max. value of PID reference	ENGINEERING	846
P247	Min. value of PID feedback	ENGINEERING	847
P248	Max. value of PID feedback	ENGINEERING	848
P249	PID reference ramp up time	ENGINEERING	849
P250	PID reference ramp down time	ENGINEERING	850
P251	Unit of measure of PID ramp	ENGINEERING	851
P252	PID ramp start rounding off	ENGINEERING	852
P253	PID ramp end rounding off	ENGINEERING	853
P254	Integral term activation threshold	ENGINEERING	854
P255	Disabling timer if Out < Min	ENGINEERING	855
P256	PID output gradient limitation	ENGINEERING	856
P257	Gain for PID measure scaling	ENGINEERING	857

11.2.1 P236 Max. Value of PID Output

P236	Range	–10000 ÷ +10000	–100,00 ÷ +100,00 %
Max. value of PID output	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 meaning depends on the programming in parameter **C294**, defining PID action. Example: if **C294** = External Out, PID regulator delivers a reference obtained based on the controlled variable and its setpoint. In that case, the PID output can be brought outside through an analog output. The matching between **P236** and the output value (see Analog 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 inverter output voltage; in that case, **P236** relates to the instant voltage value.	

11.2.2 P237 Min. Value of PID Output

P237	Range	–10000 ÷ +10000	–100,00 ÷ +100,00 %
Max. value of PID output	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 description of parameter **P236**.	

11.2.3 P238 Max. Value of Integral Term

P238	Range	0 ÷ 10000	–100,00 ÷ +100,00 %
Max. value of integral term	Default	10000	+100,00 %
	Level	ENGINEERING	
	Address	838	
	Function	This is the max. allowable value of the integral term. It is to be considered <u>as an absolute value;</u> the output value resulting from the integral term ranges from + **P238** to – **P238**.	

11.2.4 P239 Max. Value of Derivative Term

P239			
Max. value of derivative term	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.	

11.2.5 P240 Proportional Coefficient

P240			
Proportional coefficient	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).	

11.2.6 P241 Proportional Coefficient Multiplicative Factor

P241			
Proportional coefficient multiplicative factor	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. Encoded values Multiplicative factor 0 1.0 1 10.0 2 100.0 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%.	

11.2.7 P242 Integral Time

P242	Range	0 ÷ 65000	0: Cancelled integral time 1 ÷ 65000 * Ts
Integral time (multiples of Ts)	Default	500	500 Ts
	Level	ENGINEERING	
	Address	842	
	Function	Constant Ti 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 disabled.	

11.2.8 P243 Derivative Time

P243	Range	0 ÷ 65000	0: Cancelled derivative time 0,001 ÷ 65,000 * Ts
Derivative time (multiples of Ts)	Default	0	
	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.	

11.2.9 P244 Cycle Time Ts of PID Regulator

P244	Range	5 ÷ 65000	0 ÷ 65000 ms
Cycle time Ts of PID regulator	Default	5	5 ms
	Level	ENGINEERING	
	Address	844	
	Function	This parameter determines 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.	

11.2.10 P245 Min. Value of PID Reference

P245			
Min. value of PID reference	Range	–10000 ÷ +10000	+/–100.00%
	Default	–10000	–100.00%
	Level	ENGINEERING	
	Address	845	
	Function	This parameter defines the min. allowable value of the reference of the PID regulator. The PID references are to be considered as values percent; if analog references are selected, P245 relates to the max. value of the selected analog input. Example: Select analog input AIN1 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. If digital reference sources are selected, the reference is already expressed as a percentage.	

11.2.11 P246 Max. Value of PID Reference

P246			
Max. value of PID reference	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 description of P245.	

11.2.12 P247 Min. Value of PID Feedback

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

11.2.13 P248 Max. Value of PID Feedback

P248			
Max. value of PID feedback	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 description of P245.	

11.2.14 P249 PID Reference Ramp Up Time

P249			
PID reference ramp up time	Range	0 ÷ 32700	*Function of P251*
	Default	0	0 sec
	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| }).	

11.2.15 P250 PID Reference Ramp Down Time

P250			
PID reference ramp down time	Range	0 ÷ 32700	*Function of P251*
	Default	0	0 sec
	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%.	

11.2.16 P251 Unit of Measure of PID Ramp Time

P251			
	Range	0 ÷ 3	0: 10 ms 1: 100 ms 2: 1000 ms 3: 10000 ms
Unit of measure of PID reference ramp time	Default	1	1: 100 ms
	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	Encoding	Min.	Max.
0	10ms	0	327.00 s
1	100ms	0	3270.0 s
2	1000ms	0	32700 s
3	10000ms	0	327000 s

NOTE

Factory-setting: the PID reference ramp is null; 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.

11.2.17 P252 PID Ramp Start Rounding Off

P252	Range	0 ÷ 100	0 % ÷ 100%
PID ramp start rounding off	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.

11.2.18 P253 PID Ramp End Rounding Off

P253	Range	0 ÷ 100	0 % ÷ 100%
PID ramp end rounding off	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.

11.2.19 P254 Integral Term Activation Threshold

P254	Range	0.0 ÷ 5000	0.0 % ÷ 500.0%
Integral Term Activation Threshold	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 that case, the threshold value percent refers to the max. speed (or torque) absolute value set for the active motor. The integral term is not computed when the speed (or torque) value percent expressed as an absolute value is lower than the value set in P254. If P254 is set to zero, the integrator is always activated.	

11.2.20 P255 Disabling timer if Out < Min

P255	Range	0 ÷ 60000	0: Function disabled 1 ÷ 60000 Ts
Disabling timer if Out <= Min	Default	0	0: Function disabled
	Level	ENGINEERING	
	Address	855	
	Function	This parameter is expressed in time units of the PID regulator cycle (see P244) and it sets the max. time for the inverter operation with the PID regulator output continuously at its min. value. If this is true for a time equal to the time set in P255, the inverter is automatically put in stand-by until the PID output value exceeds the min. value. If C149 is set as External Out or P255 is set to zero, this function is disabled.	

11.2.21 P256 PID Output Gradient Limitation

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

11.2.22 P257 Gain for PID Measure Scaling

P257	Range	0 ÷ 65000	0,000 ; 65,000
Gain for PID measure scaling	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 M025 = M022 * P257	

12 DISPLAY/KEYPAD MENU

12.1 Overview

NOTE

Please read and understand the "Operating and Remoting the Keypad" section in Sinus Penta's Installation Manual.

The Display/Keypad menu includes special parameters for navigation and display.

This section also describes how to modify the "Keypad" page.

The "Keypad" page may be accessed by pressing the MENU key in the keypad or when the LOCAL mode is enabled.

Press the MENU key in the keypad to display the following preset pages:

- Root page
- Page enabling parameter modifications
- Software Version ID page
- Keypad Page
- Page displayed when the MENU key was pressed

The LOCAL mode enables commands and references sent from keypad. Any other source of references and commands is disabled in LOCAL mode.
(See Control Method Menu, Digital Inputs Menu, References Menu.)

12.2 Parameter List

Table 30: List of Parameters P264 ÷ P266

Parameter	FUNCTION	Access Level	MODBUS Address
P264	Type of navigation	BASIC	864
P265	Circular navigation	BASIC	865
COD	Encoding of special units of measure	BASIC	1861
Display	Measure selection display for Root page	BASIC	
P266	Type of Keypad page	BASIC	866
Keypad	Measure selection for Keypad page	BASIC	

12.2.1 P264 Type of Navigation

P264	Range	0 ÷ 1	0: By menu 1: Linear navigation by modified parameters
Type of navigation	Default	0	0: By menu
	Level	BASIC	
	Address	864	
	Function	The keypad is factory-set with navigation by menu. Navigation by menu is also preset at each power–on. Set P264=1 to navigate to the parameters that have been changed by the user. If P264=1, navigation is linear: the customized parameters appear in sequence; press the INC and DEC keys to navigate to a particular parameter. If a small number of parameters have been changed, navigation is slower, because searching is slower.	

NOTE This parameter cannot be saved: navigation by menu is restored at each power on.

12.2.2 P265 Circular Navigation

P265	Range	0 ÷ 1	0: Navigation from the beginning to the end 1: Navigation with “Wrap”
Circular navigation	Default	1	1: Navigation with “Wrap”
	Level	BASIC	
	Address	865	
	Function	When P265=1 (factory setting), navigation inside each menu is a wrap-type navigation: navigation starts from the first page of the active menu; press “ ⋀ “ to go to the next page. Once you reach the last page, press “ ⋀ “ again to return to the first page of the active menu. From the first page of the active menu, press “ ⋁ ” to go to the last page of the menu. If P265=0, once the last page of the active menu is displayed, press “ ⋁ ” to go back to the previous pages up to the first page.	

12.2.3 COD Encoding of Special Units of Measure

COD	Range		
Encoding of special units of measure	Default	0x015D255B	[%]
	Level	BASIC	
	Address	1861	(32-bit data item) !!! *Character encoding is 8-bit ASCII. There are 3 characters encoded with 8 bits each, starting from the less significant bit. Bit 24 is to be set to 1.*
	Function	This parameter allows to set a 3-character string that can be used to display the units of measures for the PID Measures: M023, M024, M025. You can change one character at a time. Press the PROG key; the cursor next to the character located on the left will flash; press "/\" and/or "\/" to scroll through the parameters that can be displayed. Select one character; press PROG to go to the next character. Select the third character and press SAVE to store the new value of the parameter. Reference, feedback and output of the PID regulator are expressed as % by measures M020, M021, M022. Parameter P257 allows to set a gain for the scaling of the three measures: M023 = P257 * 0.001 * M020; M024 = P257 * 0.001 * M021; M025 = P257 * 0.001 * M022.	

NOTE See also the description of parameter P257 in the **PID Parameters Menu**.

12.2.4 Measure Selection Display for Root Page

Display			
Measure selection display for Root page	Range	All available measures Mxx	
	Default	M00 M02	
	Level	BASIC	
	Address	This parameter may be modified via keypad only. (Modification is not possible via serial link.)	
	Function	From this page in the Display menu (page 4/5) you can choose the measures to be displayed in the ROOT page of the keypad. The ROOT page is displayed at the inverter power on (factory setting). The headline shows the inverter status; in the bottom line you can choose one of the following menus: [MIS] PAR CF SRV The second and the third line in the Root page show the second and the third line displayed in the page relating to the Display parameter. Hold down the PROG key for 5 seconds; a flashing cursor will appear on the left; an arrow < will appear on the right. Change the measure displayed with the up arrow, then press SAVE to store the new value. Press PROG to display the second measure; repeat the procedure above.	

12.2.5 P266 Type of Keypad Page

P266	Range	1 ÷ 4	1: Measures only 2: Speed 3: Torque 4: PID
Type of Keypad page	Default	2	2: Speed
	Level	BASIC	
	Address	866	
	Function	This parameter sets which type of Keypad page is displayed: **1: Measures only**: Four measures are displayed. The up arrow and down arrow keys are disabled. **2: Speed**: The first 3 lines show 3 measures; the bottom line shows the value of the **speed** reference at constant speed. In Local mode, you can change this value by pressing the “Λ” (UP arrow) and “V” (DOWN arrow) keys. **3: Torque**: The first 3 lines show 3 measures; the bottom line shows the value of the **torque** reference at constant speed. In Local mode, you can change this value by pressing the “Λ” (UP arrow) and “V” (DOWN arrow) keys. **4: PID**: The first 3 lines show 3 measures; the bottom line shows the value of the **PID** regulator at constant speed. In Local mode, you can change this value by pressing the “Λ” (UP arrow) and “V” (DOWN arrow) keys.	

NOTE

If **P266** = 2 and in SLAVE mode (torque reference), P266 is automatically forced to 3.
The torque reference can be changed in the Keypad page and in **LOCAL** mode.

If **P266** = 3 and in MASTER mode (speed reference), P266 is automatically forced to 2.
The speed reference can be changed in the Keypad page and in **LOCAL** mode.

NOTE

See also **References Menu**.

12.2.6 MEASURE SELECTION FOR KEYPAD PAGE

KEYPAD			
Measure selection for Keypad page	Range		
	Default		
	Level	BASIC	
	Address		
	Function	The Keypad page allows to change the measures displayed in the first 3 lines. (If P266=0, you can also set the measure displayed in the bottom line). Hold down the PROG key for 5 seconds; a flashing cursor will appear on the left; an arrow < will appear on the right. Press the UP arrow key to change the displayed measure; press SAVE to store the new value. Press PROG to display the second measure; repeat the procedure above. Press PROG again to display the third measure; repeat the procedure above. Do the same for measure 4 (measure may be changed provided that P266= 0).	

13 DIGITAL OUTPUTS MENU

13.1 Overview

13.1.1 DIGITAL OUTPUTS MENU

The Digital Outputs menu includes those parameters allowing to configure the inverter digital outputs (MDO1, MDO2, MDO3 and MDO4).

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

NOTE — For a detailed hardware description of the digital outputs, refer to the Installation Manual.

NOTE — Digital output MDO1 can be programmed only if the frequency output is not set up (P200 = Disable; see Analog Outputs Menu).

Digital output MDO1 is factory set to control an electromechanical brake used for lifting applications.
Digital output MDO2 is programmed as a zero speed relay that energizes when a given threshold is exceeded and deenergizes when speed drops below a second threshold.
Digital output MDO3 is active when the inverter is commuting.
Digital output MDO4 energizes when the inverter is not in emergency condition (no alarms tripped).

The diagram below is an example of the structure of one of the four MDO1 outputs; digital outputs MDO2, MDO3 and MDO4 have the same logic operation relating to the relevant parameters.

13.1.2 MDOx: DIGITAL OUTPUT MODE: P270, (P279, P288, P297)

You can select the operating mode of the digital output (Mode block in Figure 1), by choosing one of the available options:

Table 31: Digital Output Mode

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 (Figure 1).
DOUBLE DIGITAL	The digital output depends on 2 selected digital signals, on the logic function computing the output value and on the logic output function True/False (Figure 3).
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 computes the output value, whereas the logic output function True/False computes the end value (Figure 2).
DOUBLE ANALOG	The digital outputs depends on 2 selected analog variables: Test A is performed for variable A, while Test B is performed for variable B, thus obtaining 2 digital signals; starting from their value, the selected logic function computes the output value, whereas the logic output function True/False computes the end value.
DOUBLE FULL	See DOUBLE ANALOG or DOUBLE DIGITAL mode; you can select both digital signals and analog variables. If you select a digital signal, its value (TRUE or FALSE) is used to compute 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 compute the selected logic function.
BRAKE	See ABS BRAKE below; the selected variables are not expressed as absolute values, but depend on the selected tests.
ABS BRAKE	The ABS BRAKE mode allows to control the electromechanical brake of a motor used for lifting applications. To enable the relevant output, check that all the conditions depending on the inverter status are true (see 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.
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.

13.1.3 MDOx: Selecting Variable A: P271, (P280, P289, P298)

It selects the digital signal or the analog variable used for Test A (set with P273 / P282 / P291 / P300).
The whole list of selectable items and their description appears at the end of this section (see Table 8).
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.

13.1.4 MDOx: Selecting Variable B: P272, (P281, P290, P299)

It selects another digital signal or the analog variable used for Test B (set with P274 / P283 / P292 / P301).
The whole list of selectable items and their description appears at the end of this section (see Table 8).
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 32: List of the Selectable Digital Signals and Analog Variables

Selectable digital signals (BOOLEAN):

Selectable Value	Description
D0: Disable	Always FALSE: 0
D1: Inverter Run Ok	Inverter running (no standby) and no alarms tripped
D2: Inverter Ok On	Inverter OK: no alarms tripped
D3: Inverter Ok Off	Inverter KO: alarm tripped
D4: Inverter Run Alarm	Inverter KO: alarm tripped when the inverter is running
D5: Fwd Running	Speed (measured or estimated) higher than +0.5 rpm
D6: Rev Running	Speed (measured or estimated) lower than –0.5 rpm
D7: Limiting Motor	Inverter in limiting mode operating as a motor
D8: Limiting Generator	Inverter in limiting mode operating as a generator
D9: Limiting	Inverter in limiting mode (generator or motor)
D10: Precharge Ok	Capacitor Precharge relay closing
D11: PID Out Max	PID output max. saturation
D12: PID Out Min	PID output min. saturation
D13: MDI 1	Selected digital output MDI1 (remote physical OR)
D14: MDI 2	Selected digital output MDI2 (remote physical OR)
D15: MDI 3	Selected digital output MDI3 (remote physical OR)
D16: MDI 4	Selected digital output MDI4 (remote physical OR)
D17: MDI 5	Selected digital output MDI5 (remote physical OR)
D18: MDI 6	Selected digital output MDI6 (remote physical OR)
D19: MDI 7	Selected digital output MDI7 (remote physical OR)
D20: MDI 8	Selected digital output MDI8 (remote physical OR)
D21: MDI Enable	Selected digital input Enable (remote physical AND)
D22: MDI Enable S	Selected digital input Enable S (remote physical AND)
D23: MDI 1 Delayed	Digital input MDI1 (remote physical OR) DELAYED by timers MDI
D24: MDI 2 Delayed	Digital input MDI1 (remote physical OR) DELAYED by timers MDI
D25: MDI 3 Delayed	Digital input MDI1 (remote physical OR) DELAYED by timers MDI
D26: MDI 4 Delayed	Digital input MDI1 (remote physical OR) DELAYED by timers MDI
D27: MDI 5 Delayed	Digital input MDI1 (remote physical OR) DELAYED by timers MDI
D28: MDI 6 Delayed	Digital input MDI1 (remote physical OR) DELAYED by timers MDI
D29: MDI 7 Delayed	Digital input MDI1 (remote physical OR) DELAYED by timers MDI
D30: MDI 8 Delayed	Digital input MDI1 (remote physical OR) DELAYED by timers MDI
D31: MDI Enable Delayed	Digital input MDI1 (remote physical OR) DELAYED by timers MDI
D32: Tracking Error	Speed tracking error: |SetPoint – Measure| > Error_Par exceeding one timeout
D33: Fan Fault	Fault of the cooling fan

D34: Reserved	
D35: Reserved	
D36: Reserved	
D37: Reserved	
D38: Reserved	
D39: Reserved	
D40: Reserved	
D41: Reserved	
D42: Reserved	
D43: Reserved	
D44: Reserved	
D45: Reserved	
D46: Reserved	
D47: Reserved	
D48: Reserved	
D49: Reserved	

✓ Selectable analog variables:

Selectable Value	Full-scale Value	Kri	Description
A50: GROUND			Analog 0 Volt
A51: Speed	10000 rpm	1	Motor speed
A52: Speed Ref.	10000 rpm	1	Speed reference at constant speed
A53: Ramp Out	10000 rpm	1	Speed reference when ramps are over
A54: Motor Frequency	1000.0 Hz	10	Frequency produced by the inverter
A55: Motor Current	1000.0 A	10	Current RMS
A56: Output Voltage	1000.0 V	10	Output voltage RMS
A57: Output Power	1000.0 kW	10	Output power
A58: V bus DC	1000.0 V	10	DC-link voltage
A59: Torque Reference	100.00 %	100	Torque reference at constant speed
A60: Torque Demand	100.00 %	100	Torque demand
A61: Torque Output	100.00 %	100	Estimation of the torque output
A62: Torque Limit	100.00 %	100	Torque limit setpoint
A63: PID Reference	100.00 %	100	PID reference at constant speed
A64: PID Set Point	100.00 %	100	PID reference when ramps are over
A65: PID Error	100.00 %	100	Error between PID reference and PID feedback
A66: PID Feedback	100.00 %	100	PID feedback
A67: PID Out	100.00 %	100	PID output
A68: REF	100.00 %	100	Analog input REF
A69: AIN1	100.00 %	100	Analog input AIN1
A70: AIN2/PTC	100.00 %	100	Analog input AIN2/PTC
A71: EncIn	10000 rpm	1	Speed read from encoder and used as a reference
A72: PulseIn	100.00 kHz	100	Frequency input
A73: Flux Reference	1.0000 Wb	1	Flux reference at constant speed
A74: Flux	1.0000 Wb	1	Active flux reference
A75: Iq Reference	1000.0 A	10	Current reference over axis q
A76: Id Reference	1000.0 A	10	Current reference over axis d
A77: Iq	1000.0 A	10	Current measure over axis q
A78: Id	1000.0 A	10	Current measure over axis d
A79: Vq	1000.0 V	10	Voltage over axis q

A80: Vd	1000.0 V	10	Voltage over axis d
A81: Cosine	100.00 %	100	Waveform: Cosine
A82: Sine	100.00 %	100	Waveform: Sine
A83: Angle	100.00 %	100	Electric angle of delivered Vu
A84: +10V			+10 Volt Analog
A85: –10V			–10 Volt Analog
A86: Reserved			
A87: Square Wave	100.00 %	100	Square wave
A88: Saw Wave	100.00 %	100	Saw wave
A89: Heatsink Temp.	100.00 °C	100	Heatsink temperature
A90: Ambient Temp.	100.00 °C	100	Ambient temperature
A91: A Zero 1			0 Volt Analog
A92: A Zero 2			0 Volt Analog
A93: A Zero 3			0 Volt Analog
A94: A Zero 4			0 Volt Analog
A95: A Zero 5			0 Volt Analog
A96: A Zero 6			0 Volt Analog
A97: A Zero 7			0 Volt Analog
A98: A Zero 8			0 Volt Analog
A99: A Zero 9			0 Volt Analog

Minimum value = –3.2*Full-scale value
Maximum value = 3.2*Full-scale value
MODBUS Value = Parameter value* Kri

13.1.5 MDOx: Testing Variable A: P273, (P282, P291, P300)

If an analog variable is selected, a logic TEST is performed to obtain a Boolean signal TRUE/FALSE.
Seven different tests are available, that can be performed for selected variable A and its comparing value A:

Table 33: 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	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

13.1.6 MDOx: Testing Variable B: P274, (P283, P292, P301)

If an analog variable is selected, a logic TEST is performed to obtain a Boolean signal TRUE/FALSE.
Seven different tests are available, that can be performed for selected variable B and its comparing value B (see Table 33, Test Functions).

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

13.1.7 MDOx: Comparing Value for Test A: P275, (P284, P293, P302)

It 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

13.1.8 MDOx: Comparing Value for Test B: P276, (P285, P294, P303)

It 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

13.1.9 MDOx: Function Applied to the Result of the 2 Tests: P277, (P286, P295, P304)

A logic function is applied to the two Boolean signals obtained in order to obtain the output Boolean signal TRUE/FALSE.
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 to enable 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 described 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 condition is true.

(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.

(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 either condition is true.

(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

13.1.10 MDOx: Reversing the Output Logic Level: P278, (P287, P296, P305)

At the end of the processing chain, you can reverse the logic of the Boolean signal.
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

13.2 Programmable Modes (Diagrams)

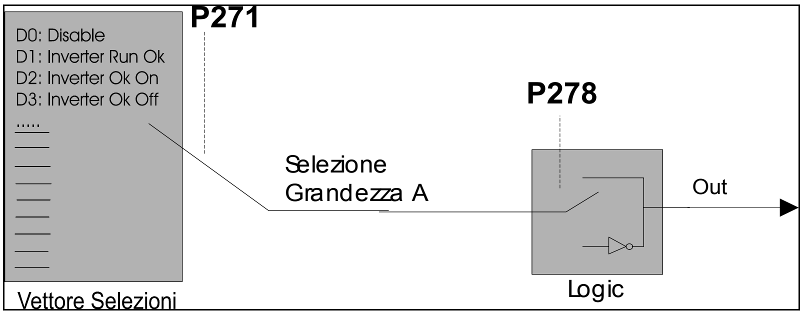


Figure 21: "DIGITAL" Mode

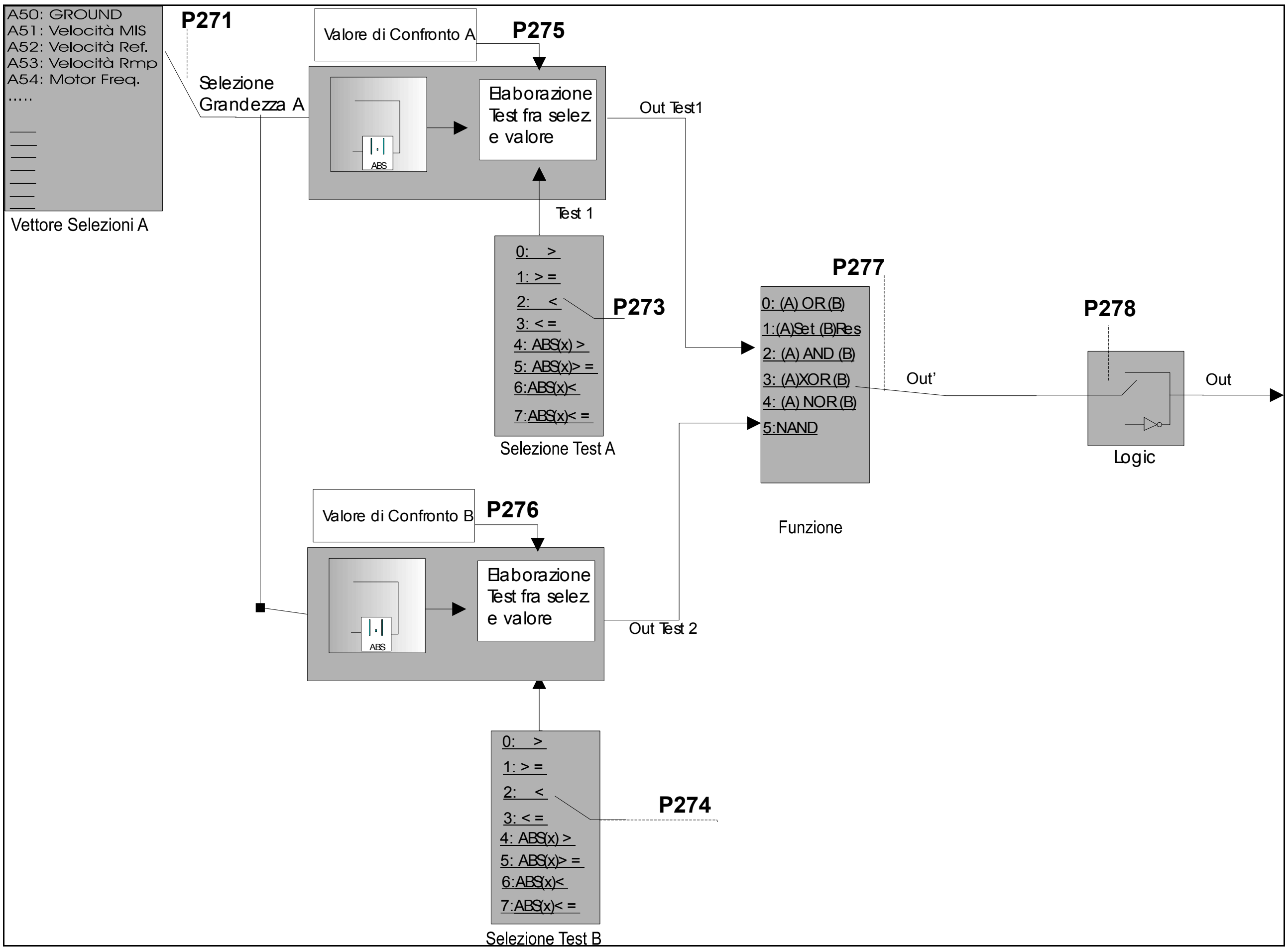


Figure 22: "ANALOG" Mode

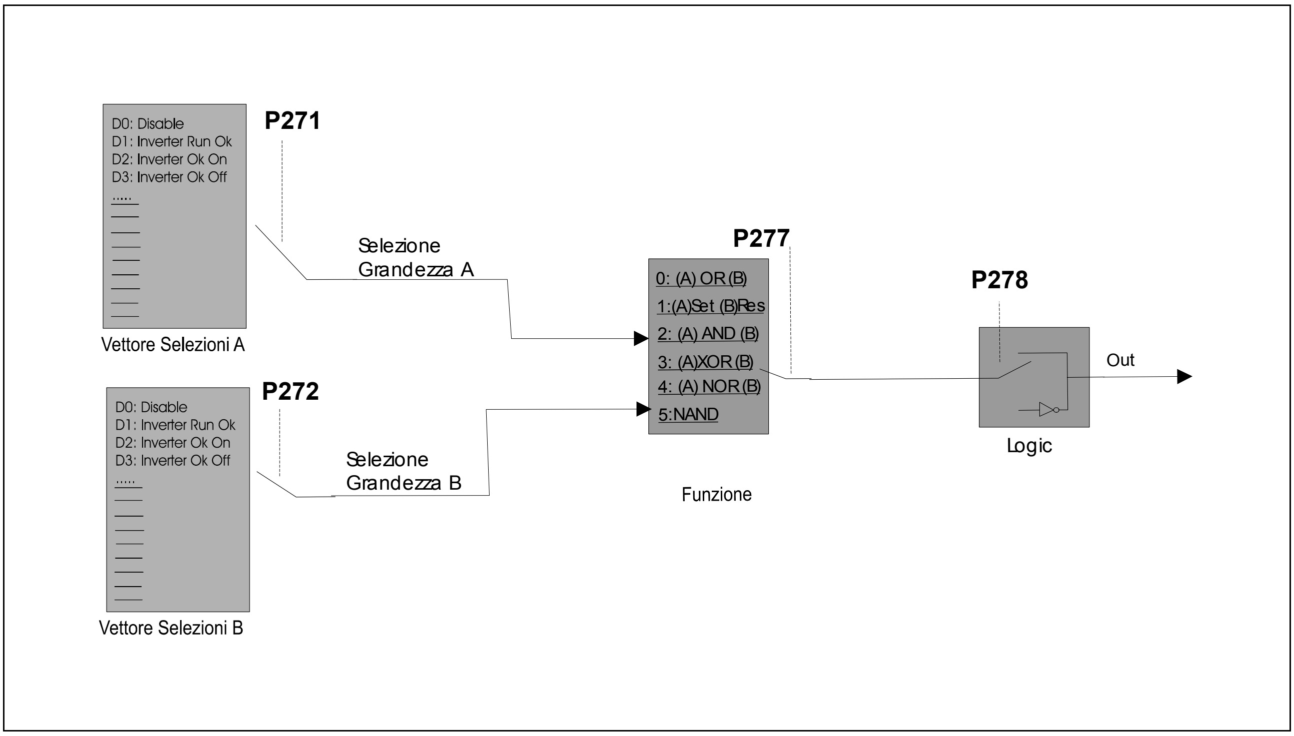


Figure 23: "DOUBLE DIGITAL" Mode

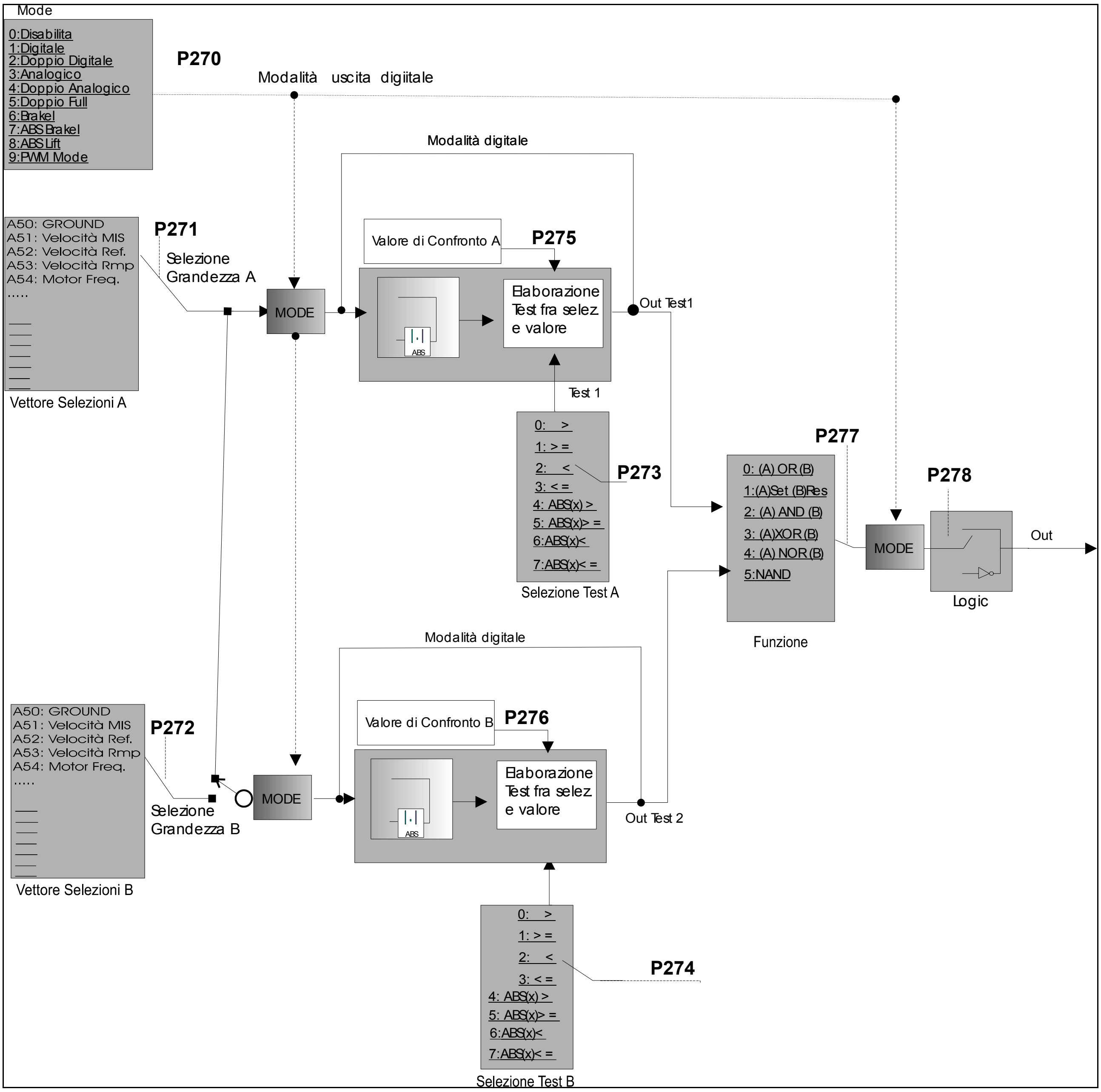


Figure 24: General Structure of the Parameterization of a Digital Output

13.3 Examples

A table stating the set up of the parameters used is given for each example.
Parameters highlighted in grey have no effect.

13.3.1 EXAMPLE 1: DIGITAL OUTPUT FOR INVERTER OK DIGITAL COMMAND (DEFAULT: DIGITAL OUTPUT MDO3)

Table 34: Parameterization for Example 1

P270	MDO1: Digital output mode	DIGITAL
P271	MDO1: Variable A selection	D2: Inverter Ok On
P272	MDO1: Variable B selection	
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	
P278	MDO1: Output logic level	TRUE

The digital output status depends on the Boolean variable "Inverter Ok", which is FALSE only when an alarm trips.

13.3.2 EXAMPLE 2: DIGITAL OUTPUT FOR DIGITAL COMMAND INVERTER RUN OK (DEFAULT: DIGITAL OUTPUT MDO4)

Table 35: Parameterization for Example 2

P270	MDO1: Digital output mode	DIGITAL
P271	MDO1: Variable A selection	D1: Inverter Run Ok
P272	MDO1: Variable B selection	
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	
P278	MDO1: Output logic level	TRUE

The digital output status depends on the Boolean variable "Inverter Run Ok", which is TRUE only when the inverter is modulating (IGBTs on).

13.3.3 EXAMPLE 3: DIGITAL OUTPUT FOR SPEED THRESHOLDS

Suppose that a digital output energizes if the motor speed exceeds 100rpm as an absolute value, and deenergizes 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 36: Parameterization for Example 3

P270	MDO1: Digital output mode	ANALOG
P271	MDO1: Variable A selection	A51: 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
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.

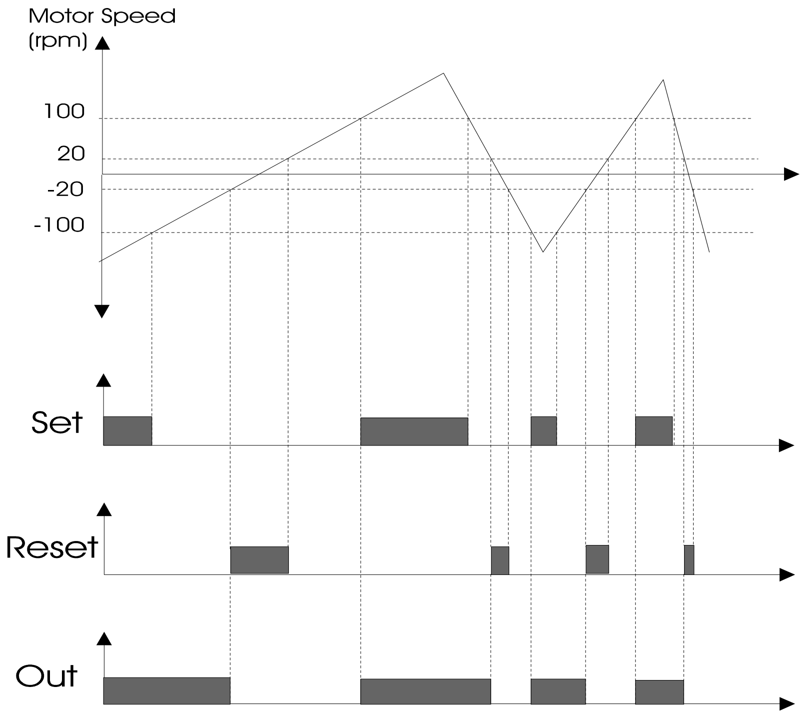


Figure 25: Example 3 – Digital Output for Speed Thresholds

13.3.4 EXAMPLE 4: DIGITAL OUTPUT FOR ELECTROMECHANICAL BRAKE FOR LIFTING APPLICATIONS (DEFAULT: DIGITAL OUTPUT MDO4)

Table 37: Parameterization for Example 4

P270	MDO1: Digital output mode	ABS BRAKE
P271	MDO1: Variable A selection	A61: Torque Output
P272	MDO1: Variable B selection	A51: Speed MEA
P273	MDO1: Testing variable A	>
P274	MDO1: Testing variable B	≤
P275	MDO1: Comparing value for Test A	20,00%
P276	MDO1: Comparing value for Test B	50,00 rpm
P277	MDO1: Function applied to the result of the two tests	(A) Set (B) Reset
P278	MDO1: Output logic level	TRUE

The digital output energizes only if no alarm has tripped. The torque demand is greater than P275 = 20.00% (Set). The digital output deenergizes if an alarm trips or if the decelerating speed is lower than the speed value set in P274 = 50% (reset).

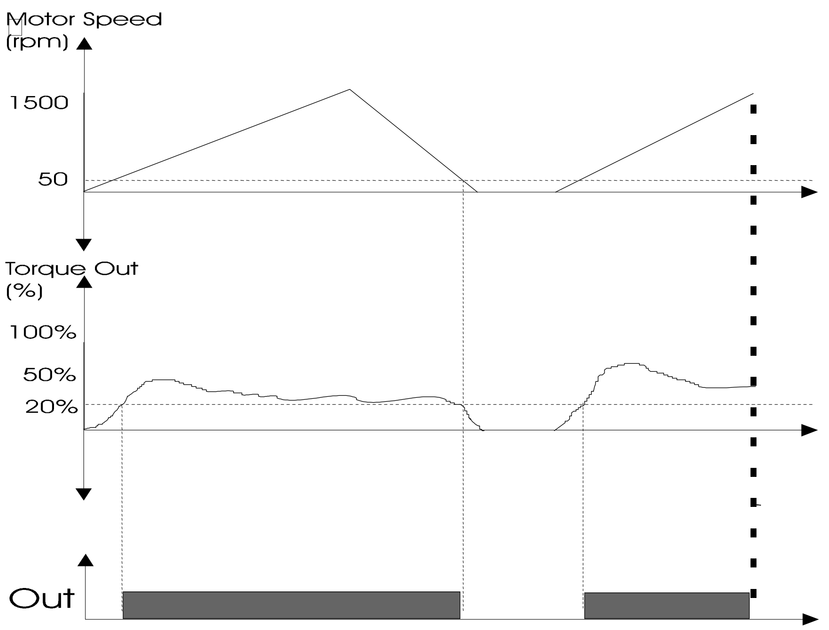


Figure 26: Example 4 – Electromechanical Brake Command

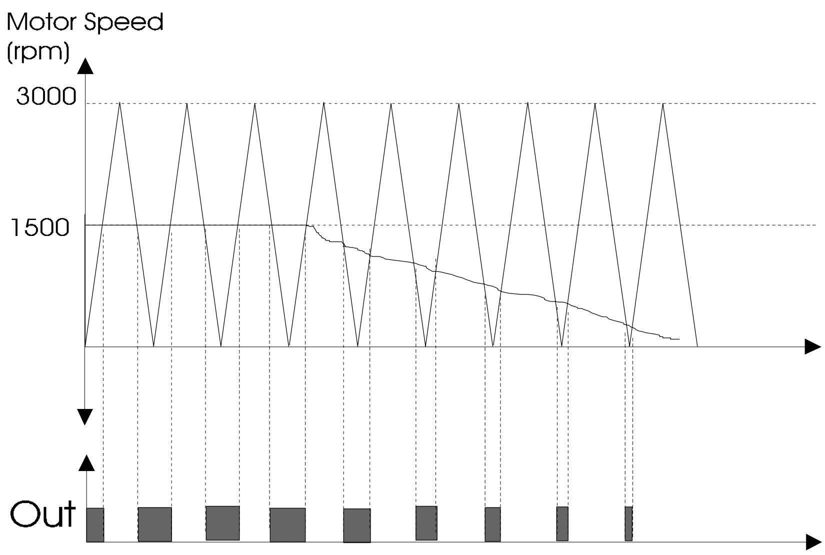
13.3.5 EXAMPLE 5: USING PWM FUNCTION

Suppose that the motor of a machine tool is controlled by an inverter. The tool must be greased based on the cutting speed. At max. cutting speed, the solenoid valve controlling greasing 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 solenoid valve 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), min. value 0rpm (when speed = 0rpm, the solenoid valve is disabled) and max. value = Spd1 100/ dtc1 = 2*Spd1.
Supposing that the tool can rotate in both directions, that Spd1 = 1500rpm and that digital output MDO2 is used, parameters are set as follows:

Table 38: Parameterization for Example 5

P270	MDO1: Digital output mode	ABS BRAKE
P271	MDO1: Variable A selection	A52: 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	
P278	MDO1: Output logic level	TRUE
P215	Saw signal frequency	0.01Hz

Parameter **P215** in Analog Outputs Menu sets the frequency of the saw wave, i.e. 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.



13.4 Parameter List

Table 39: List of Parameters P270 ÷ P305

Parameter	FUNCTION	Access Level	MODBUS Address
P270	MDO1: Digital output mode	ADVANCED	870
P271	MDO1: Selecting variable A	ADVANCED	871
P272	MDO1: Selecting variable B	ADVANCED	872
P273	MDO1: Testing variable A	ADVANCED	873
P274	MDO1: Testing variable B	ADVANCED	874
P275	MDO1: Comparing value for Test A	ADVANCED	875
P276	MDO1: Comparing value for Test B	ADVANCED	876
P277	MDO1: Function applied to the result of the 2 tests	ADVANCED	877
P278	MDO1: Output logic level	ADVANCED	878
P279	MDO2: Digital output mode	ADVANCED	879
P280	MDO2: Selecting variable A	ADVANCED	880
P281	MDO2: Selecting variable B	ADVANCED	881
P282	MDO2: Testing variable A	ADVANCED	882
P283	MDO2: Testing variable B	ADVANCED	883
P284	MDO2: Comparing value for Test A	ADVANCED	884
P285	MDO2: Comparing value for Test B	ADVANCED	885
P286	MDO2: Function applied to the result of the 2 tests	ADVANCED	886
P287	MDO2: Output logic level	ADVANCED	887
P288	MDO3: Digital output mode	ADVANCED	888
P289	MDO3: Selecting variable A	ADVANCED	889
P290	MDO3: Selecting variable B	ADVANCED	890
P291	MDO3: Testing variable A	ADVANCED	891
P292	MDO3: Testing variable B	ADVANCED	892
P293	MDO3: Comparing value for Test A	ADVANCED	893
P294	MDO3: Comparing value for Test B	ADVANCED	894
P295	MDO3: Function applied to the result of the 2 tests	ADVANCED	895
P296	MDO3: Output logic level	ADVANCED	896
P297	MDO4: Digital output mode	ADVANCED	897
P298	MDO4: Selecting variable A	ADVANCED	898
P299	MDO4: Selecting variable B	ADVANCED	899
P300	MDO4: Testing variable A	ADVANCED	900
P301	MDO4: Testing variable B	ADVANCED	901
P302	MDO4: Comparing value for Test A	ADVANCED	902
P303	MDO4: Comparing value for Test B	ADVANCED	903
P304	MDO4: Function applied to the result of the 2 tests	ADVANCED	904
P305	MDO4: Output logic level	ADVANCED	905

13.4.1 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
Operating mode of digital output MDO1	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 in the previous section.	

NOTE

Digital output MDO1 can be programmed only if the frequency output is not set up: P200 = Disable (see Analog Outputs Menu).

13.4.2 P271 MDO1: Selecting Variable A

P271	Range	0 ÷ 99	see Table 32
Variable 1 selected for MDO1	Default	51	A51: Speed MEA
	Level	ADVANCED	
	Address	871	
	Function	This parameter selects the digital signal used to compute the value of digital output MDO1. It selects an analog variable used to compute the value of digital input MDO1 if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 32.	

13.4.3 P272 MDO1: Selecting Variable B

P272	Range	0 ÷ 99	see Table 32
Variable 2 selected for MDO1	Default	51	A51: Speed MEA
	Level	ADVANCED	
	Address	872	
	Function	This parameter selects the second digital signal used to compute the value of digital output MDO1. It selects an analog variable used to compute the value of digital input MDO1 if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 32.	

13.4.4 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) ≤
Test A for MDO1	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.	

13.4.5 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) ≤
Test B for MDO1	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.	

13.4.6 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 32*
Comparing value for Test A (MDO1)	Default	50	50 rpm
	Level	ADVANCED	
	Address	875	
	Function	This parameter defines the comparing value with the selected variable for test A.	

13.4.7 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 32*
Comparing value for Test B (MDO1)	Default	10	10 rpm
	Level	ADVANCED	
	Address	876	
	Function	This parameter defines the comparing value with the selected variable for test B.	

13.4.8 P277 MDO1: Function Applied to the Result of the 2 Tests

P277	Range	0 ÷ 5	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)
Function applied to the result of the two tests (MDO1)	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 to compute the output value.	

13.4.9 P278 MDO1: Output Logic Level

P278	Range	0–1	0: FALSE 1: TRUE
Output logic level (MDO1)	Default	1	1: TRUE
	Level	ADVANCED	
	Address	878	
	Function	Digital output logic function MDO1 to apply a logic reversal (negation) to the computed output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

13.4.10 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
Operating mode of digital output MDO2	Default	6	1: DIGITAL
	Level	ADVANCED	
	Address	879	
	Function	This parameter defines the operating mode of digital output 2. The different operating modes are described in the previous section.	

13.4.11 P280 MDO2: Selecting Variable A

P280	Range	0 ÷ 99	See Table 32
Variable A selected for MDO2	Default	60	A60: Torque Demand
	Level	ADVANCED	
	Address	880	
	Function	This parameter selects the digital signal used to compute the value of digital output MDO2. It selects an analog variable used to compute the value of digital input MDO2 if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 32.	

13.4.12 P281 MDO2: Selecting Variable B

P281	Range	0 ÷ 99	See Table 32
Variable B selected for MDO2	Default	51	A51: Speed MEA
	Level	ADVANCED	
	Address	881	
	Function	This parameter selects the second digital signal used to compute the value of digital output MDO2. It selects an analog variable used to compute the value of digital input MDO2 if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 32.	

13.4.13 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) ≤
Test A for MDO2	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.	

13.4.14 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) ≤
Test B for MDO2	Default	0	0: >
	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.	

13.4.15 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 32*
Comparing value for test A (MDO2)	Default	2000	20%
	Level	ADVANCED	
	Address	884	
	Function	This parameter defines the comparing value with the selected variable for test A.	

13.4.16 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 32*
Comparing value for test B (MDO2)	Default	50	50 rpm
	Level	ADVANCED	
	Address	885	
	Function	This parameter defines the comparing value with the selected variable for test B.	

13.4.17 P286 MDO2: Function Applied to the Result of the 2 Tests

P286	Range	0 ÷ 5	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)
Function applied to the result of the two tests (MDO2)	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 to compute the output value.	

13.4.18 P287 MDO2: Output Logic Level

P287	Range	0–1	0: FALSE 1: TRUE
Output logic level (MDO2)	Default	1	1: TRUE
	Level	ADVANCED	
	Address	887	
	Function	Digital output logic function MDO2 to apply a logic reversal (negation) to the computed output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

13.4.19 P288 MDO3: Digital Output Mode

P288	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
Operating mode of digital output MDO3	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 in the previous section.	

13.4.20 P289 MDO3: Selecting Variable A

P289	Range	0 ÷ 99	*See Table 32*
Variable A selected for MDO3	Default	2	D2: Inverter Ok On
	Level	ADVANCED	
	Address	889	
	Function	This parameter selects the digital signal used to compute the value of digital output MDO3. It selects an analog variable used to compute the value of digital input MDO3 if one of the "analog" operating modes is selected. Digital signals and analog variables are detailed in Table 32.	

13.4.21 P290 MDO3: Selecting Variable B

P290	Range	0 ÷ 99	*See Table 32*
Variable B selected for MDO3	Default	2	D2: Inverter Ok On
	Level	ADVANCED	
	Address	890	
	Function	This parameter selects the second digital signal used to compute the value of digital output MDO3. It selects an analog variable used to compute the value of digital input MDO3 if one of the "analog" operating modes is selected. Digital signals and analog variables are detailed in Table 32.	

13.4.22 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) ≤
Test A for MDO3	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.	

13.4.23 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) ≤
Test B for MDO3	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.	

13.4.24 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 32*
Comparing value for Test A (MDO3)	Default	0	0
	Level	ADVANCED	
	Address	893	
	Function	This parameter defines the comparing value with the variable selected for test A.	

13.4.25 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 32*
Comparing value for Test B (MDO3)	Default	0	0
	Level	ADVANCED	
	Address	894	
	Function	This parameter defines the comparing value with the variable selected for test B.	

13.4.26 P295 MDO3: Function Applied to the Result of the 2 Tests

P295	Range	0 ÷ 5	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)
Function applied to the result of the 2 tests for MDO3	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 to compute the output value.	

13.4.27 P296 MDO3: Output Logic Level

P296	Range	0–1	0: FALSE 1: VERA
Output logic level (MDO1)	Default	1	1: VERA
	Level	ADVANCED	
	Address	896	
	Function	Digital output logic function MDO3 to apply a logic reversal (negation) to the computed output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

13.4.28 P297 MDO4: Digital Output Mode

P297	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
Operating mode of digital output MDO4	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 in the previous section.	

13.4.29 P298 MDO4: Selecting Variable A

P298	Range	0 ÷ 99	*See Table 32*
Variable A selected for MDO4	Default	1	D1: Inverter Run Ok
	Level	ADVANCED	
	Address	898	
	Function	This parameter selects the digital signal used to compute the value of digital output MDO4. It selects an analog variable used to compute the value of digital input MDO4 if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 32	

13.4.30 P299 MDO4: Selecting Variable B

P299	Range	0 ÷ 99	*See Table 32*
Variable B selected for MDO4	Default	1	D1: Inverter Run Ok
	Level	ADVANCED	
	Address	899	
	Function	This parameter selects the second digital signal used to compute the value of digital output MDO4. It selects an analog variable used to compute the value of digital input MDO4 if one of the “analog” operating modes is selected. Digital signals and analog variables are detailed in Table 32.	

13.4.31 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) ≤
Test A for MDO4	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.	

13.4.32 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) ≤
Test B for MDO4	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	

13.4.33 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 32*
Comparing value for Test A (MDO4)	Default	0	0
	Level	ADVANCED	
	Address	902	
	Function	This parameter defines the comparing value with the selected variable for test A.	

13.4.34 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 32*
Comparing value for Test B (MDO4)	Default	0	0
	Level	ADVANCED	
	Address	903	
	Function	This parameter defines the comparing value with the selected variable for test B.	

13.4.35 P304 MDO4: Function Applied to the Result of the 2 Tests

P304	Range	0 ÷ 5	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)
Function applied to the result of the two tests (MDO4)	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 to compute the output value.	

13.4.36 P305 MDO4: Output Logic Level

P305	Range	0–1	0: FALSE 1: TRUE
Output logic level (MDO4)	Default	1	1: TRUE
	Level	ADVANCED	
	Address	905	
	Function	Digital output logic function MDO4 to apply a logic reversal (negation) to the computed output signal: (0) FALSE = a logic negation is applied; (1) TRUE = no negation is applied.	

14 AUTOTUNE MENU

14.1 Overview

NOTE

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

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 sections Motor Control Menu and Encoder Frequency Input Menu.

The selected motor may be tuned in order to obtain the machine ratings or the parameterization required for the control algorithms. It is also possible to check the proper operation/wiring of the encoder used as a speed feedback.

The Autotune menu includes programming parameters I073 and I074. Parameter I073 allows to enable and select the type of autotune. Parameter I074—that can be programmed only if I073 = Motor Tune— determines if the autotune procedure relates to the estimation of the motor ratings or to the adjusting loops of the control algorithms.

14.1.1 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 sections Motor Control Menu and Encoder Frequency Input Menu.

Table 40: Programmable "Motor Tune" Functions

I074 Setup	Algorithm	Type of Tune
0: Mis. Rs Ldis	VTC (recommended for any type of control)	Estimation of the stator resistance and the leakage inductance. Tuning mode required for the correct operation of VTC control algorithm and recommended for any type of control algorithm, as it detects the motor stator resistance.
1: AutCurrLoop	FOC	Autotune of the current loop. Tuning mode required for the correct operation of algorithm FOC. If autotune of the current loop fails (Alarm A065 Autotune Ko trips), the current loop may be manually tuned using an oscilloscope (see 2: ManCurrLoop).
2: ManCurrLoop	FOC	Manual tune of the current loop. Display analog outputs AO1 and AO2, showing the current reference and the current value obtained with the preset parameters of the current regulator. Set the regulator's parameters so as to obtain the smaller difference between the two waveforms. Please refer to the FOC Regulator Menu.
3: ManFluxLoop	FOC	Manual tune of the flux loop. The correct parameters of the flux regulator are computed whenever the rotor time constant value changes (see 5: Mis Tau Rot). Display analog outputs AO1 and AO2, showing the flux reference value and the flux value obtained. Set the regulator's parameters so as to obtain the smaller difference between the two waveforms.

		Please refer to the FOC Regulator Menu.
4: ManSpdLoop	FOC	Manual tune of the speed loop. Display analog outputs AO1 and AO2, showing the speed reference value (0 rpm) and the speed value measured by the encoder. Then perform the speed regulator parameterization so as the variance of the detected speed—due to torque disturbance occurring while tuning—is reduced to a minimum. Please refer to the Speed Loop Menu.
5: Mis Tau Rot	FOC	After entering the no-load current value (parameters C021, C064, C107 for motors M1, M2, and M3 respectively) and after performing the autotune or the manual tune of the current loop, you can measure the rotor time constant. The motor will rotate (no-load rotation) up to 90% of its rpm rating.

Column 1 in Table 40 states the values set in I074; column 2 states the control algorithm to be tuned; column 3 describes the function of the control algorithm.

NOTE

If a manual tune is selected, do the following to quit the function:
disable the Enable command and set I073 = [0: Disable]

14.1.2 CHECKING THE ENCODER OPERATION

Set I073 as Encoder Tune to check the correct operation of the encoder selected as a speed feedback (see Encoder\Frequency Input Menu).

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 Input 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 inverter is disabled. The following messages can be displayed:

A059 Encoder Fault
A095 Encoder Link Error
W031 Encoder OK

If alarm A059 Encoder Fault trips: on the encoder input, the value measured by the inverter does not match with the real speed of rotation of the motor. Check that the encoder is properly set up (Encoder\Frequency Input Menu) and connected; if the Encoder B input is used, check the configuration of the dip–switches located on optional board ES836 (see Installation Manual).

If alarm A095 Encoder Link Error trips: the direction of rotation detected at the input of the encoder programmed as a speed feedback is opposite to the direction of rotation used in the closed-chain control algorithms of the inverter. Before using the speed feedback from encoder, reverse two phases of the motor link or reverse the channels of the encoder.

If W031 Encoder OK appears: speed feedback from encoder is correct.

14.2 Parameter List

Table 41: List of Parameters I073÷ I074

Parameter	FUNCTION	Access Level	MODBUS Address
I073	Type of tune	BASIC	1460
I074	Type of loop	BASIC	1461

14.2.1 I073 Type of Tune

I073	Range	0 ÷ 2	0: Disable 1: Motor Tune 2: Encoder Tune
Type of tune	*Default*	*This is not a parameter: the input is set to zero whenever the inverter 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 sections 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 section Checking the Encoder Operation).	

14.2.2 I074 Type of Loop

I074	Range	0 ÷ 5	0: Mis. Rs Ldis 1: AutCurrLoop 2: ManCurrLoop 3: ManFluxLoop 4: ManSpd Loop 5: Mis.Tau Rot
Type of loop	*Default*	*This is not a parameter: the input is set to zero whenever the inverter 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 sections Motor Autotune and Adjusting Loops).	

15 CARRIER FREQUENCY MENU

15.1 Overview

The Carrier Frequency Menu sets some characteristics of PWM modulation based on the preset type of control.

15.1.1 IFD CONTROL

The IFD control allows to gain access to all the parameters included in the Carrier Frequency menu.
The user can set the minimum value and the maximum value of the switching carrier frequency and the number of pulses per period used to produce the output frequency when switching from min. carrier frequency to max. carrier frequency (synchronous modulation). The preset max. value of carrier frequency also limits the max. allowable speed value for the selected motor, because we need to ensure at least 16 pulses per period at max. output frequency.
Max. allowable speed → rated speed * (max. output frequency/rated frequency)
where the max. output frequency results from C002/16 (max. carrier frequency and number of pulses per period respectively).
The silent modulation function can be enabled.

15.1.2 EXAMPLE (IFD):

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).
The max. speed of the inverter will produce an output voltage with a frequency value equal to 100Hz; carrier frequency should be the greatest as possible. Suppose that a model having a max. carrier frequency of 16kHz is used.
Assign the following:
C001 = 1600Hz
C002 = 16000Hz
C003 >= (C002 / 100Hz) = (160 pulses per period)

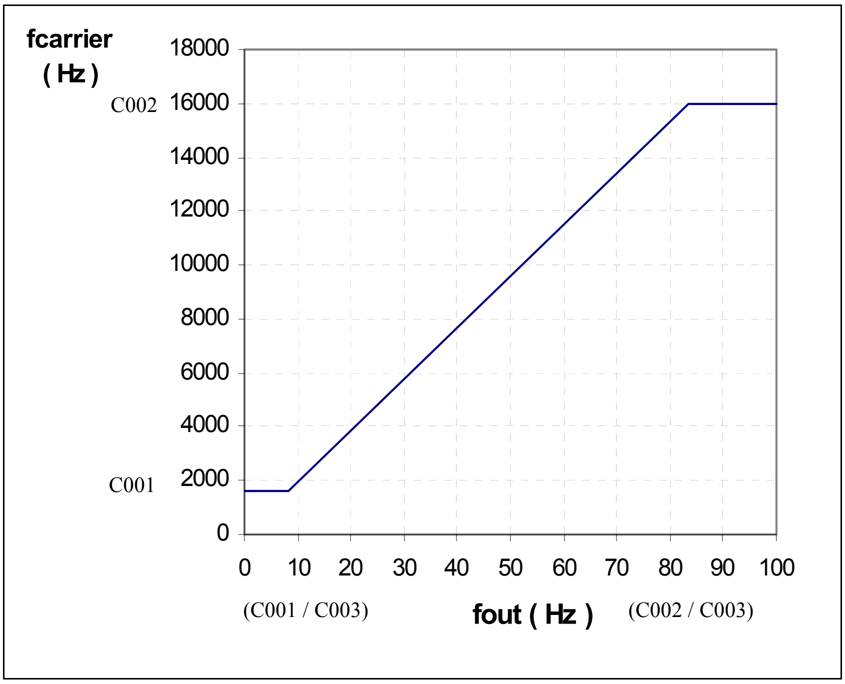


Figure 27: Example of Carrier Frequency

Suppose that we configure 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, a synchronous modulation is obtained and the carrier frequency applied results from: f carrier = fout * C003 [Hz].

15.1.3 VTC CONTROL

The only parameter of the Carrier Frequency menu used for VTC control algorithm is C004, allowing to enable silent modulation. The modulation frequency to be used is internally defined.

15.1.4 FOC CONTROL

FOC control algorithm selects the silent modulation mode (C004) and allows to increase carrier frequency when possible. FOC algorithm uses a carrier frequency corresponding to:

Min [8kHz ; Max. carrier freq. allowed for the inverter size];

In C002, if you set a higher value than the value resulting from the formula above, FOC control will use C002 as the modulation frequency.

15.2 Parameter List

Table 42: List of Parameters C140 ÷ C147

Parameter	FUNCTION	Access Level	MODBUS Address
C001	Minimum carrier frequency	ENGINEERING	1001
C002	Maximum carrier frequency	ENGINEERING	1002
C003	Number of pulses	ENGINEERING	1003
C004	Silent modulation	ENGINEERING	1004

The default values of carrier frequency C001 and C002 and their max. values depend on the inverter size.

Table 43: Default Values and Max. Values of the Carrier Frequency Depending on the Inverter Size

SIZE	MODEL	Carrier (Default) [kHz]	Carrier (Max.) [kHz]
S05	0005	5	16
S05	0007	5	16
S05	0009	5	16
S05	0011	5	16
S05	0014	5	16
S10	0017	5	16
S10	0020	5	16
S10	0025	3	16
S10	0030	3	16
S10	0035	3	16
S15	0040	5	16
S20	0049	5	12.8
S20	0060	5	12.8
S20	0067	5	12.8
S20	0072	5	12.8
S20	0086	5	12.8
S30	0113	3	10
S30	0129	3	10
S30	0150	3	5
S30	0162	3	5
S40	0179	2	4
S40	0200	2	4
S40	0216	2	4
S40	0250	2	4
S50	0312	2	4
S50	0366	2	4
S50	0399	2	4
S60	0457	2	4
S60	0524	2	4
S70	0598	2	4
S70	0748	2	4
S70	0831	2	4

15.2 1 C001 MINIMUM CARRIER FREQUENCY

C001	Range	1600	*1600Hz* *Depending on the inverter size (see Table 43)*
Minimum carrier frequency	Default	*Depending on the inverter size*	
	Level	ENGINEERING	
	Addr	1001	
	F	IFD Control only: It represents the min. value of the modulation frequency 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.

15.2.2 C002 MAXIMUM CARRIER FREQUENCY

C002	Range	1600	*1600Hz* *Depending on the inverter size (see Table 43)*
Maximum carrier frequency	Default	*Depending on the inverter size*	
	Level	ENGINEERING	
	Addr	1002	
	F	IFD and FOC Control only: It represents the min. value of the modulation frequency used. As per FOC control, the modulation frequency set in C002 is used only if it exceeds the modulation frequency resulting from the following formula: Min. [8kHz ; Max. carrier freq. allowed for the inverter size]; Example: Max. carrier freq. allowed: 10kHz If C002 = 5kHz for FOC control; modulation frequency is 8kHz. If C002 = 10kHz for FOC control; modulation frequency is 10kHz.	

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 IFD Control only: The max. value in C002 also determines the max. allowable speed value for the selected motor, because we need to ensure at least 16 pulses per period.

15.2.3 C003 Pulse Number

C003	Range	0: [12] ; 5: [384]	
Pulse number	Default	1: [24]	
	Level	ENGINEERING	
	Addr	1003	
	F	IFD Control only: This parameter has effect only if C001≠C002. It represents the min. value of pulses per period obtained when modulation frequency changes (synchronous modulation). The table below states the allowable values for C003.	

C003	Pulse number
0	12
1	24
2	48
3	96
4	192
5	384

15.2.4 C004 Silent Modulation

C004	Range	0: [No] ; 1: [Yes]	
Silent modulation	Default	0: [No] ;	
	Level	ENGINEERING	
	Addr	1004	
	F	This parameter enables silent modulation. The elctric noise due to the commutation frequency is dampened and becomes similar to a mechanical noise.	

16 MOTOR CONTROL MENU

16.1 Overview

The Sinus Penta allows to configure three different types of motors and three different types of control algorithms.

The parameter set for the selected motor is included in the Motor Control menu:

- ✓ The Motor Control 1 Menu concerns motor 1;
- ✓ The Motor Control 2 Menu concerns motor 2;
- ✓ The Motor Control 3 Menu concerns motor 3.

Factory setting allows to configure only one motor. To gain access to the configuration menus of the other connected motors, just 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 Digital Inputs Menu).

The parameters included in the Motor Control Menus are detailed in the table below.

Table 44: Description of the Parameters Classified by Motor

Parameter Contents	Motor Control 1	Motor Control 2	Motor Control 3
• number of motors to be configured	C009	————	————
• control algorithm being used	C010	C053	C096
• type of reference being used (speed/torque) (see Torque control section)	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	C034 ÷ C038	C077 ÷ C081	C120 ÷ C124
• slip compensation activation	C039	C082	C125
• fluxing ramp time period	C041	C084	C127
• time period of flux weakening for DC braking	C042	C085	C128

The parameters that can be modified depend on the type of control that has been selected. The parameters highlighted in grey are explained below.

16.1.1 Motor Specifications

This group of parameters can be divided into two subunits: the first includes the motor ratings, the second includes the parameters of the equivalent circuit of the asynchronous machine being used.

Motor Ratings

Table 45: 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

Parameters of the Equivalent Circuit of the Asynchronous Machine

Table 46: 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

Where:

Rs: Stator resistance (wires included)
Rr: Rotor resistance
l_1+l_2: Full leakage inductance
M: Mutual inductance (not required for motor activation)
S: Slip
τ rot. ≅ M / Rr rotor time constant.

Because the motor characteristics are generally unknown, the Sinus Penta is capable of automatically determining the motor characteristics (see “START UP” in the Installation Manual).
Some parameters may be manually adjusted to meet the requirements of special applications.

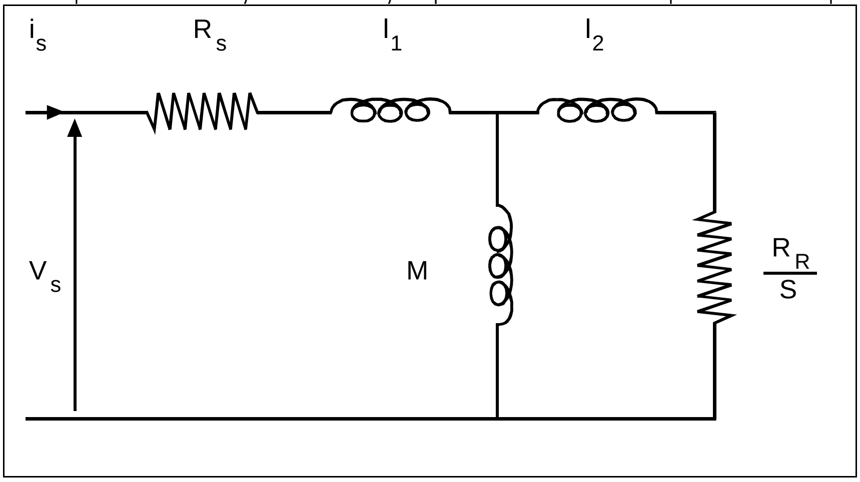


Figure 28: Equivalent Circuit of the Asynchronous Machine

The parameters used for the different control algorithms are stated in the table below.

Table 47: Motor Parameters Used by Control Algorithms

Parameter	IFD	VTC	FOC
Stator resistance	➥	➥	➥
Leakage inductance	—	➥	—
Mutual inductance	—	—	➥
Rotor time constant	—	—	➥

➥ Used ; — Not used

16.1.2 TORQUE CONTROL (VTC AND FOC ONLY)

VTC and FOC controls allow to control the inverter with a torque reference instead of a speed reference. To do so, select VTC or FOC and set [1: Torque] in the relevant parameter (C011 for motor 1, C054 for motor 2, and C097 for motor 3).
In that 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 Limits Menu 2 and Limits Menu 3.

Using a 0020 inverter 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 equal to 120%.
If a 7.5kW motor is connected, C048 may exceed 200%; torques 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

16.1.3 V/F PATTERN (IFD ONLY)

The V/f pattern parameter set defines the trend of the V/f pattern obtained by the inverter when IFD control algorithm is used.

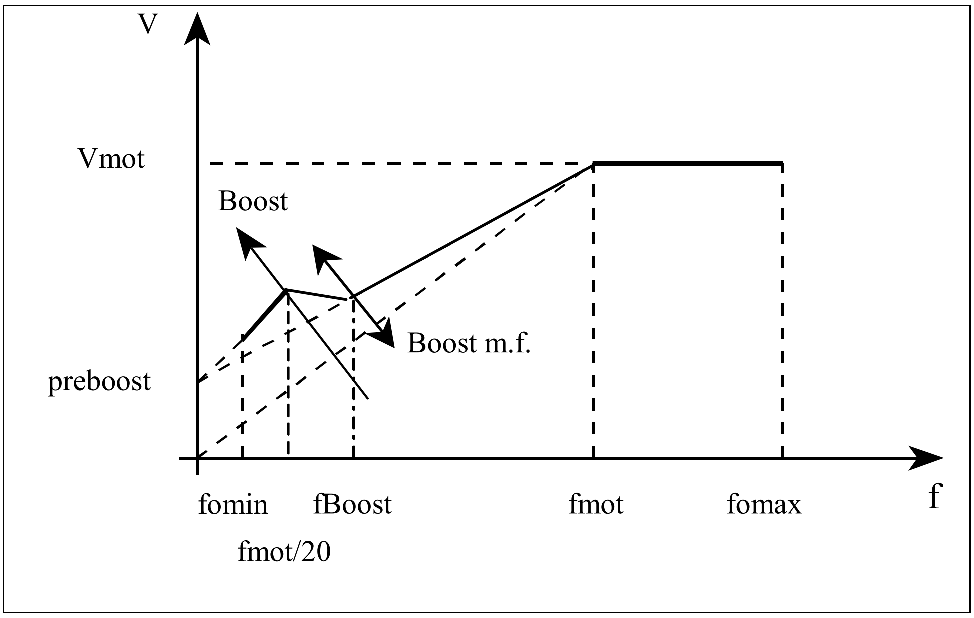


Figure 29: V/F Pattern Parameter for IFD Control

Table 48: IFD Control Parameters for the connected motor

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
Voltage preboost: determines the voltage produced by the inverter at min. output frequency fomin.	C034	C077	C120
Voltage boost at 5 % of rated frequency: determines the variation of the output rated voltage at fnom/20; Boost >0 increases the starting torque.	C035	C078	C121
Voltage boost at preset frequency: (Boost m.f. in the figure) determines the voltage variation with respect to rated voltage at preset frequency.	C036	C079	C122
Frequency for the application of the voltage boost: (fBoost in the figure) determines the frequency for the application of the boost at preset frequency.	C037	C080	C123
Autoboost: 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 rated torque.	C038	C081	C124

EXAMPLE 1:

Motor 1: voltage/frequency pattern is to be programmed for an asynchronous motor (400V/50Hz) with a rated speed of 1500rpm up to 2000rpm.

Rated frequency	C015	= 50 Hz
Rated voltage	C019	= 400 V
Preboost	C034	= depending on the starting torque
Boost at 5% of fnom	C035	= 2.5%
Max. speed	C115	= 2000rpm

EXAMPLE 2:

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 computed as follows:

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
Boost at 5% of fnom	C035	= 2.5%
Autoboost	C038	= 4%

Voltage compensation (AutoBoost) results from the formula below:

$\Delta V = C019 \times (C038 / 100) \times (T / Tn)$

Where T is the estimated motor torque and Tn is the motor rated torque.

Tn is computed as follows:

$Tn = (Pn \times \text{polar torques} / 2\pi f = (C017 \times \text{polar torques}) / (2\pi \times C015)$

Where polar torques is the integer number obtained by approximating (60* C015/C016) by defect.

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.

16.1.4 SLIP COMPENSATION (IFD ONLY)

This function allows to compensate the speed decrease of the asynchronous motor when the mechanical load increases (slip compensation).
Parameters relating to this function are included in the Motor Control Menu (Configuration Menu).

Table 49: Parameters for 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 inverter power output is estimated and subtracted to the power leakage due to Joule effect and to the mechanical parts of the equipment (function of the output power and the no-load power), 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 motor.

16.2 Parameter List

Table 50: List of Parameters C009 ÷ C128

Parameter		FUNCTION	Access Level	MODBUS Address
C009	M1	Number of configured motors	ENGINEERING	1009
C010	M1	Type of control algorithm	BASIC	1010
C053	M2		BASIC	1053
C096	M3		BASIC	1096
C011	M1	Type of reference	ADVANCED	1011
C054	M2		ADVANCED	1054
C097	M3		ADVANCED	1097
C012	M1	Speed feedback from encoder	BASIC	1012
C055	M2		BASIC	1055
C098	M3		BASIC	1098
C015	M1	Motor rated frequency	BASIC	1015
C058	M2		BASIC	1058
C101	M3		BASIC	1101
C016	M1	Motor rated rpm	BASIC	1016
C059	M2		BASIC	1059
C102	M3		BASIC	1102
C017	M1	Motor rated power	BASIC	1017
C060	M2		BASIC	1060
C103	M3		BASIC	1103
C018	M1	Motor rated current	BASIC	1018
C061	M2		BASIC	1061
C104	M3		BASIC	1104
C019	M1	Motor rated voltage	BASIC	1019
C062	M2		BASIC	1062
C105	M3		BASIC	1105
C020	M1	Motor no-load power	BASIC	1020
C063	M2		BASIC	1063
C106	M3		BASIC	1106
C021	M1	Motor no-load current	BASIC	1021
C064	M2		BASIC	1064
C107	M3		BASIC	1107
C022	M1	Motor stator resistance	ADVANCED	1022
C065	M2		ADVANCED	1065
C108	M3		ADVANCED	1108
C023	M1	Leakage inductance	ADVANCED	1023
C066	M2		ADVANCED	1066
C109	M3		ADVANCED	1109
C024	M1	Mutual inductance	ADVANCED	1024
C067	M2		ADVANCED	1067
C110	M3		ADVANCED	1110
C025	M1	Rotor time constant	ADVANCED	1025
C068	M2		ADVANCED	1068
C111	M3		ADVANCED	1111
C028	M1	Motor min. speed	BASIC	1028
C071	M2		BASIC	1071

C114	M3	Motor min. speed	BASIC	1114
C029	M1	Motor max. speed	BASIC	1029
C072	M2		BASIC	1072
C115	M3		BASIC	1115
C030	M1	Flux weakening speed	BASIC	1030
C073	M2		BASIC	1073
C116	M3		BASIC	1116
C031	M1	Max. speed alarm	ADVANCED	1031
C074	M2		ADVANCED	1074
C117	M3		ADVANCED	1117
C034	M1	Voltage Preboost	ADVANCED	1034
C077	M2		ADVANCED	1077
C120	M3		ADVANCED	1120
C035	M1	Voltage Boost at 5% of the motor rated frequency	ADVANCED	1035
C078	M2		ADVANCED	1078
C121	M3		ADVANCED	1121
C036	M1	Voltage Boost at programmable frequency	ADVANCED	1036
C079	M2		ADVANCED	1079
C122	M3		ADVANCED	1122
C037	M1	Frequency for application of voltage Boost at programmable frequency	ADVANCED	1037
C080	M2		ADVANCED	1080
C123	M3		ADVANCED	1123
C038	M1	Autoboost	ADVANCED	1038
C081	M2		ADVANCED	1081
C124	M3		ADVANCED	1124
C039	M1	Slip compensation	ADVANCED	1039
C082	M2		ADVANCED	1082
C125	M3		ADVANCED	1125
C041	M1	Fluxing ramp time	ADVANCED	1041
C084	M2		ADVANCED	1084
C127	M3		ADVANCED	1127
C042	M1	Flux weakening time for DCB	ADVANCED	1042
C085	M2		ADVANCED	1085
C128	M3		ADVANCED	1128

16.2.1 C009 Number of Configured Motors

C009			
Number of configured motors	Range	1 ÷ 3	1 ÷ 3
	Default	1	1
	Level	ENGINEERING	
	Address	1009	
	Function	This parameter determines the number of motors to be configured. The active motor is selected through digital inputs programmed with **C173** and **C174** (see **Digital Inputs Menu**). 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.	

16.2.2 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
Type of control algorithm	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 vectorial control 2: FOC Field orienting control <u>V/f control</u> allow to control the motor by producing voltage depending on frequency. The V/f pattern may be modified (as explained at the beginning of this section) with parameters C034÷C038 for motor 1 (C077÷C081 for motor 2, C120÷C124 for motor 3). <u>Sensorless vectorial control</u> processing the machine equations depending on the equivalent parameters of the asynchronous machine as stator resistance and leakage inductance (C022, C023 for motor 1; C065, C066 for motor 2; C108, C109 for motor 3) allows to separate torque control from flux control with no need to use a transducer; the inverter can be then controlled with a torque reference instead of a speed reference. <u>Field orienting control</u> is a closed-chain 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 to separate torque control from flux control with no need to use a transducer; the inverter can be controlled with a torque reference instead of a speed reference.	

NOTE FOC control requires a speed transducer.

16.2.3 C011 (C054,C097) TYPE OF REFERENCE (MASTER/SLAVE)

C011 (motor 1) C054 (motor 2) C097 (motor 3)	Range	0 ÷ 1	0: Speed (MASTER mode) 1: Torque (SLAVE mode)
Type of reference mode (Master/Slave)	Default	0	0: Speed (MASTER mode)
	Level	ADVANCED	
	Address	1011 1054 1097	
	Function	VTC and FOC only. This parameter defines the type of reference to be used. The torque control may be set up (see Torque Control section).	

16.2.4 C012 (C055,C098) SPEED FEEDBACK FROM ENCODER

C012 (motor 1) C055 (motor 2) C098 (motor 3)	Range	0 ÷ 1	0: No 1: Yes
Speed feedback from encoder	Default	0	0 ÷ 1
	Level	BASIC	
	Address	1012 1055 1098	
	Function	VTC and FOC only. 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 optional board) is used as a speed feedback (see **Encoder Menu – Frequency Menu**).	

16.2.5 C015 (C058,C101) Motor Rated Frequency

C015 (motor 1) C058 (motor 2) C101 (motor 3)	Range	10 ÷ 10000	1.0 Hz ÷ 1000.0 Hz
Motor rated frequency	Default	500	50.0 Hz
	Level	BASIC	
	Address	1015 1058 1101	
	Function	This parameter defines the motor rated frequency (frequency rating).	

16.2.6 C016 (C059,C102) Motor Rated Rpm

C016 (motor 1) C059 (motor 2) C102 (motor 3)	Range	1 ÷ 32000	1 ÷ 32000 rpm
Motor rated rpm	Default	1420	1420 rpm
	Level	BASIC	
	Address	1016 1059 1102	
	Function	This parameter defines the motor rated rpm (rpm rating).	

16.2.7 C017 (C060,C103) Motor Rated Power

C017 (motor 1) C060 (motor 2) C103 (motor 3)	Range	0 ÷ 2000 *See table at the end of this section (parameters depending on inverter size).*	0,0 ÷ 200,0 kw *See table at the end of this section (parameters depending on inverter size).*
Motor rated power	Default	*See table at the end of this section (parameters depending on inverter size).*	
	Level	BASIC	
	Address	1017 1060 1103	
	Function	This parameter defines the motor rated power (power rating).	

16.2.8 C018 (C061,C104) Motor Rated Current

C018 (motor 1) C061 (motor 2) C104 (motor 3)	Range	50 ÷ 12000 *See table at the end of this section (parameters depending on inverter size).*	5,0 ÷ 1200,0 A *See table at the end of this section (parameters depending on inverter size).*
Motor rated current	Default	*See table at the end of this section (parameters depending on inverter size).*	
	Level	BASIC	
	Address	1018 1061 1104	
	Function	This parameter defines the motor rated current (current rating).	

16.2.9 C019 (C062,C105) Motor Rated Voltage

C019 (motor 1) C062 (motor 2) C105 (motor 3)	Range	50 ÷ 12000	5.0 ÷ 1200.0 V
Motor rated voltage	Default	3800 for inverters of class 4T 2300 for inverters of class 2T	380.0V for inverters of class 4T 230.0V for inverters of class 2T
	Level	BASIC	
	Address	1019 1062 1105	
	Function	This parameter defines the motor rated voltage (voltage rating).	

16.2.10 C020 (C063,C106) Motor No-Load Power

C020 (motor 1) C063 (motor 2) C106 (motor 3)	Range	0 ÷ 1000	0.0 ÷ 100.0%
Motor no-load power	Default	0	0.0%
	Level	BASIC	
	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.	

16.2.11 C021 (C064,C107) Motor No-Load Current

C021 (motor 1) C064 (motor 2) C107 (motor 3)	Range	1 ÷ 100	1 ÷ 100%
Motor no-load current	Default	30	30%
	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)	

16.2.12 C022 (C065,C108) MOTOR STATOR RESISTANCE

C022 (motor 1) C065 (motor 2) C108 (motor 3)	Range	0 ÷ 32000	0.000 ÷ 32.000Ω
Motor stator resistance	Default	*See table at the end of this section (parameters depending on inverter size).*	
	Level	ADVANCED	
	Address	1022 1065 1108	
	Function	This parameter defines stator resistance Rs. With a star connection, it matches with the value of the resistance of one phase (half the resistance measured between two terminals); with a delta connection, it matches with 1/3 of the resistance of one phase.	

16.2.13 C023 (C066,C109) MOTOR LEAKAGE INDUCTANCE

C023 (motor 1) C066 (motor 2) C109 (motor 3)	Range	0 ÷ 32000	0.00 ÷ 320.00mH
Motor leakage inductance	Default	*See table at the end of this section (parameters depending on inverter size).*	
	Level	ADVANCED	
	Address	1023 1066 1109	
	Function	This parameter defines the global leakage inductance of the connected motor. With a star connection, it matches with the value of the inductance of one phase; with a delta connection, it matches with 1/3 of the inductance of one phase.	

16.2.14 C024 (C067,C110) MUTUAL INDUCTANCE

C024 (motor 1) C067 (motor 2) C110 (motor 3)	Range	0 ÷ 32000	0.00 ÷ 320.00mH
Mutual inductance of the connected motor	Default	*See table at the end of this section (parameters depending on inverter size).*	
	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 with the formula below: $M \cong (Vnom - Rstat*Io) / (2\pi fnom* Io)$	

16.2.15 C025 (C068,C111) Rotor Time Constant

C025 (motor 1) C068 (motor 2) C111 (motor 3)	Range	0 ÷ 5000	1 ÷ 5000msec
Rotor time constant	Default	*See table at the end of this section (parameters depending on inverter size).*	
	Level	ADVANCED	
	Address	1025 1068 1111	
	Function	This parameter is used for FOC control only and it defines the rotor time constant of the connected motor. If the rotor time constant is not stated by the motor manufacturer, do the following: with IFD control, wait until the motor attains its rated speed; using an oscilloscope provided with an isolate probe for voltage measurement, measure voltage on the motor terminals when IGBT commutation is suppressed (Enable open). Considering two voltage values in the curve obtained (V_1 and V_2) and the time interval (Δt) between V_1 and V_2: τ rot = $-\Delta t / \ln (V_2/V_1)$	

NOTE

Whenever one of these parameters is written, the equipment automatically computes and saves the parameters of flux regulator PI and FOC control: proportional constant P158 (P165, P172) and integral time P159 (P166, P173).

16.2.16 C028 (C071,C114) MOTOR MIN. SPEED

C028 (motor 1) C071 (motor 2) C114 (motor 3)	Range	0 ÷ 32000 (*)	0 ÷ 32000 rpm (*)
Min. speed of the connected motor	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: AIN 1] Selection of reference 2 source C145 → [0: Disable] Selection of reference 3 source C146 → [0: Disable] Selection of reference 2 source Reference Menu P050 → [0: +/– 10V] Type of reference for input REF P051 → [– 10V] Value of the min. reference for input REF P052 → [+10V] Value of the max. reference for input REF P055 → [0: +/– 10V] Type of reference for input AIN1 P056 → [– 5 V] Value of min. reference for input AIN1 P057 → [+5 V] Value of max. reference for input AIN1 The speed reference is the min. speed set in **C028** (for motor 1) when both input REF and input AIN1 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 depends on the type of control used, on the rated speed of the connected motor and on the max. carrier frequency (for IFD and FOC only; for VTC control, the max. carrier frequency is always set to 5kHz). The max. allowable value is:

Max Speed = a * Spd nom with a = min [4 ; (max fcar /16) / nom Freq]

where Spd nom is the rated speed of the connected motor (C016 for motor 1 and C059, C102 for motor 2 and motor 3 respectively) and a is the min. value between 4 and the ratio 1/16 max. carrier frequency and motor rated frequency, ensuring min. 16 pulses per period at max. output frequency.

NOTE The value set as the min. speed is used as 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 CWCCW 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 inverter. The motor rpm will be –C029 <C028.

16.2.17 C029 (C072,C115) MOTOR MAX. 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)
Max. speed of the connected motor	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.	

16.2.18 C030 (C073,C116) FLUX WEAKENING SPEED

C030 (motor 1) C073 (motor 2) C116 (motor 3)	Range	0 ÷ 200	0% ÷ 200%
Flux weakening speed of the connected motor	Default	90	90%
	Level	BASIC	
	Address	1030 1073 1116	
	Function	FOC control only. Defines the speed value determining the motor flux weakening. This is expressed as a percentage of the motor rated speed: C016 (C059,C102)	

16.2.19 C031 (C074,C117) MAX. SPEED ALARM

C031 (motor 1) C074 (motor 2) C117 (motor 3)	Range	0 ÷ 32000	0: Disabled 0 ÷ 32000 rpm
Max. speed alarm	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.	

16.2.20 C034 (C077,C120) VOLTAGE PREBOOST

C034 (motor 1) C077 (motor 2) C120 (motor 3)	Range	0 ÷ 50	0.0 ÷ 5.0 %
Voltage preboost	Default	*See table at the end of this section (parameters depending on inverter size).*	
	Level	ADVANCED	
	Address	1034 1077 1120	
	Function	IFD only. Torque compensation at low rpm. Determines the increase of the output voltage at 0Hz.	

16.2.21 C035 (C078,C121) VOLTAGE BOOST AT 5% OF RATED FREQUENCY

C035 (motor 1) C078 (motor 2) C121 (motor 3)	Range	–100 ÷ +100	–100 ÷ +100 %
Voltage Preboost at 5% of the rated frequency	Default	0	0 %
	Level	ADVANCED	
	Address	1035 1078 1121	
	Function	IFD only. 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).	

16.2.22 C036 (C079,C122) VOLTAGE BOOST AT PROGRAMMABLE FREQUENCY

C036 (motor 1) C079 (motor 2) C122 (motor 3)	Range	−100 ÷ +400	−100 ÷ +400 %
Voltage boost at programmable frequency	Default	0	0 %
	Level	ADVANCED	
	Address	1036 1079 1122	
	Function	IFD only. 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).	

16.2.23 C037 (C080,C123) FREQUENCY FOR APPLICATION OF VOLTAGE BOOST AT PROGRAMMABLE FREQUENCY

C037 (motor 1) C080 (motor 2) C123 (motor 3)	Range	6 ÷ 99	6 ÷ 99 %
Frequency for application of voltage Boost at programmable frequency	Default	50	50 %
	Level	ADVANCED	
	Address	1037 1080 1123	
	Function	IFD only. 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.	

16.2.24 C038 (C081,C124) AUTOBOOST

C038 (motor 1) C081 (motor 2) C124 (motor 3)	Range	0 ÷ 10	0 ÷ 10 %
Autoboost	Default	1	1 %
	Level	ADVANCED	
	Address	1038 1081 1124	
	Function	IFD only. 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.	

16.2.25 C039 (C082,C125) SLIP COMPENSATION

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

16.2.26 C041 (C084,C127) FLUXING RAMP TIME PERIOD

C041 (motor 1) C084 (motor 2) C127 (motor 3)	Range	40 ÷ 4000	40 ÷ 4000 msec
Fluxing ramp time period	Default	*See table at the end of this section (parameters depending on inverter size).*	
	Level	ADVANCED	
	Address	1041 1084 1127	
	Function	VTC and FOC only. This parameter indicates the time spent for motor fluxing.	

16.2.27 C042 (C085,C128) TIME PERIOD OF FLUX WEAKENING FOR DC BRAKING

<table>
<tr><td>C042 (motor 1)
C085 (motor 2)
C128 (motor 3)</td><td>Range</td><td>2 ÷ 300</td><td>2 ÷ 300 msec</td></tr>
<tr><td rowspan="4">Time period of flux weakening for DC braking</td><td>Default</td><td colspan="2">See table at the end of this section (parameters depending on inverter size).</td></tr>
<tr><td>Level</td><td colspan="2">ADVANCED</td></tr>
<tr><td>Address</td><td colspan="2">1042
1085
1128</td></tr>
<tr><td>Function</td><td colspan="2">IFD and VTC only. This parameter represents the time spent for flux weakening before performing DC braking.</td></tr>
</table>

16.3 TABLE OF THE PARAMETERS DEPENDING ON THE INVERTER SIZE

Table 51: Parameters Depending on the Inverter Size

Size.	MOD.	Inom Inv. [A]	Imax Inv. [A]	Carrier default [kHz]	Carrier max [kHz]	Imot [A]	Pnom Def [kW]	Rstat. def [Ω]	Ldisp. def [mH]	M def [mH]	τ rot def [msec]	Preboost def [% Vnom]	tflux def [msec]	tdeflx dcb def [msec]	I lim acc\run def (%Inom)	I lim Dec def (%Inom)	Max Torque def (%Cnom)
Paramrter ID	M1			C001 C002	C001 C002	C018	C017	C022	C023	C024	C025	C034	C041	C042	C043, C044	C045	C048
	M2					C061	C060	C065	C066	C067	C068	C077	C084	C085	C086, C087	C088	C091
	M3					C104	C103	C108	C109	C110	C111	C120	C127	C128	C129, C130	C131	C134
S05	0005	10,5	11,5	5	16	8.5	4	2.000	25.00	250.00	134	1.0%	300	50	120	120	120
S05	0007	12,5	13,5	5	16	10.5	4.7	1.300	16.00	250.00	173	1.0%	300	50	120	120	120
S05	0009	16,5	17,5	5	16	12.5	5.5	1.000	12.00	250.00	192	1.0%	300	50	120	120	120
S05	0011	16,5	21	5	16	16.5	7.5	0.700	8.00	250.00	208	1.0%	300	50	120	120	120
S05	0014	16,5	25	5	16	16.5	7.5	0.600	7.50	250.00	300	1.0%	300	50	120	120	120
S10	0017	30	32	5	16	24	11	0.500	5.00	250.00	264	1.0%	300	50	120	120	120
S10	0020	30	36	5	16	30	15	0.400	3.00	250.00	248	1.0%	300	50	120	120	120
S10	0025	41	48	3	16	36.5	18.5	0.350	2.00	250.00	258	1.0%	300	50	120	120	120
S10	0030	41	56	3	16	41	22	0.300	2.00	250.00	228	1.0%	300	50	120	120	120
S10	0035	41	72	3	16	41	22	0.300	2.00	250.00	228	1.0%	300	70	120	120	120
S15	0040	72	75	5	16	59	30	0.250	2.00	250.00	197	1.0%	300	70	120	120	120
S20	0049	80	96	5	12.8	72	37	0.200	2.00	250.00	208	1.0%	300	80	120	120	120
S20	0060	88	112	5	12.8	80	45	0.100	1.20	250.00	358	1.0%	300	80	120	120	120
S20	0067	103	118	5	12.8	103	55	0.050	1.00	250.00	554	1.0%	300	100	114	114	114
S20	0074	120	144	5	12.8	120	65	0.050	1.00	250.00	628	1.0%	300	100	120	120	120
S20	0086	135	155	5	12.8	135	75	0.050	1.00	250.00	553	1.0%	300	150	114	114	114
S30	0113	180	200	3	10	170	95	0.020	1.00	250.00	1310	0.5%	300	150	117	117	117
S30	0129	195	215	3	10	180	100	0.020	1.00	250.00	1564	0.5%	300	150	119	119	119
S30	0150	215	270	3	5	195	110	0.020	1.00	250.00	1946	0.5%	300	200	120	120	120
S30	0162	240	290	3	5	240	132	0.020	0.90	250.00	1764	0.5%	300	200	120	120	120
S40	0179	300	340	2	4	260	140	0.020	0.80	250.00	1551	0.5%	450	200	120	100	120
S40	0200	345	365	2	4	300	170	0.020	0.70	250.00	1344	0.5%	450	220	120	100	120
S40	0216	375	430	2	4	345	200	0.020	0.60	250.00	1169	0.5%	450	250	120	100	120
S40	0250	390	480	2	4	375	215	0.020	0.50	250.00	1075	0.5%	450	250	120	100	120
S50	0312	480	600	2	4	440	250	0.020	0.40	250.00	916	0.5%	450	250	120	100	120
S50	0366	550	660	2	4	480	280	0.020	0.30	250.00	840	0.5%	450	250	120	100	120
S50	0399	630	720	2	4	550	315	0.020	0.30	250.00	733	0.5%	450	250	120	100	120
S60	0457	720	880	2	4	720	400	0.020	0.30	250.00	733	0.5%	450	250	120	100	120
S60	0524	800	960	2	4	800	450	0.020	0.30	250.00	733	0.5%	450	250	120	100	120
S60	0598	900	1100	2	4	900	500	0.020	0.30	250.00	733	0.5%	450	250	120	100	120
S70	0748	1000	1300	2	4	1000	560	0.020	0.30	250.00	733	0.5%	450	250	120	100	120
S70	0831	1200	1440	2	4	1200	630	0.020	0.30	250.00	733	0.5%	450	250	120	100	120

17 LIMITS MENU

17.1 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.

A special parameter sets the decrement of the limit current value when the motor runs at constant power (flux weakening).

If a VTC control or a FOC control is used, limits are expressed as a percentage of the motor rated 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, the maximum allowable torque derivative can be limited (C049 for motor 1, C092 for motor 2 and C135 for motor 3).

17.2 Parameter List

Table 52: List of Parameters C043 ÷ C135

Parameter		FUNCTION	Access Level	MODBUS Address
C043	M1	Current limit while accelerating	ADVANCED	1043
C086	M2		ADVANCED	1086
C129	M3		ADVANCED	1129
C044	M1	Current limit at constant rpm	ADVANCED	1044
C087	M2		ADVANCED	1087
C130	M3		ADVANCED	1130
C045	M1	Current limit while decelerating	ADVANCED	1045
C088	M2		ADVANCED	1088
C131	M3		ADVANCED	1131
C046	M1	Current limit decrease in flux weakening	ADVANCED	1046
C089	M2		ADVANCED	1089
C132	M3		ADVANCED	1132
C047	M1	Minimum torque	ADVANCED	1047
C090	M2		ADVANCED	1090
C133	M3		ADVANCED	1133
C048	M1	Maximum torque	ADVANCED	1048
C091	M2		ADVANCED	1091
C134	M3		ADVANCED	1134
C049	M1	Maximum allowable torque derivative	ADVANCED	1049
C092	M2		ADVANCED	1092
C135	M3		ADVANCED	1135

17.2.1 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%*]
Current limit while accelerating	Default	*Depending on the inverter size*	*See table at the end of this section Motor Control*
	Level	ADVANCED	
	Address	1043 1086 1129	
	Function	IFD only. 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 inverter size.*

17.2.2 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%*]
Current limit at constant rpm	Default	*Depending on the inverter size*	*See table at the end of this section Motor Control*
	Level	ADVANCED	
	Address	1044 1087 1130	
	Function	IFD only 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 inverter size.*

17.2.3 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%*]
Current limit while decelerating	Default	*Depending on the inverter size*	*See table at the end of this section Motor Control*
	Level	ADVANCED	
	Address	1045 1088 1131	
	Function	IFD only. 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 inverter size.*

17.2.4 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
Current limit decrease in flux weakening	Default	0	0: Disabled
	Level	ADVANCED	
	Address	1046 1089 1132	
	Function	IFD only. 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 inverter: limit = current limit being used * (Fnom/ Fout).	

17.2.5 C047 (C090, C133) MINIMUM TORQUE

C047 (motor 1) C090 (motor 2) C133 (motor 3)	Range	–5000 ÷ 5000 (*)	–Tmax ÷ +Tmax *where:* Tmax = Min[*Imax inverter/Inom mot, 500,0%*]
Minimum torque	Default	0	0,0%
	Level	ADVANCED	
	Address	1047 1090 1133	
	Function	VTC / FOC only. This parameter determines 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.	

(*) *The max. allowable value and min. allowable values depend on the inverter size.*

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).

17.2.6 C048 (C091, C134) MAXIMUM TORQUE

C048 (motor 1) C091 (motor 2) C134 (motor 3)	Range	–5000(*) ÷ 5000 (*)	–Tmax ÷ +Tmax *where:* Tmax = Min[*Imax inverter/Inom mot , 500,0%*]
Maximum torque	Default	1200 (**)	(**) *Min*[Imax inverter/Inom mot , 120,0%]
	Level	ADVANCED	
	Address	1048 1091 1134	
	Function	VTC / FOC only. This parameter determines 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.	

(*) *The max. allowable value and min. allowable values depend on the inverter size.*

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).

17.2.7 C049 (C092, C135) MAXIMUM TORQUE DERIVATIVE

C049 (motor 1) C092 (motor 2) C135 (motor 3)	Range	0.0 ÷ 10000	0.0 ÷ 1000.0 %/sec
Maximum torque derivative	Default	2000	200.0 %/sec
	Level	ADVANCED	
	Address	1049 1092 1135	
	Function	VTC / FOC only. This parameter determines the maximum limit of the torque derivative. It is expressed as a torque variation ΔTrq: as a percentage of the rated torque of the selected motor/second: C049 = (ΔTrq / Tnom)% / sec	

18 CONTROL METHOD MENU

18.1 Overview

NOTE

Please refer to Sinus Penta's Installation Manual for the hardware description of digital inputs (COMMANDS) and analog inputs (REFERENCES).

See also References Menu and Analog Inputs Menu in this manual.

Factory setting: digital commands are sent via terminal board, the main speed reference is sent from analog input REF, and no external limit for torque limitation is enabled.

The parameters included in this menu allow to do the following:

1. Select the source of the inverter commands (digital inputs) from three signal sources (through parameters C140, C141, C142) which are combined so as to obtain active command set M031.
   For each of these 3 parameters you can select the source of the command signals from 4 different sources.
2. Select the source of the speed reference (or torque reference) from 4 different sources (that can be selected with parameters C143, C144, C145, C146) and sum up the 4 different sources.
   For each of these 3 parameters you can select the source of the reference signals from 9 different sources.
3. Select the source of the torque limit reference (through parameter C147).
   Parameter C147 sets the reference source from 9 different sources.

In that way, you can select different command sources (hardware or virtual sources), different speed (or torque) references (hardware or virtual sources) and enable an external torque limitation.

The inverter commands may be sent from:

- Hardware terminal board
- Keypad
- Remote virtual terminal board: through serial link with MODBUS communication protocol
- Remote virtual terminal board: through Field bus (optional board).

Multiple terminal boards may also be activated (up to 3 terminal boards with parameters C140, C141, C142); in that case, the inverter will apply logic functions OR or AND to the different terminals to obtain the activated terminal board (see next section, Command Sources).

References and torque limit signal can be selected among:

- the three analog inputs acquired on the hardware terminal board (REF, AIN1, AIN2),
- the frequency input,
- the encoder input,
- the keypad,
- the serial link,
- the Field bus (optional board).

Multiple reference sources may be activated (up to 4 reference sources with parameters C143, C144, C145, C146); in that case, the inverter will consider the sum of all active reference as the main reference.

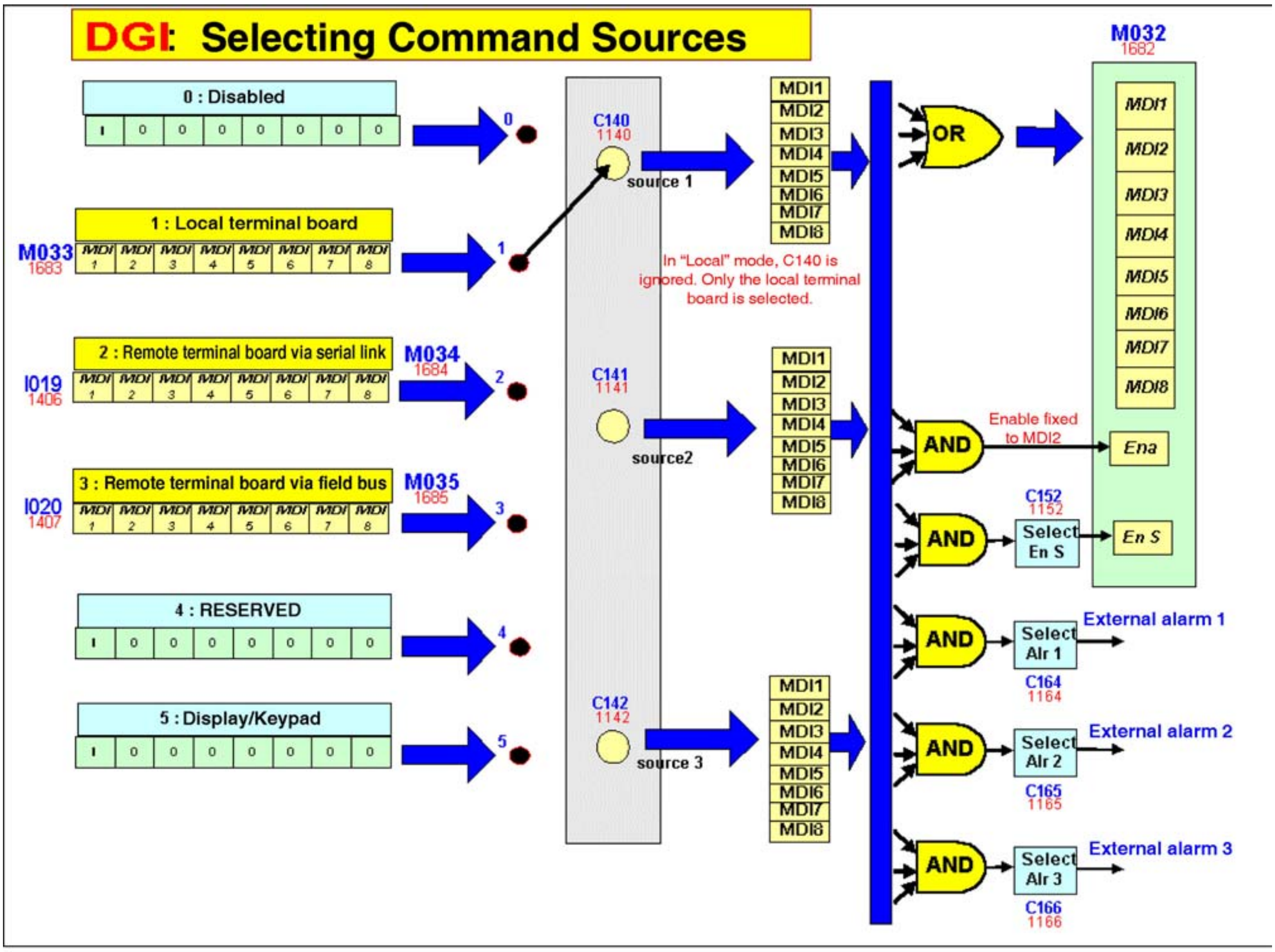
To set up the torque limit signal (C147), the same options considered for speed (or torque) references are available.

18.1.1 COMMAND SOURCES

The inverter commands may be sent from the following sources:

0. *Source disabled*
1. Terminal boards
2. Serial link (with MODBUS protocol)
3. Field bus (field bus on optional board)
4. RESERVED *(for future use)*
5. Keypad (remotable display/keypad)

Factory setting enables one common source only (C140=1, C141=0, C142=0).
(See also Digital Inputs Menu.)
Most commands may be delayed when enabled or disabled: please refer to Timers Menu.



P000121-B

Figure 30: 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 that case, the logic function accomplished by the inverter for the terminals of all active command sources is the following:

- AND for terminals where the following functions are programmed. ENABLE, ENABLE–S, External Alarms n.1, n.2, n.3;

OR for any other terminal.

NOTE

The keypad is a particular command source: no terminals are provided on the keypad, but it is provided with function keys: START, STOP, RESET, Fwd/Rev, Loc/Rem.

If the keypad is enabled as a command source, the START, STOP, RESET, Fwd/Rev, Loc/Rem functions are enabled. The keypad is ignored for the processing of logic functions (AND/OR) of the other command sources that are enabled at that moment.

NOTE

The ENABLE (MDI2) command of the hardware terminal board is always active, because it enables the inverter acting as a hardware safety device. It is active even when no parameter among C140, C141 or C142 selects the keypad (=1) as a command source. As a result, the ENABLE function is generated in AND between the logic signal on terminal MDI2 in the terminal board and the similar command generated from any other active command source.

NOTE

The command for the LOCAL function is unique: even if several sources are enabled, this function is active on the terminal board only, even when it is not selected. This function enabling or disabling cannot be delayed, even if one timer is activated for a terminal enabling this function through C180.

NOTE

The commands for the External Alarm n.1, n.2, n.3 function are unique: they are implemented with the AND logic function, and the enabling and disabling of this command function cannot be delayed:
if it is not enabled with C164, C165, C166, this function is ignored.

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 as the only command source, thus ignoring the values set in parameters C140, C141, C142.

The following command functions are enabled on the hardware terminal board: External Alarm n.,1 n.2, n.3, Motor Sel. n.2, Motor Sel. n.3, SLAVE, PID Disable, LOCAL; the ENABLE and RESET functions are always enabled in terminals MDI2 and MDI3.

Table 53: Command MODBUS Inputs

MODBUS Address	Input Code	Access Level	Description	Range
1406	I019	ADVANCED	Remote, virtual terminal board from serial link	Bit input: 0÷1 for 8 bits corresponding to MDI1÷ MDI8
1407	I020	ADVANCED	Remote, virtual terminal board from field bus	Bit input: 0÷1 for 8 bits corresponding to MDI1÷ MDI8

EXAMPLE:

Set C140 = 3 (Field bus) and C141 = 2 (Serial link): the ENABLE command is sent by closing terminal MDI2 in the terminal board and (AND) by forcing bit MDI2 from serial link on input I019 (address MODBUS 1406) and bit MDI2 from field bus on input I020 (address: MODBUS 1407).

The START command may also be sent (OR) by forcing bit MDI1 from serial link on input I019 or by forcing bit MDI1 from Field bus on input I020 .

18.1.2 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 inverter.
This reference is acquired by the inverter only if the START command and the ENABLE command are active; otherwise, it is ignored.
When the main reference is acquired by the inverter (START and ENABLE are active), it becomes the input signal managed by the "time ramp" functions generating the speed/torque reference set–point for the connected motor.

Three voltage analog inputs are available in the terminal board, that are capable of sending the main reference to the inverter: input REF, input AIN1, input AIN2. They can be set up as voltage inputs (range: –10 ÷ +10 V) or as current inputs (range: 4 ÷20 mA) through a dip–switch.

The speed or torque references may come from these 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*)
5. Serial link (*with MODBUS protocol*)
6. Field Bus (*field bus on optional board*)
7. Keypad (*remotable display/keypad*)
8. Encoder (*in terminal board MDI6–ECHA , MDI7–ECHB or optional board*)
9. RESERVED (*command sources for future use*)

Factory setting enables one reference source only (C143=1, C144=0, C145=0, and C146=0). REF only is selected. (Please refer to References Menu and Analog Inputs Menu as well).
If multiple reference sources are selected by programming C144, C145, or C146, the processed reference is the algebraic sum of all enabled references.

Sources *REF*, *AIN1* and *AIN2* come from the terminal board and generate a reference resulting from the set up of the relevant parameters (from P050 to P064), for the scaling, offset compensation and filtering of the reference obtained (see References).

Source *FIN* is a frequency input in terminal MDI8; it produces a reference determined by the programming of the relevant parameters (from P071 to P072), allowing scaling (see References).

The *Serial* source is an input on MODBUS link: the reference value shall be written by the user to the addresses below:

Table 54: Reference MODBUS Inputs

MODBUS Address	Input	Access Level	Type of Reference	Description	Range	Unit of Measure	Note
1412	I025	ADVANCED	Speed	Speed reference (integer)	Min. speed ÷ Max. speed	RPM	(1)
1413	I026	ENGINEERING	Speed	Speed reference (decimal portion)	–99 ÷ 99	RPM/100	(2)
1416	I029	ADVANCED	Torque	Torque reference or torque limit (integer)	Min. torque ÷ Max. torque	Tenths %	(3)

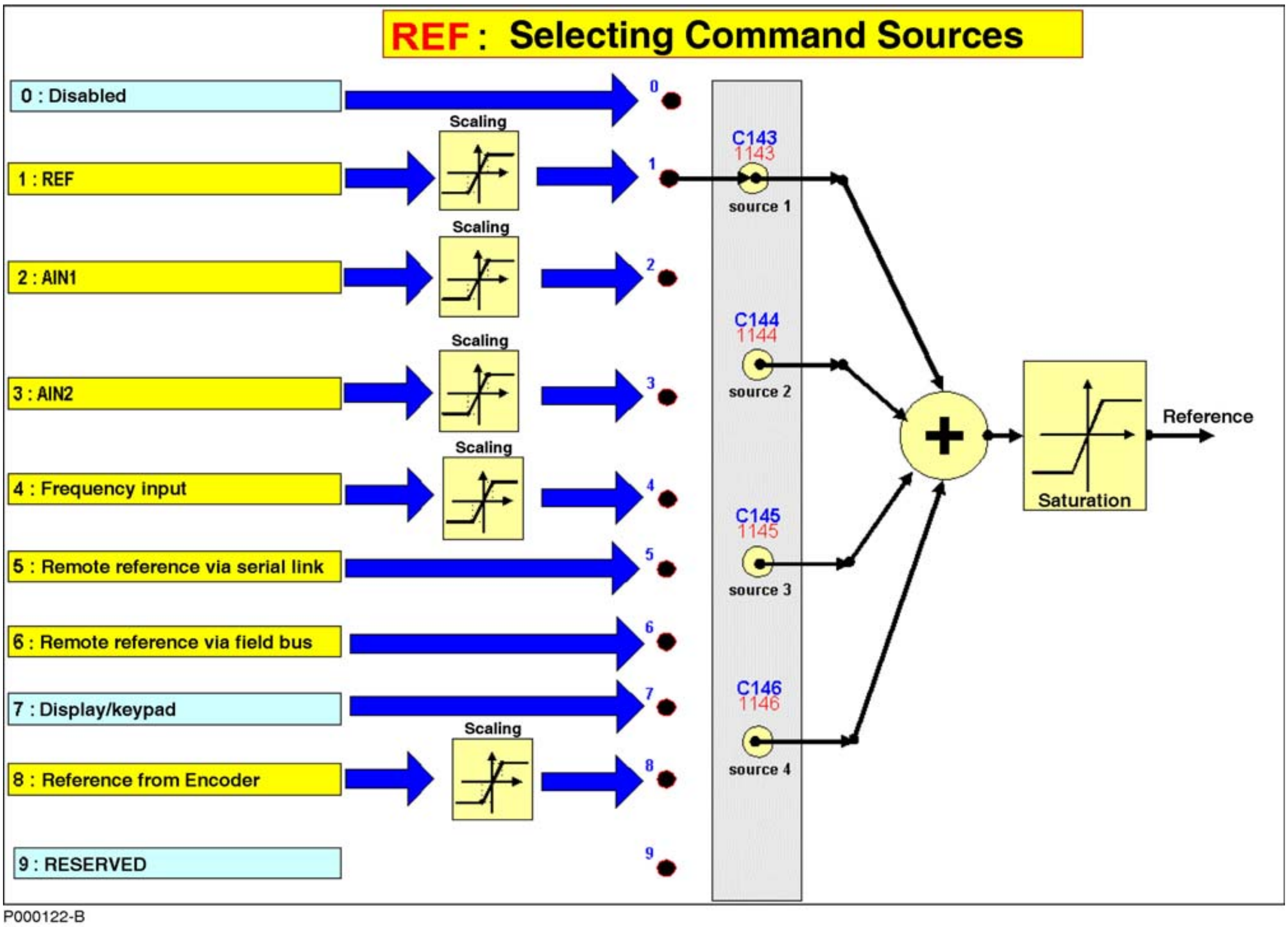


Figure 31: Selecting the Reference Sources

(1) NOTE IO25 is the speed reference in RPM; its range depends on the active min. speed value and max. speed value (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.

(2) NOTE IO26 is active with FOC control only and is used to send a reference expressed in RPM (a decimal speed reference is also possible). This reference will be summed up to the reference given by I025 and will form a unique serial-link reference resulting from the formula below:
reference from serial link= I025 + I026*0.01.
This is a decimal reference occurring only if the speed sensor offers a proper resolution.

(3) NOTE IO29 this signal is used as a torque reference or as a Torque Limit. It is expressed as a percentage of the absolute max. torque set with 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%

The *Encoder* source is an encoder input: it can come from the terminal board (terminals MDI6, MDI7) or from the optional encoder board (see Encoder Menu). It generates a reference resulting from the correct setup of the relevant parameters (P073, P074), allowing scaling (see References Menu).

NOTE The keypad is a particular reference source.
If the keypad is enabled, use the *INC* key (/\ ) and the *DEC key* (\/) to add a **variation** to the active reference by way of an algebraic sum. The active reference is computed 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 terminal board (see Digital Inputs: C161 and C162).

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 as the only command source, thus ignoring the values set in parameters C143, C144, C145, C146.

18.1.3 TORQUE LIMIT SOURCE

The source of the Torque Limit can be selected with parameter C147.
The Torque limit function is a limitation of the absolute value of the torque required from the inverter.
The output torque ranges between the values of max. positive torque (motor operating as a real motor) and the max. negative torque (motor operating as a braking device).
(– Torque limit) <= torque <= (+ Torque limit)

<u>The torque limit reference</u> may come from the following 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*)
5. Serial link (*with MODBUS protocol*)
6. Field Bus (*field bus on optional board*)
7. Keypad (*remotable display/keypad*)
8. Encoder (*in terminal board MDI6–ECHA , MDI7–ECHB or optional board*)
9. RESERVED (*command sources for future use*)

NOTE (*) If the reference source is disabled, the torque limit results from the max. absolute torque determined by the inverter 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, so torque limit depends on the max. absolute torque (see References Menu and Analog Inputs Menu).

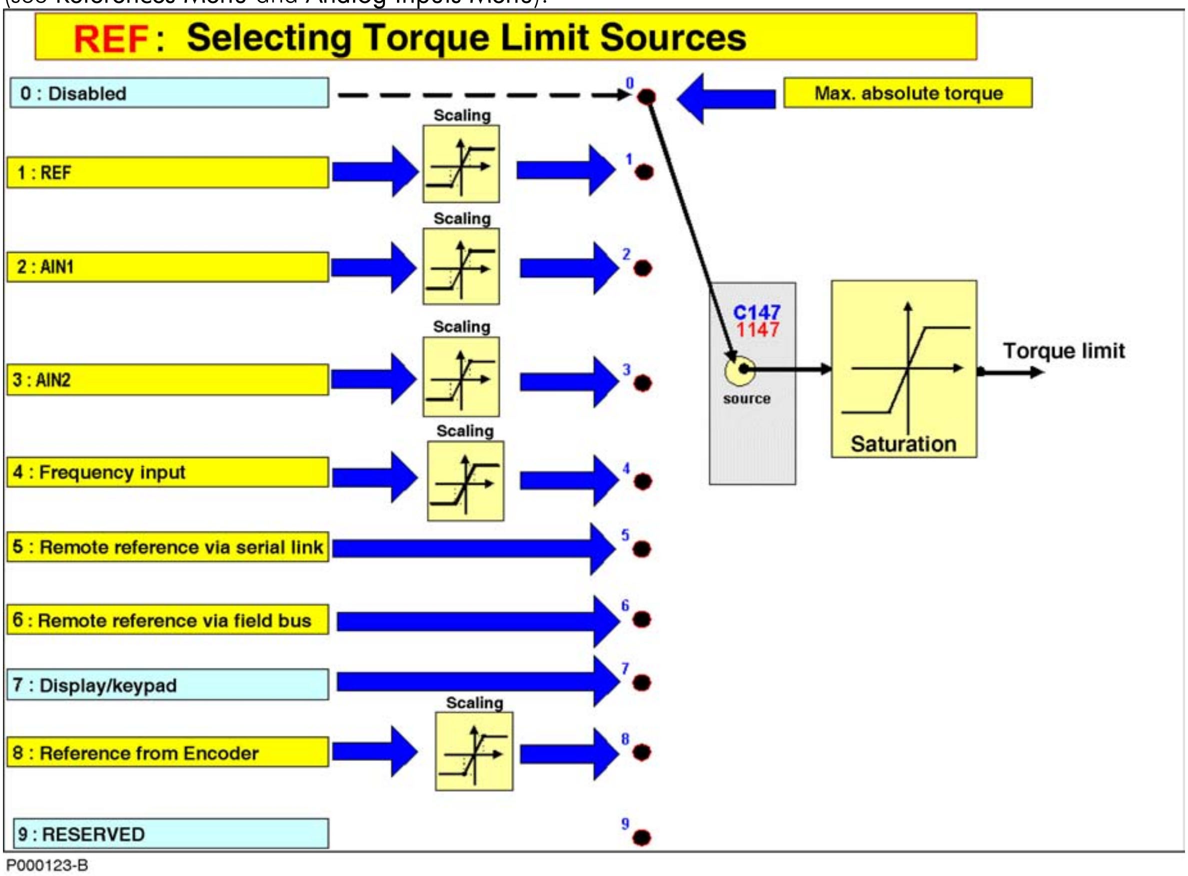


Figure 32: Selecting the Torque Limit Source

18.2 Parameter List

Table 55: List of Parameters C140 ÷ C147

Parameter	FUNCTION	Access Level	MODBUS Address
C140	Command digital input 1	ADVANCED	1140
C141	Command digital input 2	ENGINEERING	1141
C142	Command digital input 3	ENGINEERING	1142
C143	Reference input 1	ADVANCED	1143
C144	Reference input 2	ENGINEERING	1144
C145	Reference input 3	ENGINEERING	1145
C146	Reference input 4	ENGINEERING	1146
C147	Torque limit input	ENGINEERING	1147

NOTE The programmable range for parameters C140, C141, C142 depends on programming of parameter C150 and viceversa.
(See detailed description of the parameters above.)

18.2.1 C140 Command Digital Input 1

C140	Range	0 ÷ 5	0: Disabled, 1: Terminal board, 2: Serial link, 3: Field bus, 4: RESERVED(*), 5: Keypad(**).
Command digital input 1	Default	1	1: Terminal board
	Level	ADVANCED	
	Address	1140	
	F	This parameter selects source 1 for the inverter digital commands.	

NOTE (*) Do not select value 4 (RESERVED), which is used for future applications.

NOTE (**) Value 5 (keypad) can be selected in two cases only:

- When parameter **C150** (STOP input) is programmed;

- When parameter **C150** (STOP input) IS NOT programmed and the other sources (C141 and C142) are disabled.

In any other case, the max. value is (4) RESERVED.

18.2.2 C141 Command Digital Input 2

C141	Range	0 ÷ 5	0: Disabled, 1: Terminal board, 2: Serial link, 3: Field bus, 4: RESERVED (*), 5: Keypad(**).
Command digital input 2	Default	0	0: Disabled
	Level	ENGINEERING	
	Address	1141	
	F	This parameter selects source 2 for the inverter digital commands.	

NOTE (**) Value 5 (Keypad) can be set up only if parameter **C150** (STOP Input) <u>IS</u> programmed (C150 ≠ 0).
If **C150** (STOP Input) <u>IS NOT</u> programmed (**C150**=0), the max. value in C141 depends on **C140**:

- The max. value is 4: RESERVED if **C140** is other than 5;
- The max. value is 0: Disabled if **C140**=5.

If source 1 is set in the keypad, source 2 (C141) and source 3 (C142) cannot be programmed.

18.2.3 C142 Command Digital Input 3

C142	Range	0 ÷ 5	0: Disabled, 1: Terminal board, 2: Serial link, 3: Field bus, 4: RESERVED (*), 5: Keypad(**).
Command digital input 3	Default	0	0: Disabled
	Level	ENGINEERING	
	Address	1142	
	F	This parameter selects source 3 for the inverter digital commands.	

NOTE (**) Value 5 (Keypad) can be set up only if parameter **C150** (STOP Input) <u>IS</u> programmed (C150 ≠ 0).
If **C150** (STOP Input) <u>IS NOT</u> programmed (**C150**=0), the max. value in C141 depends on **C140**:

- The max. value is 4: RESERVED if **C140** is other than 5;
- The max. value is 0: Disabled if **C140**=5.

If source 1 is set in the keypad, source 2 (C141) and source 3 (C142) cannot be programmed.

18.2.4 C143 Reference Input 1

C143	Range	0 ÷ 9	0. Disabled, 1. REF, 2. AIN1, 3. AIN2, 4. Frequency reference, 5. Serial link, 6. Field bus, 7. Keypad, 8. Encoder, 9. RESERVED
Reference input 1	Default	0	1: REF
	Level	ENGINEERING	
	Address	1143	
	F	This parameter selects source 1 for the speed/torque reference.	

18.2.5 Reference Input 2

C144	Range	0 ÷ 9	0. Disabled, 1. REF, 2. AIN1, 3. AIN2, 4. Frequency input, 5. Serial link, 6. Field bus, 7. Keypad, 8. Encoder, 9. RESERVED
Reference input 2	Default	0	0: Disabled
	Level	ENGINEERING	
	Address	1144	
	F	This parameter selects source 2 for the speed/torque reference.	

18.2.6 C145 Reference Input 3

C145	Range	0 ÷ 9	0. Disabled, 1. REF, 2. AIN1, 3. AIN2, 4. Frequency input, 5. Serial link, 6. Field bus, 7. Keypad, 8. Encoder, 9. RESERVED
Reference input 3	Default	0	0: Disabled
	Level	ENGINEERING	
	Address	1145	
	F	This parameter selects source 3 for the speed/torque reference.	

18.2.7 C146 Reference Input 4

C146	Range	0 ÷ 9	0. Disabled, 1. REF, 2. AIN1, 3. AIN2, 4. Frequency input, 5. Serial link, 6. Field bus, 7. Keypad, 8. Encoder, 9. RESERVED
Reference input 4	Default	0	Disabled
	Level	ENGINEERING	
	Address	1146	
	F	This parameter selects source 4 for the speed/torque reference.	

18.2.8 C147 Torque Limit Input

C147	Range	0 ÷ 9	0. Disabled, (*) 1. REF, 2. AIN1, 3. AIN2, 4. Frequency input, 5. Serial link, 6. Field bus, 7. Keypad, 8. Encoder, 9. RESERVED
Torque limit input	Default	0	Disabled
	Level	ENGINEERING	
	Address	1147	
	F	This parameter selects the torque limit source. The ramp times set in P026–P027 will be assigned to the selected reference source for torque limit.	

NOTE (*) If the reference source is disabled, the torque limit results from the max. absolute torque determined by the inverter 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 |)

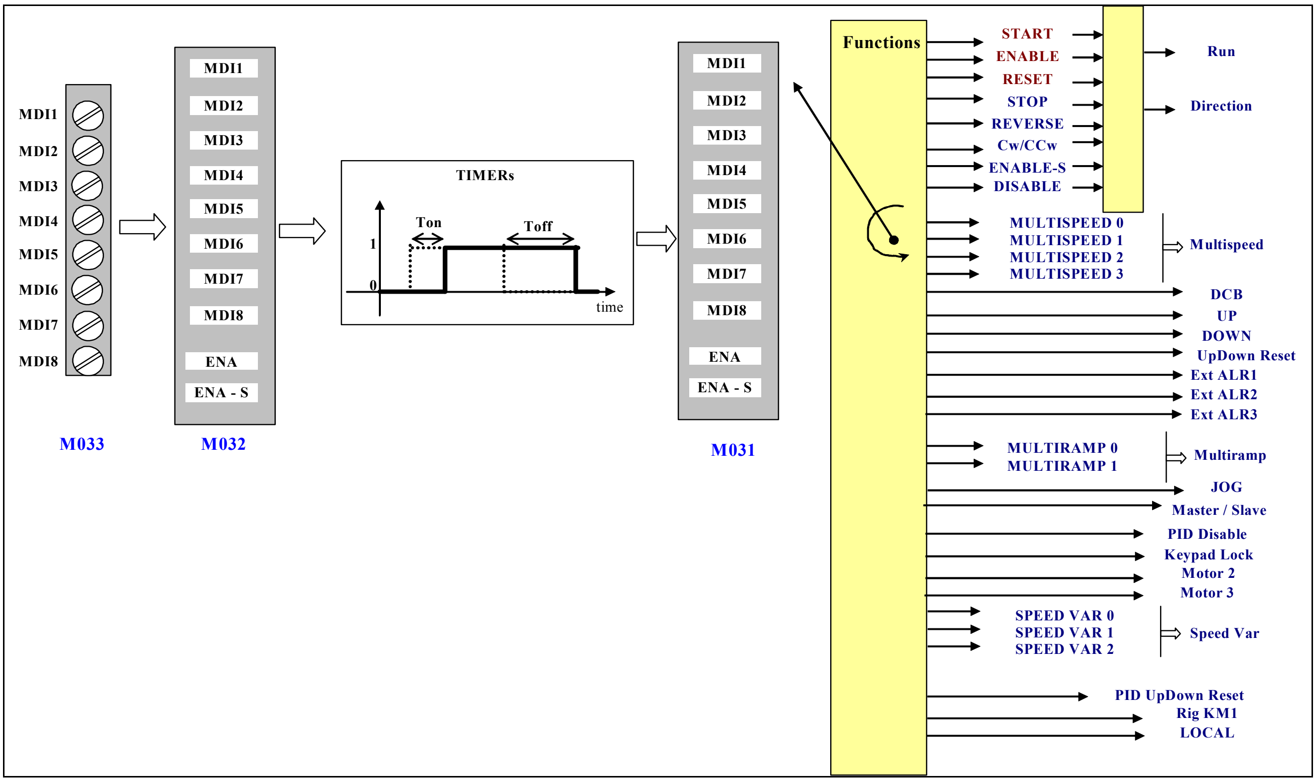
Factory setting is C147=0; the reference source is disabled, so torque limit depends on the max. absolute torque (see **References Menu** and **Analog Inputs Menu**).

19 DIGITAL INPUTS MENU

19.1 Overview

NOTE Please refer to Sinus Penta's Installation Manual for the description of the digital inputs.

The parameters included in this menu assign particular digital command functions to each digital input in the terminal board. Each parameter has a particular function, which is assigned to a terminal in the terminal board.



The full processing of the digital inputs also includes the selection of other remote/virtual terminal boards (see Control Method Menu) and the possibility of delaying input digital signal enabling/disabling by means of software timers (see Timers Menu).

The digital input status is displayed in measures M031, M032, M033 (see Figure above).

Measure M033 shows the current status of the 8 inputs in the hardware local terminals on the inverter board.
In the display/keypad, the logic levels for terminals M033 are displayed with symbol □ for inactive inputs, and are displayed with symbol ■ for active inputs.

Measure M032 shows the current status of the virtual terminal board obtained by processing all active terminal boards. It includes 10 signals, two additional signals if compared 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;

Input ENABLE–S 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 digital inputs M032.
The inverter uses this terminal board to acquire digital commands.
Some functions cannot be programmed, but they are assigned to special terminals:

Table 56: Functions that Cannot be Programmed

Function	*Terminal*
ENABLE	MDI2
RESET	MDI3
START	MDI1

Some terminals in the hardware local terminal board can be used for other functions as well:

Table 57: 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

19.1.1 START (TERMINAL MDI1)

The input function is active if at least one digital input source is assigned to a digital signal in the Control Method menu, but the START command can also be sent from the keypad/display. Enabling/disabling of input MDI1 can be delayed through software timers.

The START input function is assigned to terminal MDI1 and cannot be set up in other terminals. The same terminal may be assigned to multiple functions.

When START is active (when also ENABLE is active), RUN 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 shall be other than zero.)

When START is inactive (even when ENABLE is active) RUN 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 how START enables or disables the RUN command also depends on the setup of 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. If the START and REVERSE commands are both active, the RUN command is disabled.
In that case, START means CW and REVERSE means CCW. When both Start and Reverse are active, the system cannot interpret the query to be clockwise or counterclockwise.
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 descriptions of the STOP function (C150).

NOTE If only the keypad is enabled as the command source, press the START key in the keypad to enable the inverter RUN; press the STOP key to disable the inverter RUN.

19.1.2 ENABLE (TERMINAL MDI2)

The ENABLE input function is assigned to terminal MDI2. It **enables the inverter operation**. It cannot be programmed in other terminals, but additional functions may be assigned to the ENABLE terminal.

The ENABLE **input must always be active in all activated terminals to enable the inverter operation, independently of the control mode.**
If the ENABLE input is disabled, the inverter output voltage is always cut off, so the connected motor starts idling (the motor idles and stops due to friction or the mechanical load).
In case of pulled loads, such as lifting applications, the motor could reach uncontrolled speed due to the mechanical load!

At power on, if the ENABLE command is active, the inverter will not start until terminal MDI2 opens and closes again. This safety measure may be disabled in parameter C181.

If the ENABLE input is disabled when the inverter is controlling the motor, it is closed with a delay time depending on the inverter size. The Enable delay starts from the instant when the input is disabled regardless of the enabling 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 inverter also depends on programming of the ENABLE–S and DISABLE functions.

IFD control: the inverter enabling is also dependent on the START input and on the current value of the active reference. If START is active but the reference is lower than a preset threshold, the inverter operation is inactive. To enable this operating mode with other types of control, properly set parameters P065 and P066.
The PID regulator may also disable the inverter operation (see parameter P255).

CAUTION If the input signal in MDI2 (ENABLE) is disabled for one of the active motors, the inverter is instantly disabled and the motor starts idling! The motor could reach uncontrolled speed due to the mechanical load.

CAUTION If a protection/alarm trips, the inverter 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 When ENABLE is active, configuration parameters (C parameters) cannot be modified.

NOTE The activation of the ENABLE command enables particular alarms controlling the configuration consistency of certain parameters.

NOTE When ENABLE is active, you CANNOT modify the active *Master/Slave mode* or the active *Local mode*.

19.1.3 RESET (TERMINAL MDI3)

The RESET function is assigned to input terminal MDI3. It resets the alarms to unlock the inverter operation. It cannot be programmed in other terminals, but additional functions may be assigned to the RESET terminal.

If a protection trips, the inverter 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 **AutoReset Menu** and **Alarms and Warnings Menu**).

Reset procedure
To unlock the inverter, activate the RESET input for a while, or press the " RESET " key in the keypad. When the inverter unlocks and the cause responsible for the alarm disappears, the display shows "Inverter OK", otherwise, the alarm persists and cannot be reset.
Factory-setting: to restart the inverter, activate and deactivate the ENABLE command (see parameter C181).

NOTE	Factory setting does not reset alarms at power off. Alarms are stored and displayed at next power on and the inverter is locked. Perform a reset procedure to unlock the inverter. The alarms stored may be automatically reset at power on by setting special parameters in the Autoreset Menu.
CAUTION	If an alarm trips, see Autodiagnostics Menu. Reset the equipment when the cause responsible for the alarm has disappeared.
DANGER!!	Electrical shock hazard exists on output terminals (U,V,W) and resistive braking module terminals (+, -, B) even when the inverter is disabled.

19.2 Factory-setting of the Digital Inputs

Table 58: Terminal Board: Factory-setting

Function	Terminal	Description
START	MDI1	Enables the inverter RUN
ENABLE	MDI2	Enables the inverter
RESET	MDI3	Resets the alarms tripped
MULTISPEED 0	MDI4	Bit 0 for Multispeed selection
MULTISPEED 1	MDI5	Bit 1 for Multispeed selection
Available for Encoder Channel A	MDI6	
Available for Encoder Channel B	MDI7	
CwCCW 1	MDI8	Reference reversal

19.3 Parameter List

Parameters ranging from **C150** to **C180** (one for each command function) activate single functions and set the terminal for each function enabling/disabling.
Parameter **C181** enables a safety START mode.

Table 59: List of Parameters C150 ÷ C181

Parameter	FUNCTION	Access Level	MODBUS Address
C150	STOP Input	ENGINEERING	1150
C151	REVERSE Input	ADVANCED	1151
C152	ENABLE–S Input	ADVANCED	1152
C153	DISABLE Input	ADVANCED	1153
C155	MULTISPEED 0 Input	ADVANCED	1155
C156	MULTISPEED 1 Input	ADVANCED	1156
C157	MULTISPEED 2 Input	ADVANCED	1157
C158	MULTISPEED 3 Input	ADVANCED	1158
C159	Cw/CCW Input	ADVANCED	1159
C160	DCB Input	ADVANCED	1160
C161	UP Input	ADVANCED	1161
C162	DOWN Input	ADVANCED	1162
C163	Reset UP/DOWN Input	ADVANCED	1163
C164	External alarm 1 Input	ADVANCED	1164
C165	External alarm 2 Input	ADVANCED	1165
C166	External alarm 3 Input	ADVANCED	1166
C167	MultiRamp 0 Input	ENGINEERING	1167
C168	MultiRamp 1 Input	ENGINEERING	1168
C169	JOG Input	ADVANCED	1169
C170	SLAVE Input	ADVANCED	1170
C171	PID DISABLE Input	ADVANCED	1171
C172	KEYPAD LOCK Input	ADVANCED	1172
C173	MOTOR 2 SEL. Input	ENGINEERING	1173
C174	MOTOR 3 SEL. Input	ENGINEERING	1174
C175	SPEED VAR. 0 Input	ENGINEERING	1175
C176	SPEED VAR. 1 Input	ENGINEERING	1176
C177	SPEED VAR. 2 Input	ENGINEERING	1177
C178	PID Up/Down Reset Input	ADVANCED	1178
C179	Rig KM1 Closed Input	ADVANCED	1179
C180	LOCAL Input	ADVANCED	1180
C181	Start safety enabling	ADVANCED	1181
C182	Multiprogramming enabling	ENGINEERING	1182
C183	Fluxing max. time before inverter disabling	ADVANCED	1183

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. Parameter **C181** is not used to select a function, but to enable the safety Start. See description of **C181**.

CAUTION

To set up two functions in the same terminal, set parameter **C182**=1. Setting two functions in the same terminal is not recommended for inexperienced users.

19.3.1 C150 STOP INPUT

C150	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8 (*)
STOP Input	Default	0	Inactive
	Level	ADVANCED	
	Addr	1150	
	Function	This parameter disables the RUN function enabled by the START command. The setup of this function has effect on the enabling/disabling mode of the RUN command, which is enabled/disabled using the START and STOP buttons instead of the START button as an ON/OFF switch (factory-setting). If the inverter is enabled: • Press START to enable the inverter RUN, • Press STOP to disable the inverter 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 that case, the *START key* and the *STOP key* in the display/keypad are active and can enable or disable the inverter RUN.	

The key-operated RUN/STOP mode is incompatible with the switch-operated mode (by level).

(*) NOTE

Factory setting: only the hardware terminal board selected with command source 1 (C140=1) is active with the switch-operated mode (C150=0).
To switch to the key-operated mode, set the STOP input as follows: C150 ≠0. The keypad and other terminal boards may be selected in key-operated mode only.
If STOP 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).

Therefore, dynamic, mutual limits are set for possible combinations of parameters C150, C140, C141, C142.
Once enabled (C150 ≠0), the STOP function may be disabled only if command sources 2 and 3 are disabled (C141=0) (C142=0).
Set (C141≠0) or (C142≠0) to program this function for a different terminal. Disabling is not allowed.

NOTE

If the REVERSE function is enabled, this can enable the RUN command in key-operated mode as for the START command, but the reference will have an opposite sign.

NOTE

The STOP function has priority over the START function; if both inputs are active, the STOP input prevails. The STOP input acts as a key and as a **switch**.

NOTE

In key-operated mode (C150 ≠0), the inverter keeps track of the activation of the START and STOP keys and/or of the activation of the START and STOP inputs, unless the ENABLE input is active, an alarm has tripped or the inverter is disabled through functions ENABLE–S or DISABLE.
When the inverter is disabled, the STOP button, the START button and the *START key* and the *STOP key* in the display/keypad are ignored.

19.3.2 C151 REVERSE INPUT

C151	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
REVERSE Input	Default	0	Inactive
	Level	ADVANCED	
	Addr	1151	
	Function	The REVERSE function is very similar to the START command, but it reverses the motor direction of rotation. This function reverses the **sign of the active reference**: the connected motor decelerates to zero speed following the preset deceleration ramp, then it accelerates again to reach the new reference value depending on the preset acceleration ramp. The **REVERSE** command activates only if the **START** command is disabled: before activating the **REVERSE** input, make sure that the **START** input is disabled. If both inputs (**START** and **REVERSE)** are active, they automatically disable because they are incompatible: the inverter is then sent a STOP command (*see figures below: START and REVERSE enable the inverter RUNNING with a XOR logic function*). If the **STOP** input function is not programmed (**C150**=0) the **REVERSE** signal and the **START** input act as switches, otherwise they act as buttons.	

NOTE

If the keypad is active, pressing the REV key in 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 (input function) as well (C159 ≠ 0).

NOTE

If the keypad is active, pressing the REV key in the display/keypad will also reverse the direction of rotation of the connected motor.
The activation of the keypad and the terminal board at a time is enabled only if the STOP function is activated (C150 ≠ 0). In that case, three reversing sources are available: REVERSE, Cw/CCw, *REV key*; reversal occurs if all three sources are active, but it does not if only two sources are active.

CAUTION

When the reference sign is reversed, the direction of rotation of the connected motor is not instantly reversed: the setpoint decreases to zero following the preset deceleration ramp, and it increases up to the reference value having the opposite sign following the preset acceleration ramp.

CAUTION

When transients due to ramps are over, if the motor direction of rotation has not changed, make sure that the motor cables are properly connected to terminals U, V, W.

The figure below illustrates the logic diagram for processing the START, REV, Cw/CCw functions and the *START, STOP, REV* keys in the display/keypad if the STOP function is not programmed.

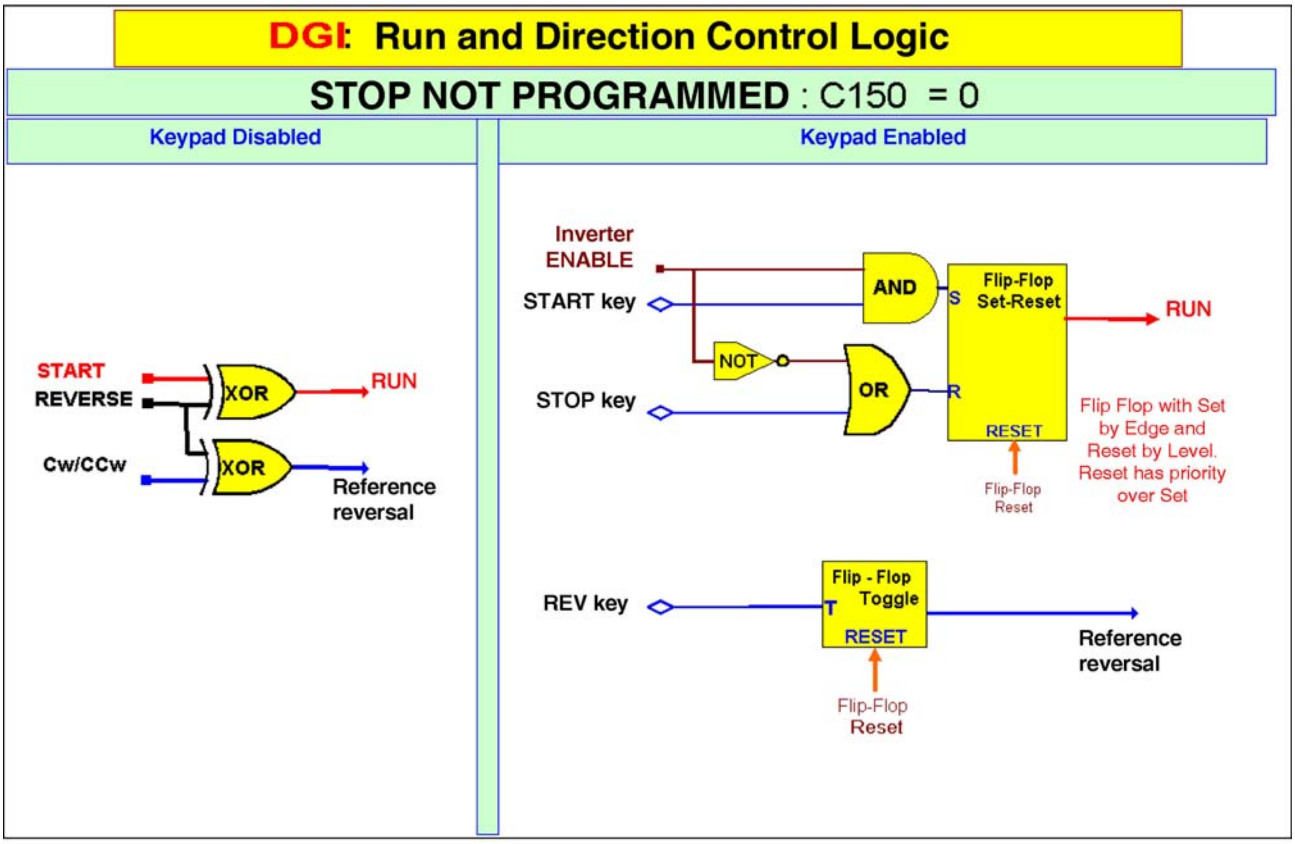


Figure 33: Controlling Run and Direction when STOP is not Programmed

Figure 3 illustrates the processing logic diagram of the START, REV, Cw/CCw functions and of the *START, STOP, REV keys* in the display/keypad, if the STOP function is set up.

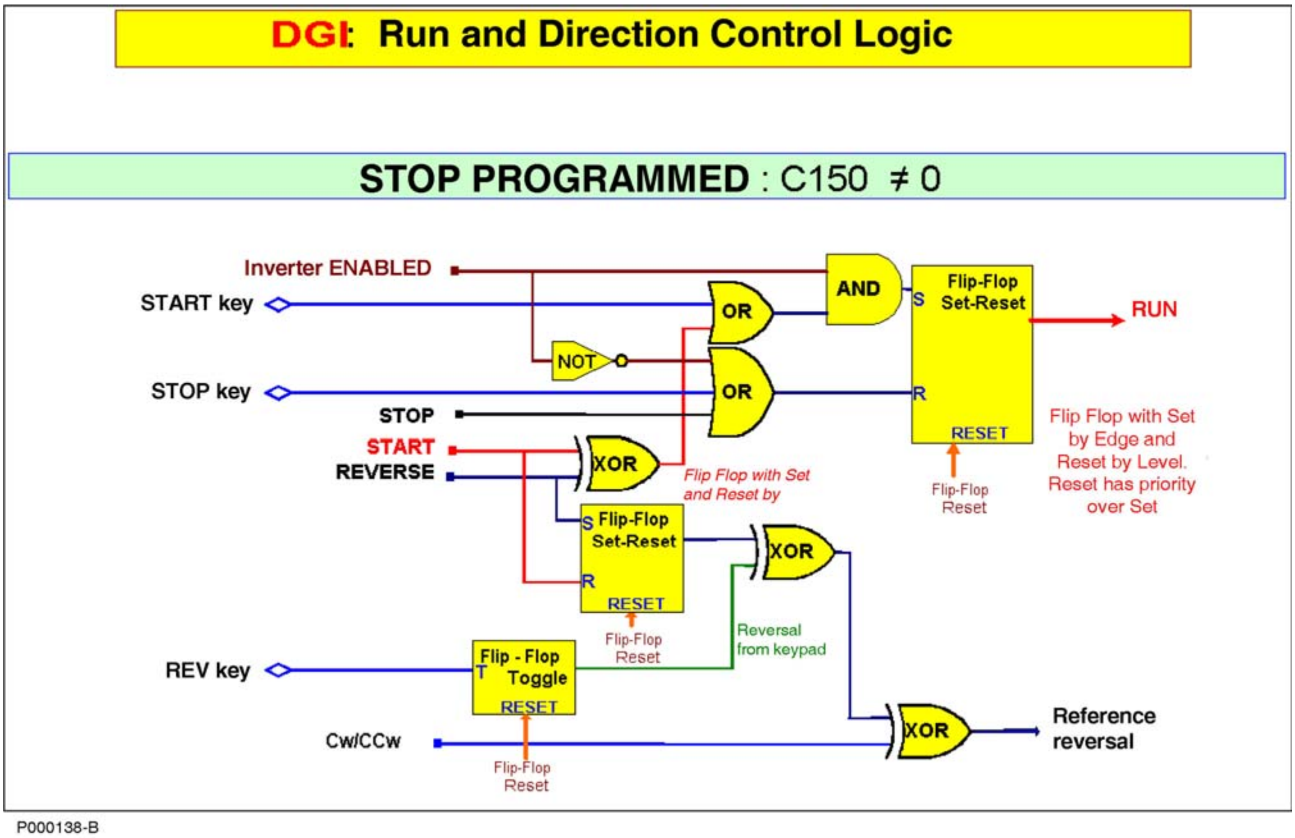


Figure 34: Run and Direction Control when the STOP Input is Set Up.

19.3.3 C152 ENABLE–S INPUT

C152	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
ENABLE–S Input	Default	0	Inactive
	Level	ADVANCED	
	Addr	1152	
	Function	This is a safety ENABLE: if this function is enabled, the inverter activates only if both ENABLE and ENABLE–S inputs are active. Once the inverter is turned off, the ENABLE–S input must be disabled and enabled again to activate the inverter.	

NOTE

The ENABLE–S signal cannot be delayed by software timers: if a timer is programmed for the terminal relating to ENABLE–S, it has no effect on the ENABLE–S function, whereas it normally delays other functions programmed for the same terminal.

19.3.4 C153 DISABLE INPUT

C153	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
DISABLE Input	Default	0	Inactive
	Level	ADVANCED	
	Addr	1153	
	Function	The DISABLE function disables the inverter and overrides the ENABLE signals. The DISABLE command sets to zero the inverter output voltage, so the motor starts idling (the motor idles and stops due to friction or the mechanical load). If the DISABLE function is set up (C153≠0), deactivate the input signal in the terminal selected with C153 to enable the inverter; then activate the ENABLE function (and the ENABLE–S function, if programmed).	

19.3.5 C155 C156 C157 C158 MULTISPEED INPUTS

C155 C156 C157 C158	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
Multispeed inputs: MULTISPEED 0 MULTISPEED 1 MULTISPEED 2 MULTISPEED 3	Default	C155 = 4, C156 = 5, C157 = 0, C158 = 0.	C155 = MDI4, C156 = MDI5, C157 = Inactive, C158 = Inactive.
	Level	ADVANCED	
	Addr	1155, 1156, 1157, 1158	
	Function	This function generates up to 15 speed references that can be programmed with parameters P081÷P098 based on the programming mode set in P080. The Multispeed 0,1,2,3 functions determine the active speed references among the 15 speed references: 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) as stated in Tables 60 and 61. If one of these functions is not set up, its relevant bit is "zero".	

Table 60: Multispeed

	Bit 3	Bit 2	Bit 1	Bit 0
Selected multispeed =	**MULTISPEED 3**	**MULTISPEED 2**	**MULTISPEED 1**	**MULTISPEED 0**

Table 61: 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
Selected multispeed	*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 for two different terminals, only multispeed 0, 1, 8, 9 can be selected, relating to the following speed references:

(*)	P081	P091	P092

(*) Factory-setting: (P080 = *Preset Speed*), if no multispeed function is selected, the active reference is the reference set with the parameters in the References Menu.
If P080 = *Speed Sum*, the selected multispeed function will **sum up** to the active reference: the active reference is the reference set with the parameters in the 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 **References Menu** for the reference processing sequence: the **Speed Decrease** function and the **Reference Reversal** function become active downstream of the **Multispeed** function.

(**) If the FOC control is active, multispeed 0, 1 and 2 will have a decimal portion: P082, P084, P086, which is summed up to the integer portion expressed by P081, P083, P085. See References Menu for more details.

NOTE

Table 6:
0 ⇒ inactive input;
1 ⇒ active input;
X ⇒ input having no effect.

19.3.6 C159 Cw/CCw Input

C159	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
Cw/CCw Input	Default	8	MDI8
	Level	ADVANCED	
	Addr	1159	
	Function	The Cw/CCw input reverses the **sign of the active reference**: motor reverses its direction of rotation; it decelerates to zero following the preset deceleration ramp, than it accelerates following the preset acceleration ramp until it reaches the new reference value. Other functions are available for the reversal of the active reference sign (+/-): see description of the REVERSE parameter (C151).	

The **reference sign is reversed** after selecting, computing and processing the active reference:

The max. preset speed is factory-set as C028=1500 rpm; the min. preset speed is factory set as C029=0 rpm.
For example, if the active reference value is 1000rpm before enabling the sign reversal with the Cw/CCw function, the REVERSE function or the REV key in the display/keypad, the active reference will be –1000 rpm after activation.

NOTE

Reference must range between the min. value and the max. value set in C028 and C029:
If C029 <= C028, then **minimum speed** = C029, **maximum speed** = C028.
If C029 >= C028, then **minimum speed** = C028, **maximum speed** = C029.

If the sign reversal is <u>inactive</u>, saturation occurs as follows:
minimum speed <= active reference <= maximum speed

If the sign reversal <u>is activated</u>, saturation occurs as follows:
(–maximum speed) <= active reference <= (–minimum speed)

19.3.7 C160 DCB Input

C160	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
DCB Input	Default	0	Inactive
	Level	ADVANCED	
	Addr	1160	
	Function	This function is enabled with IFD or VTC controls only. For other types of control, this function has no effect even if C160≠0. DCB command enables **DC braking** for a time depending on the speed value determining the input activation. See DC Braking Menu for more details.	

19.3.8 C161 C162 UP Input and DOWN Input

C161 C162	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
UP Input DOWN Input	Default	0	Inactive
	Level	ADVANCED	
	Addr	1161, 1162	
	Function	This function increments (UP) or decrements (DOWN) the active speed (or torque) reference by adding a quantity to the speed/torque reference. This also depends on the following parameters: C163 Up/Down Reset, P067 Up/Down Ramp Time, P068 Up/Down MEM, P069 Unipolar Up/Down. With factory-setting (P069=1), if the (UP) command is active, the speed/torque reference increases following the acceleration ramp (set in P067) up to the max. speed/torque; if the (DOWN) command is active, the speed/torque reference decreases to zero following the deceleration ramp (set in P067). Set (P069=0); keep terminal (DOWN) closed to reverse the motor direction of rotation (provided that min. speed is lower than zero) until it reaches its min. speed. With factory setting (parameter P068=YES), the quantity added to the speed/torque reference obtained with UP and DOWN inputs is stored at power off. When the inverter is turned on again, the current speed reference is summed up to the quantity added (or subtracted) with the UP and/or DOWN keys before power off. If the current reference value has not been altered, the global value does not change. To reset the value of the added quantity, just enable the Reset Up/Down input function (C163 ≠ 0) and activate the relevant input.	

19.3.9 C163 Reset Up/Down Input

C163	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
Reset Up/Down Input	Default	0	Inactive
	Level	ADVANCED	
	Addr	1163	
	Function	When required, this function resets the variation of the speed/torque reference obtained with the UP or DOWN inputs, or with the *UP key* or the *DOWN key* in the display/keypad.	

19.3.10 C164 C165 C166 EXTERNAL ALARM INPUT

C164 C165 C166	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
External Alarm Input	Default	0	Inactive
	Level	ADVANCED	
	Addr	1164, 1166, 1166	
	Function	If one of these 3 functions is programmed for a terminal in the terminal board, an alarm trips when the command contact **opens** the terminal selected with parameter **C164**, **C165** or **C166**. To restart the inverter, close the command contact (signal enabled) and perform a RESET procedure. Alarms generated by these 3 functions are **A083**, **A084**, **A085** respectively. Factory-setting: this function is disabled.	

CAUTION

The terminal board for these 3 functions is not delayed by software timers (see **TIMERS Menu**), (**M032**).
If multiple command sources are enabled (see **Control Method Menu**), each "External Alarm" signal command is obtained by computing the logic AND of the input signals for the terminal selected in all enabled command sources. In order to avoid any external alarm, the input signal for the selected terminal must be active in all terminal boards.
The External Alarm trips when only one input signal for the terminal selected in one of the active command sources is disabled.

19.3.11 C167 C168 MULTIRAMP INPUTS

C167 C168	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
Multiramp 0 Multiramp 1 Inputs	Default	C167 = 0, C168 = 0.	C167 = Inactive, C168 = Inactive.
	Level	ENGINEERING	
	Addr	1167, 1168	
	Function	This function allows selecting up to **4 acceleration/deceleration ramps**. Each ramp has its own programming parameters (see **Ramps Menu**, **P009** ÷ **P025**). It determines which of the 4 ramps is 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), as stated in Tables 62 and 63. **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 value of the relevant bit is "zero".	

Table 62: Multiramp Selection

		Bit 1	Bit 0	
Selected ramp =	(	**Multiramp 1**	**Multiramp 0**	) + 1

Table 63: 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 P011 (*)	P012 P013 P014 (*)	P015 P016 P017 (*)	P018 P019 P020 (*)

If one of these functions is not programmed, the value of the relevant bit is "zero".
Example: if C167 is Inactive (0) and C168 is programmed for one terminal, you can select only ramp 1 or ramp 4.

NOTE (*) If the ramp rounding off function is enabled (P021≠0), the real ramp times also depend on the values of parameters P022, P023, P024, P025, P031.

19.3.12 C169 JOG Input

C169	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
Reset Up/Down Input	Default	0	Inactive
	Level	ADVANCED	
	Addr	1169	
	Function	When the JOG function is enabled, the motor rotates at low speed with slow ramps manually controlled by the user with a JOG button. If the inverter is enabled (ENABLE activated) but is not RUNNING, and if the JOG input is enabled, the inverter will RUN: the connected motor will accelerate with a JOG ramp (P029) up to the JOG speed reference (P070). On the other hand, if the JOG input is disabled, the inverter 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 activation of this terminal determines the motor RUN (if the inverter is enabled).

The RUN function (obtained with the START, REVERSE command or the *Start key* if the display/keypad is enabled) will override the JOG function: as a result, if the RUN function is active, the JOG function is ignored.

NOTE

If the RUN function is enabled when the JOG function is active (the connected motor is running), the JOG function is disabled: the preset reference is restored (**References Menu**) and the motor will reach the preset reference following the ramps programmed in the **Ramps Menu**.
Factory setting is JOG P070=0.
Set the desired JOG speed in P070 before activating the JOG terminal.

NOTE

If the JOG terminal is enabled and P070=0, the active reference is null and the motor does not start.
In *SLAVE* mode (torque reference instead of speed reference) if the motor is not running, it can rotate at JOG speed by enabling the JOG function.

NOTE

In SLAVE mode, the JOG function is ignored if the motor is still rotating for an active reference torque.

19.3.13 C170 SLAVE Input (VTC or FOC Only)

C170			
SLAVE Input	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
	Default	0	Inactive
	Level	ADVANCED	
	Addr	1170	
	Function	Activate the terminal enabling this function so as the main reference becomes a **torque reference** ignoring the speed loop. This function is active for VTC and FOC controls only. This function enables the *SLAVE* operating mode (**torque reference**), instead of the *MASTER* operating mode (speed reference). The Torque References and the Torque Ramps are used (**References Menu** and **Ramps Menu**).	

NOTE

This function is ignored if the operating mode selected for the active motor is the *SLAVE* mode, i.e. C011=1 (motor 1), C054=1 (motor 2), C097=1 (motor 3).

Factory-setting: commands are sent in *MASTER* mode; speed reference is selected; (C011= 0 ; C054 =0 ; C097 = 0)
This function is acquired only if the inverter is disabled (inactive ENABLE function). When the inverter is enabled (active ENABLE function) it operates in *MASTER* or *SLAVE* mode, depending on the operating mode selected before activating the inverter.

CAUTION

It is possible to switch from *MASTER to SLAVE mode (or viceversa)* only when the inverter is disabled.

19.3.14 C171 PID DISABLE INPUT

C171			
PID DISABLE Input	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
	Default	0	Inactive
	Level	ADVANCED	
	Addr	1171	
	Function	This function is used to disable the PID regulator (see **PID Configuration Menu**): PID output and PID integral term are set to zero. 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, Reference Sum up** mode or **Voltage Sum Up** mode, the PID regulator is used to generate a reference, to correct the reference obtained or to correct output voltage (IFD only). In **Reference mode**, the PID output replaces the main active reference, which is ignored until the PID regulator is disabled. In Reference mode, the **PID DISABLE** function disables the PID regulator and commutates the reference, thus becoming the main active reference again.	

19.3.15 C172 KEYPAD LOCK INPUT

C172			
KEYPAD LOCK Input	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
	Default	0	Inactive
	Level	ADVANCED	
	Addr	1172	
	Function	This function avoids accessing parameter modification through the remotable 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 inhibits activation of the LOCAL mode.

19.3.16 C173 Motor 2 SEL. Input

C173	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
MOTOR 2 Sel. Input	Default	0	Inactive
	Level	ENGINEERING	
	Addr	1173	
	Function	This function **activates motor** 2 and sets the programming parameters for motor 2 (see Table 64). This function has effect only if the number of selectable motors is (C009 > 1); otherwise, alarm A098 trips. The active motor may be changed only when the inverter is disabled.	

19.3.17 C174 Motor 3 SEL. Input

C174	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
MOTOR 3 Sel. Input	Default	0	Inactive
	Level	ENGINEERING	
	Addr	1174	
	Function	This function **activates motor** 3 and sets the programming parameters for motor 3 (see Table 64). This function has effect only if the number of selectable motors is (C009 > 2); otherwise, alarm A098 trips. The active motor may be changed only when the inverter is disabled.	

NOTE

When both motor selection functions are programmed (C173 ≠ 0) and (C174 ≠ 0), and both the relevant terminals are active, it is not possible to determine which motor is actually selected, so alarm A098 trips.

Table 64: Motor Selection

Terminal selecting the **Motor 2 Sel.** function (C173)	Terminal selecting the **Motor 3 Sel.** Function (C174)	**Active motor**
0	**0**	**Motor 1**
1	**0**	**Motor 2**
0	**1**	**Motor 3**
1	**1**	***Alarm* A098**

19.3.18 C175 C176 C177 Speed Var. Inputs

C175 C176 C177	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
SPEED VAR. 0 SPEED VAR. 1 SPEED VAR. 2 Inputs	Default	0	Inactive
	Level	ENGINEERING	
	Addr	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 the active value for speed reference variation: the active value (1) or inactive value (0) of each preset input signal determines a bit-logic binary number; SPEED VAR. 0 is the less significant bit (bit 0), while SPEED VAR. 2 is the most significant bit (bit 3) (Tables 65 and 66). If one of these functions is not set up, its relevant bit is "zero".	

Table 65: Selection of the Speed Reference Variation

Variation of the selected speed reference =	Bit 2	Bit 1	Bit 0
	SPEED VAR. 2	**SPEED VAR. 2**	**SPEED VAR. 0**

Table 66: Selection of the Speed Reference Variation

Function:	Status of the relevant input							
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	*No variation*	*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 relevant bit is “zero”.
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.
Output speed must never exceed the max. allowable speed, even when a higher speed is required.

NOTE

In table 66:
0 ⇒ inactive input;
1 ⇒ active input.

19.3.19 C178 PID Up/Down Reset Input

C178	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
PID Up/Down Reset Input	Default	0	Inactive
	Level	ADVANCED	
	Addr	1178	
	Function	This function resets the variation of the PID reference obtained with the *INC* key and the *DEC key* from the KEYPAD page of the user interface (display/keypad) in PID mode.	

19.3.20 C179 Rig KM1 Closed Input

C179	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
Rig KM1 Closed Input	Default	0	Inactive
	Level	ADVANCED	
	Addr	1179	
	Function	Function reserved for future use. Do not activate this function.	

19.3.21 C180 LOCAL INPUT

C180	Range	0 ÷ 8	Inactive, MDI1 ÷ MDI8
LOCAL Input	Default	0	Inactive
	Level	ADVANCED	
	Addr	1180	
	Function	The **LOCAL mode** can be enabled from the hardware terminal board (see M033) and it ignores the enabling/disabling delays set with the software timers. When the inverter is disabled, the Local mode con also be enabled with the *LOC/REM key* in the display/keypad. The **LOCAL mode** can be accessed only when the inverter is **DISABLED**. The **LOCAL mode** ignores programming of parameters **C140, C141, C142, C143, C144**, as well as the digital command sources and references; **only programming via KEYPAD is enabled**. In the hardware terminal board, the following functions remain active: **ENABLE, External Alarm1,2,3 , Motor 2 Sel., Motor 3 Sel., SLAVE, PID, Disable**, and the LOCAL function. Deactivate the Local input when the inverter is disabled to reactivate signals coming from other command sources.	

19.3.22 C181 SAFETY START ENABLING INPUT

C181	Range	0 ÷ 1	Inactive, Active
Safety START enabling input	Default	0	Inactive
	Level	ADVANCED	
	Addr	1181	
	Function	This function enables the *Safety START mode*. When this function is enabled and the inverter is to be restarted after resetting an alarm, open and close the **ENABLE** terminal (**MDI2**). In that way, when the inverter is turned off and on again after a mains loss and the START and ENABLE inputs are on, the inverter will not RUN.	

NOTE

If multiple terminal boards are selected with parameters **C140, C141, C142**, just open and close the **ENABLE** terminal (**MDI2**) in one of the active terminal boards to restart the inverter.

19.3.23 C182 MULTIPROGRAMMING ENABLING INPUT

C182	Range	0 ÷ 1	Inactive, Active
Multiprogramming Enabling Input	Default	1	Inactive
	Level	ENGINEERING	
	Addr	1182	
	Function	This function permits to program 2 functions for the same terminal. Not all combinations are possible. For each function to be enabled with parameters ranging from C150 to C182, the software will refuse illegal configurations: "ILLEGAL DATA" will be displayed when you attempt to enter a new illegal value.	

19.3.24 C183 MAX. FLUXING TIME BEFORE DISABLING

C183	Range	0 ÷ 65000	0 ÷ 65000 sec
Max. Fluxing Time Before Disabling	Default	0	Disabled
	Level	ADVANCED	
	Addr	1183	
	Function	This function disables the inverter if the fluxing time period is longer than the time set in C182 (for VTC or FOC controls if an Enable command, not a RUN command, is sent). To restore motor fluxing, disable and enable the Enable command, or send a Run command when Enable is active.	

20 ENCODER/FREQUENCY INPUTS MENU

20.1 Overview

Three quick acquisition digital inputs are available in Sinus Penta's control board:

- MDI6/ECHA/FINA ;
- MDI7/ECHB ;
- MDI8/FINB ;

Using optional board ES836 (see Sinus Penta's Installation Manual), an additional encoder can be connected (encoder B).

NOTE — If MDI6 and MDI7 are used for encoder reading, only Push–Pull encoders can be used.

20.1.1 If Optional Board 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 Sinus Penta's Installation 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 input MDI6 or MDI8 can be used.
If MDI6 is programmed as a frequency input (FINA) with C189, no other function must 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 must be assigned, and encoder optional board ES836 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 programmed for MDI6 or MDI7;
- A101 MDI8 Illegal Configuration, if additional functions are programmed for MDI8 or if the power drive detects the presence of optional board ES836.

20.1.2 With Optional Board ES836:

- Reading 1 or 2 Encoders:

To read one Encoder, use optional board ES836 or digital inputs MDI6 and MDI7 (if a push–pull encoder is used).
You can use both the optional board and digital inputs MDI6 and MDI7 to read two encoders at a time. Use parameter C189 to set the reading of the speed measure of the controlled motor or to read values as a reference.
You can use encoder A or encoder B as a speed feedback or as 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 (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, you cannot program any function for MDI6 and MDI7; otherwise, alarm A082 Illegal Encoder Configuration will trip when Enable closes.

If encoder B is selected and optional board ES836 is not detected by the inverter, alarm A082 Illegal Encoder Configuration will trip when Enable closes.

- Reading a Frequency Input:

Only digital input MDI6 (FINA) can be used as a frequency input; if MDI8 is programmed as a frequency input (FINB) with C189, if the optional board is installed, alarm A101 MDI8 Illegal Configuration trips.
No additional function must be assigned to MDI6; otherwise, alarm A100 MDI6 Illegal Configuration will trip when Enable closes.

- Reading a Frequency Input and an Encoder:

Digital input MDI6 (FINA) is used as a frequency input and Encoder B is used (because reading frequency input FINB with MDI8 is not possible due to the installation of optional board ES836).

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 inverter did not detect optional board ES836 (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 the speed alarm;
- define a time constant applied to reading filtering;
- define whether encoders are read by means of squaring channels or by channel A only, letting channel B define the direction of rotation (ChB low level→negative rotation; ChB high level→positive rotation).

20.1.3 USING TWO ENCODERS

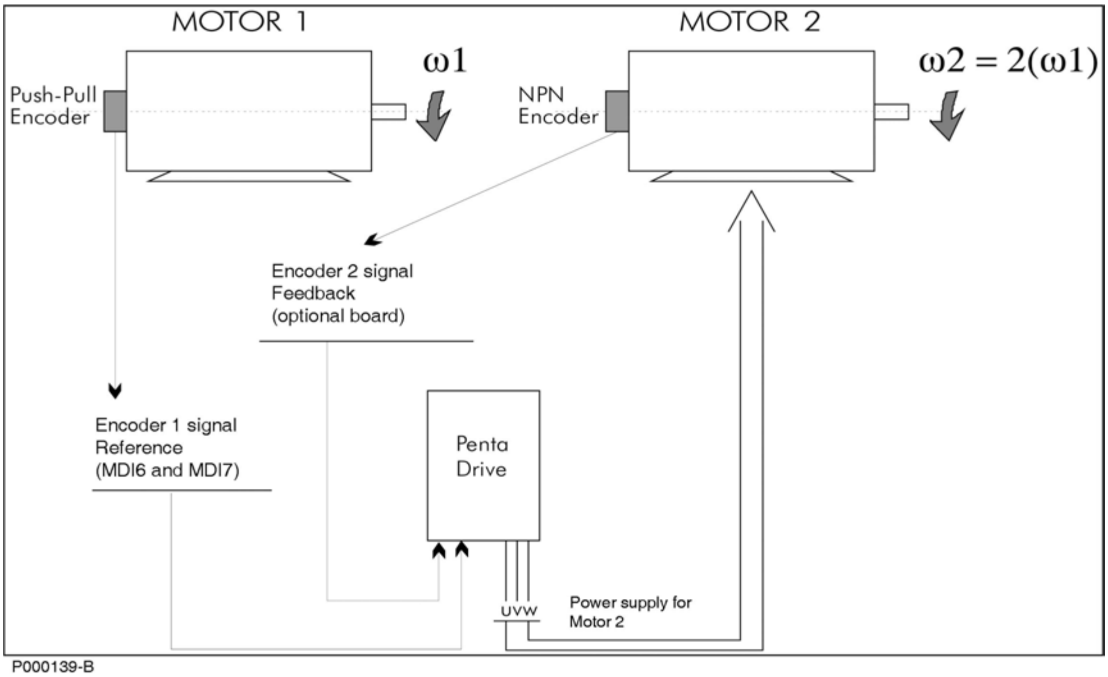


Figure 35: Using Two Encoders (Example)

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 Penta Drive, and use the speed measure of encoder B, coaxial to the motor controlled by the inverter, 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 equipment, must be connected to optional board ES836 (inverter Encoder B), whereas the encoder of motor 1 (Push–Pull), used as a reference, shall be connected to terminals MDI6 and MDI7 (inverter Encoder A).
Encoder configuration is as follows:

ENCODER/FREQUENCY INPUTS MENU:

(operating modes and encoder features 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)

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 inverter is 1500 rpm (C029), the speed reference is 1500 rpm.

20.2 Parameter List

Table 67: List of Parameters C189 ÷ C197

Parameter	FUNCTION	Access Level	MODBUS Address
C189	Encoder/Frequency input operating mode	BASIC	1189
C190	Number of pls/rev for encoder A	BASIC	1190
C191	Number of pls/rev for encoder B	ADVANCED	1191
C192	Speed searching error timeout	ENGINEERING	1192
C193	Error between reference and speed	ENGINEERING	1193
C194	Tracking error alarm enabling	ENGINEERING	1194
C195	Filter time constant over value of feedback from encoder	ENGINEERING	1195
C196	Filter time constant over value of reference from encoder	ENGINEERING	1196
C197	Number of channels of Encoder A	ENGINEERING	1197
C198	Number of channels of Encoder B	ENGINEERING	1198

20.2.1 C189 Encoder/Frequency Input Operating Mode

C189	Range	0 ÷ 14	Coded , see Table 68
Encoder/Frequency input operating mode	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 optional board for encoder B is not required. Digital input MDI6 may be used as a frequency input; if used along with MDI7, it can be used for encoder A reading. Reading of 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 Control Method 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 68. If the encoder is used as a reference source, the detected speed value will be saturated and scaled based on values 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|]. <u>If a frequency input is selected, its reading is saturated and scaled based on parameters P071 and P072 respectively (minimum and maximum value for the frequency input).</u>	

Table 68: Coding of C189

Value	Using Encoder A/FINA	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.

20.2.2 C190 Number of Pls/Rev for Encoder A

C190	Range	256 ÷ 10000	256 ÷ 10000 pls/rev
Number of pls/rev for encoder A	Default	1024	1024
	Level	BASIC	
	Address	1190	
	Function	Defines the number of pls/rev for encoder A (encoder in the terminal board).	

20.2.3 C191 Number of Pls/Rev for Encoder B

C191	Range	256 ÷ 10000	256 ÷ 10000 pls/rev
Number of pls/rev for encoder B	Default	1024	1024
	Level	BASIC	
	Address	1191	
	Function	Defines the number of pls/rev for encoder B (encoder that can be connected to the optional board).	

20.2.4 C192 Timeout for Speed Alarm

C192	Range	0 ÷ 65000	0,00 ÷ 650,00 sec
Timeout for speed alarm	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 for a speed searching error to digital outputs set with BRAKE or LIFT mode. Digital outputs are then disabled.	

20.2.5 C193 Speed Error Threshold

C193	Range	0 ÷ 32000	0 ÷ 32000 rpm
Speed error threshold	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 for a speed searching error to digital outputs set with BRAKE or LIFT mode. Digital outputs are then disabled.	

20.2.6 C194 Speed Error Enabling

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

20.2.7 C195 Filter Time Constant over Value of Feedback from Encoder

C195	Range	5 ÷ 5000	5 ÷ 5000 ms
Filter time constant over value of feedback from encoder	Default	5	5 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.	

20.2.8 C196 Filter Time Constant over Value of Reference from Encoder

C196	Range	5 ÷ 5000	5 ÷ 5000 ms
Filter time constant over value of reference from encoder	Default	5	5 ms
	Level	ENGINEERING	
	Address	1196	
	Function	This parameter defines the time constant used for filtering the reading of the encoder used as a reference.	

20.2.9 C197 Number of Channels of Encoder A

C197	Range	0 ÷ 1	0: 2 Squaring Channels 1: Channel only
Number of channels of encoder A	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).	

20.2.10 C198 NUMBER OF CHANNELS OF ENCODER B

C198	Range	0 ÷ 1	0: 2 Squaring channels 1: Channel only
Number of channels of encoder B	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).	

21 BRAKING RESISTANCE MENU

21.1 Overview

The Braking Resistance Menu enables the clamp transistor command and sets its max. duty cycle in the inverter braking resistance. If no braking resistance is installed, you can adjust promptness of the DC bus voltage control in order to avoid OVERVOLTAGE alarm, causing abrupt deceleration.

When the clamp transistor command is enabled, braking resistance is obtained by setting C210 [ENABLE] (where Enable = –0.01). In this operating mode, when DC bus voltage exceeds a preset threshold value depending on the inverter voltage class, the clamp transistor closes in the braking resistor, so energy in excess is dissipated over the resistor and DC bus voltage does not exceed voltage ratings.
The max. duty cycle of the braking resistor is parameterized with C211 and C212: maximum duty cycle (100 * Ton / (Ton+Toff) [%]) and maximum time of continuous supply (Ton). 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 – C211) * C212 / C211 [sec].
Factory-setting assumes that no braking resistor is provided. In that case, C210 sets the 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, deceleration slows down when given values of the voltage bar are reached (depending on the inverter 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 the deceleration ramp time.

21.2 Parameter List

Table 69: List of Parameters C210 ÷ C212

Parameter	FUNCTION	Access Level	MODBUS Address
C210	Clamp enabling or Vbus control speeding up	ENGINEERING	1210
C211	Duty Cycle	ENGINEERING	1211
C212	Max. time of continuous supply	ENGINEERING	1212

21.2.1 C210 Clamp Enabling or Vbus Control Speeding Up

C210		
	R	Enable (–0.01); 320.00%
	D	0.10%
	Level	ENGINEERING
	Address	1210
	F	Enabling the clamp transistor if C210 = –0.01 or C210 > 0.00 for a quicker deceleration lock due to bar voltage derivative.

21.2.2 C211 Duty Cycle

C211		
	R	0; 100 %
	D	10%
	Level	ENGINEERING
	Address	1211
	F	C211 = (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 continuously operates for the max. time set in C212.

21.2.3 C212 Maximum Time of Continuous Supply

C212		
	R	0 ; 320.00 sec
	D	2.00 sec
	Level	ENGINEERING
	Address	1212
	F	This parameter determines the max. continuous operating time required for the braking resistance.

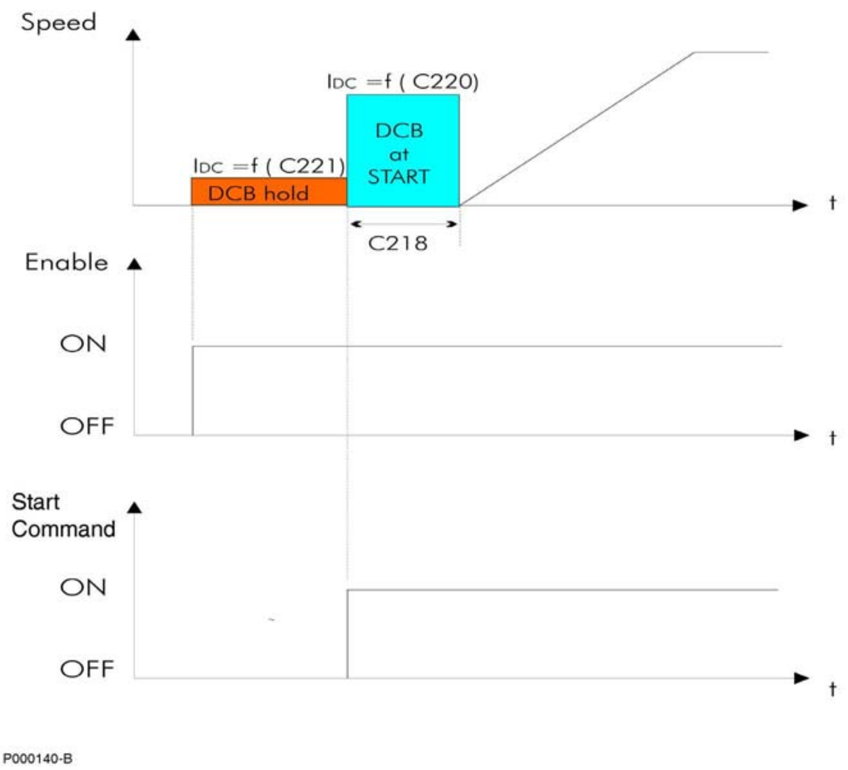
22 DC BRAKING MENU

22.1 Overview

Using the Frequency or Direct Torque control algorithm, DC current is injected to 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 submenu in the Configuration menu. DC current level is expressed as a value percent of the rated current of the active motor.

22.1.1 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 parameters:
C220 Expressed as a percentage of the rated current of the controlled motor.
C218 Expressed in seconds.



The non-condensing function consists in injecting DC to the motor. DC current brakes the motor and heats the motor windings, thus avoiding condensation. This function is active only for the Frequency 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 to 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 DC level;
C221 setting resistance DC level (this function is active for the Frequency control only).

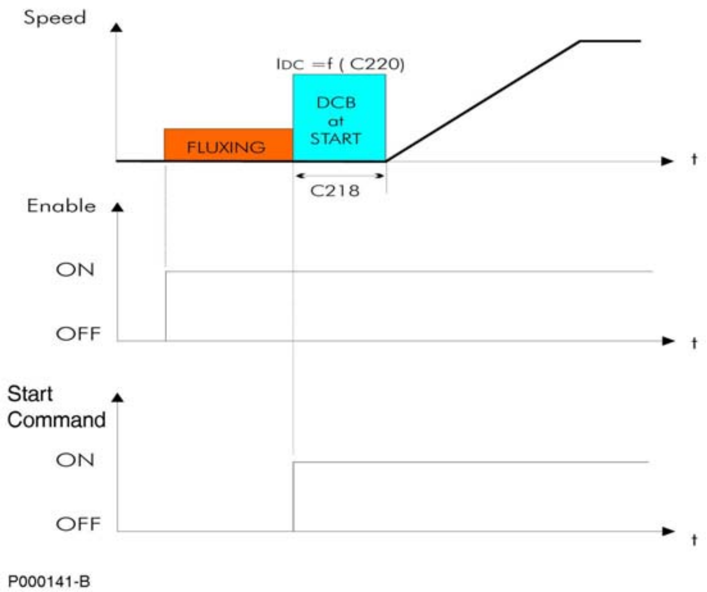


Fig. 33: Output Speed and DC Braking when the DCB At Start Function is Active for the Direct Torque control.

22.1.2 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 inverter 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 DC braking level.

In Power Down mode, if C234 (Power Down Stop Mode) is set as DCB:

C235 motor speed at the beginning of DC Braking;

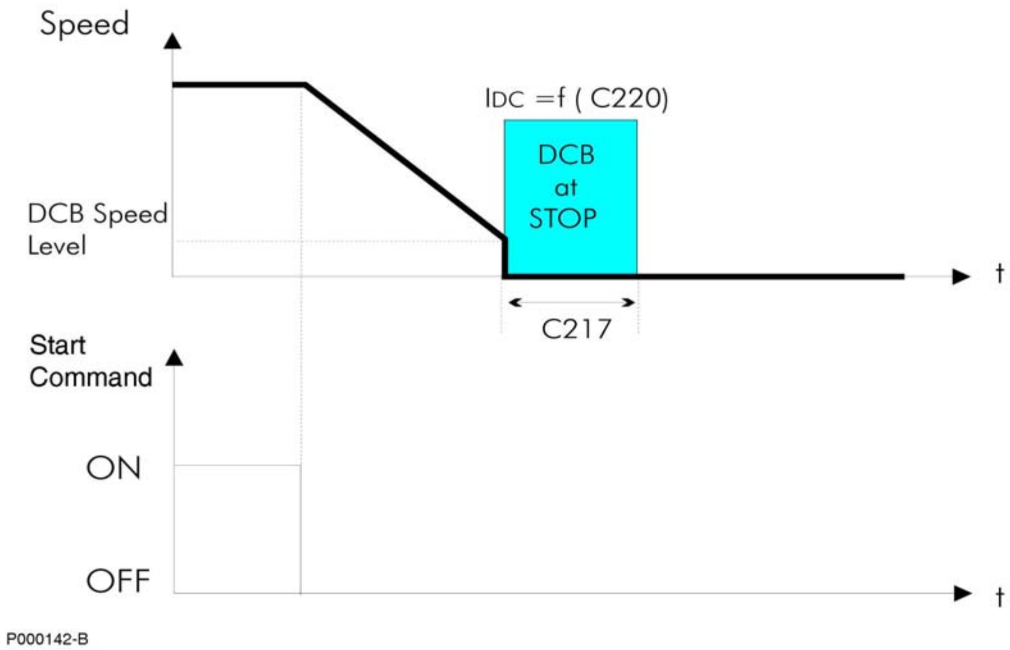


Fig. 34: Motor Speed and DC Braking Trends when the DC BRAKING AT STOP Function is Active.

22.1.3 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:

$$t^* = C217 * (n_{OUT} / C219) \quad \text{with } n_{OUT} / C219 \text{ equal to max. } 10.$$

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 Fig. 39.)

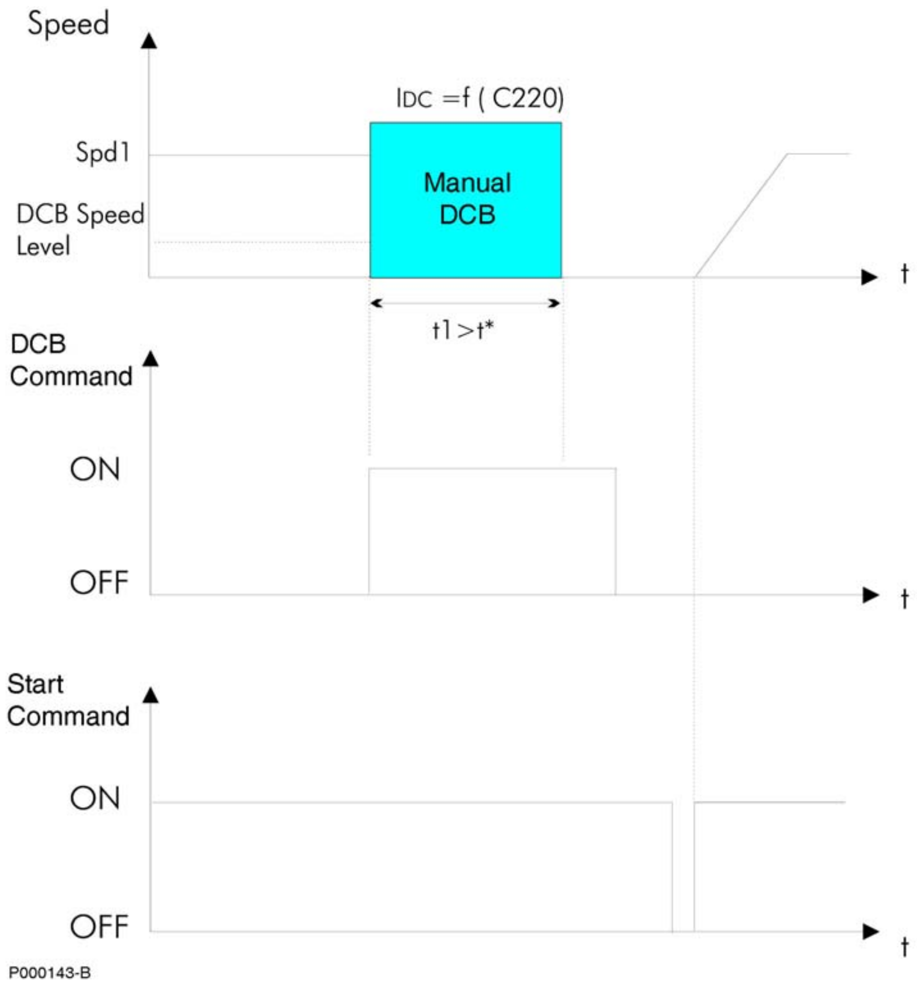


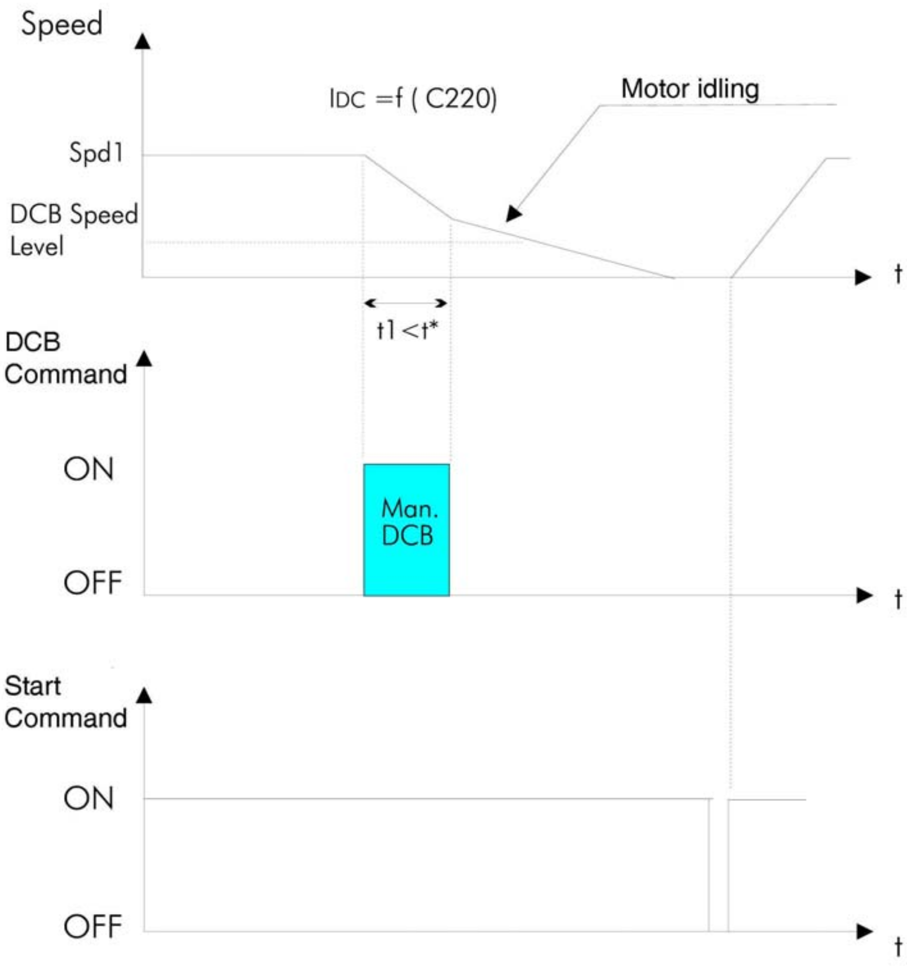
Fig. 35: Motor Speed, DC Braking, and Manual DCB Command and START Command if t1>t*

b) t1 < t* time t1 for braking command is shorter than t*.

Two different cases may occur, depending on the control algorithm and the setup of the motor speed searching function.

<u>Direct Torque</u> or <u>Frequency</u> Control when the <u>Speed Searching function is disabled</u> (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, just disable and enable the START command (see fig. 40).



P000144-B

Fig. 36– Motor Speed, DC Braking and Manual DCB Command and START Command if t1<t* and the Control Algorithm is Direct Torque or Frequency when the Speed Searching Function is Disabled.

Frequency 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 fig. 41)

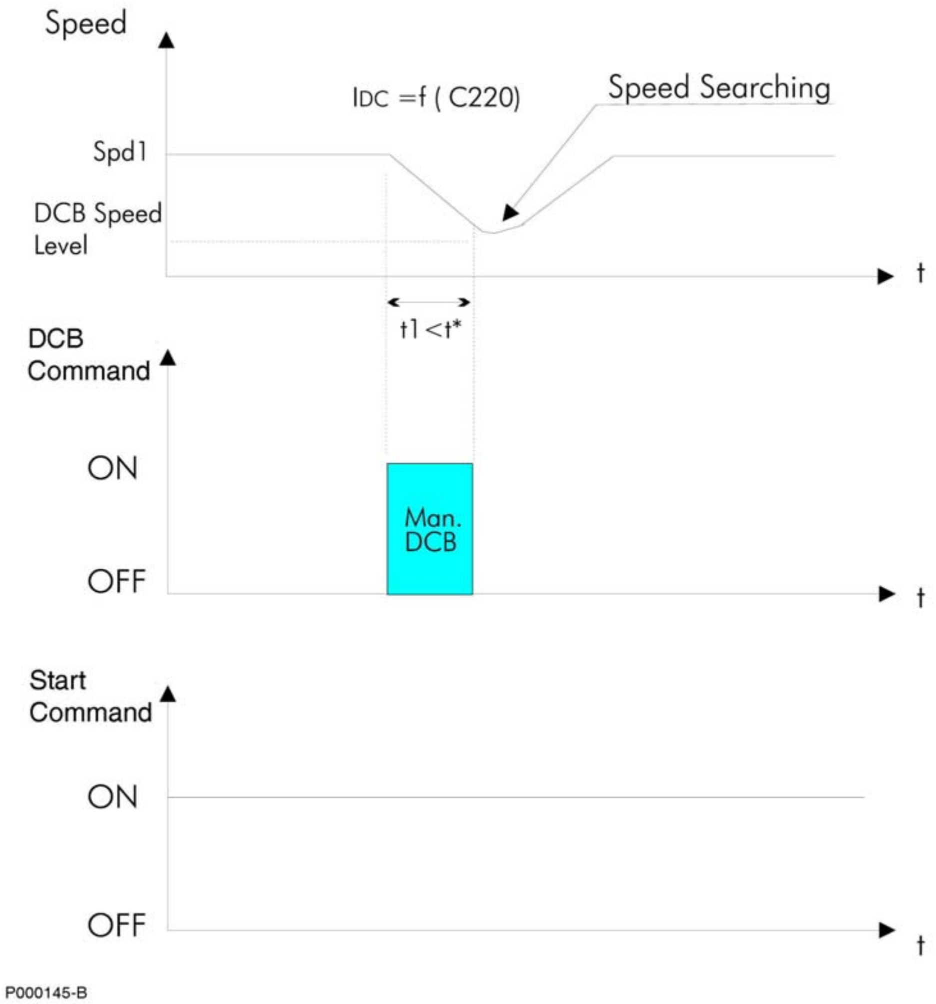


Fig. 37– Motor Speed, DC Braking and Manual DCB Command and START Command if t1<t*, the control algorithm is Frequency and the Speed Searching Function is Enabled.

22.2 Parameter List

For Direct Torque (except for C221) or Frequency control algorithms.

Table 70: List of Parameters C215 ÷ C221

Parameter	FUNCTION	Access Level	MODBUS Address
C215	Enabling DCB at Stop function	ADVANCED	1215
C216	Enabling DCB at Start function	ADVANCED	1216
C217	DCB at Stop duration	ADVANCED	1217
C218	DCB at Start duration	ADVANCED	1218
C219	Speed at the beginning of DCB at Stop	ADVANCED	1219
C220	DCB current level	ADVANCED	1220
C221	DC current in resistance	ADVANCED	1221

22.2.1 C215 Enabling DCB at Stop Function

C215			
	R	No ; Yes	
	D	No	
	Level	ADVANCED	
	MdbId	1215	
	F	Enables the DC Braking at Stop function when the speed set in C219 is reached (or the speed set in C235 if in Power Down mode and C234 [DCB]):	

22.2.2 C216 Enabling DCB at Start Function

C216			
	R	No ; Yes	
	D	No	
	Level	ADVANCED	
	MdbId	1216	
	F	Enables the DC Braking at Start function.	

22.2.3 C217 DCB at Stop Duration

C217			
	R	0.1 ; 60.0 sec.	
	D	0,5	
	Level	ADVANCED	
	MdbId	1217	
	F	Determines the duration of the DCB at Stop function.	

22.2.4 C218 DCB AT START DURATION

C218	R	0.1 ; 60.0 sec.	
	D	0,5	
	Level	ADVANCED	
	MdbId	1218	
	F	Determines the duration of the DCB at Start function.	

22.2.5 C219 SPEED AT THE BEGINNING OF DCB AT STOP

C219	R	0 ; 1000 rpm.	
	D	50rpm	
	Level	ADVANCED	
	MdbId	1219	
	F	Determines the speed at the beginning of DCB at stop while decelerating.	

22.2.6 C220 DCB CURRENT LEVEL

C220	R	0 ; MIN [120% ; (inverter Imax /motor Inom)*100)%]	
	D	100%	
	Level	ADVANCED	
	MdbId	1220	
	F	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.	

22.2.7 C221 DC CURRENT IN RESISTANCE

C221	R	0 ; 100%	
	D	0%	
	Level	ADVANCED	
	MdbId	1221	
	F	Determines the level of direct current injected for the DC Current in Resistance function (to obtain non-condensing effects). This function is active for the Frequency control only. 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.	

23 POWER DOWN MENU

23.1 Overview

In case of power down, the inverter 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 inverter, thus avoiding loosing the inverter 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). In that case only, you can enable alarm A064 (mains loss) by setting C233 to [Yes].

– [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.

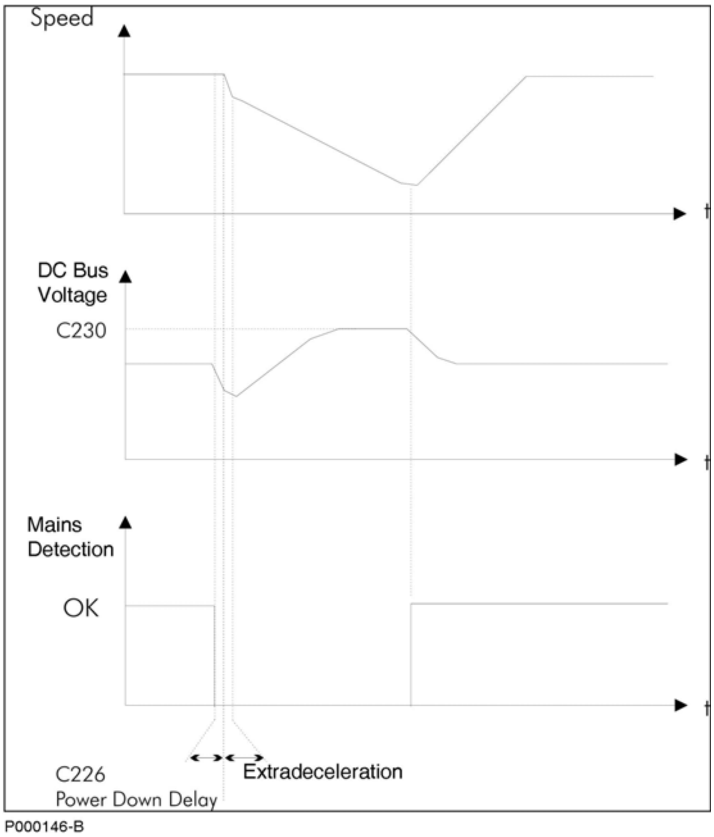


Figure 38: Example of a Power Down

Figure 1 illustrates the trends of the motor speed and the DC bus voltage in case of mains loss. In that case, power supply is restored before the inverter 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]:Regardless of the value set in C235, the inverter will control the motor until it stops down; 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 inverter is put in stand–by; if power supply is restored when the inverter is in stand-by, the RUN command must be disabled and enabled again to accelerate the motor.

23.2 Parameter List

Table 71: List of Parameters C225 ÷ C235

Parameter	FUNCTION	Access Level	MODBUS Address
C225	Type of Power Down	ENGINEERING	1225
C226	Power Down enabling delay	ENGINEERING	1226
C227	Deceleration ramp in Power Down	ENGINEERING	1227
C228	Start increment of ramp gradient in P.D.	ENGINEERING	1228
C229	Mains loss detection advance coefficient	ENGINEERING	1229
C230	Voltage level of DC bus in Power Down	ENGINEERING	1230
C231	Proportional coefficient of deceleration in Power Down	ENGINEERING	1231
C232	Integral time of deceleration in Power Down	ENGINEERING	1232
C233	Mains loss alarm trip	ENGINEERING	1233
C234	Operating mode at the end of Power Down	ENGINEERING	1234
C235	Motor speed at the end of Power Down	ENGINEERING	1235

23.2.1 C225 Type of Power Down

C225	Range	0 ÷ 2	0: Disabled 1: Yes 2: YesV
Type of Power Down	Default	0	0: Disabled
	Level	ENGINEERING	
	Address	1225	
	Function	Type of power down: 0: Disabled The Power Down function is disabled. In this condition only, if C233 [Yes], the mains loss alarm trips. 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.	

23.2.2 C226 Power Down Enabling Delay

C226	Range	1 ÷ 250	1 ÷ 250 ms
Power down enabling delay	Default	1	1 ms
	Level	ENGINEERING	
	Address	1226	
	Function	This parameter determines the Power Down delay after a mains loss is detected by the inverter. When Power Down is disabled (C225 =Disable) and the mains loss alarm is enabled (C233=Yes), the Power Down enabling delay is applied to the alarm trip. If the Power Down delay is too long, the inverter can turn off in case of mains loss.	

23.2.3 C227 Deceleration Ramp in Power Down

C227	Range	1 ÷ 32000	1 ÷ 32000 sec
Deceleration ramp in power down	Default	20	20 sec
	Level	ENGINEERING	
	Address	1227	
	Function	Determines the gradient of the deceleration ramp occurring at Power Down (after the first extradeceleration stage) if C225 = Yes. Control algorithm IFD: C227 is the basic gradient for deceleration adjustment when C225= Yes V.	

23.2.4 C228 Start Increment of Ramp Gradient in Power Down

C228	Range	1 ÷ 1000	1 ÷ 1000 %
Start increment of ramp gradient in P.D.	Default	100	100%
	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.	

23.2.5 Mains Loss Detection Advance Coefficient

C229	Range	1 ÷ 250	1 ÷ 250
Mains loss detection advance coefficient	Default	1	1
	Level	ENGINEERING	
	Address	1229	
	Function	Based on voltage trend on the DC bus, this function allows to detect 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.	

23.2.6 C230 Voltage Level of DC Bus in Power Down

C230	Range	250 ÷ 450 *for Class 200T* 600 ÷ 750 *for Class 400T*	250 ÷ 450 V *for Class 200T* 600 ÷ 750 V *for Class 400T*
Voltage level of DC bus in Power Down	Default	375 *for Class 200T* 650 *for Class 400T*	375 V *for Class 200T* 650 V *for Class 400T*
	Level	ENGINEERING	
	Address	1230	
	Function	Determines the reference value for DC bus voltage in case of automatic deceleration in Power Down; C225 = Yes V.	

23.2.7 C231 Proportional Coefficient of Deceleration in Power Down

C231	Range	0 ÷ 32000	0,000 ÷ 32,000
Proportional coefficient of deceleration in Power Down	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.	

23.2.8 C232 Integral Time of Deceleration in Power Down

C232	Range	1 ÷ 32000	0,001 ÷ 31,999 sec 32000 = Disabled
Integral time of deceleration in Power Down	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.	

23.2.9 C233 Mains Loss Alarm Trip

C233	Range	0 ÷ 1	0: No 1: Yes
Mains Loss Alarm Trip	Default	0	0: No
	Level	ENGINEERING	
	Address	1233	
	Function	This parameter enables mains loss alarm trip. The alarm trip is enabled only when C225 is set as [Disable]; otherwise, the selected Power Down function is performed in case of mains loss.	

23.2.10 C234 Operating Mode at the End of Power Down

C234	Range	0 ÷ 2	0: Stop 1: Stand–by 2: Dcb
Operating mode at the end of Power Down	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] regardless of the speed value set in C235, if the inverter is capable of bearing DC bus voltage, it will control the motor until it stops. 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 imposed to the motor with the preset acceleration ramp. [Stand–by] When decelerating, once the speed value set in C235 is attained, the inverter is put in stand–by and the motor keeps decelerating (motor idling). If power supply is restored, the same conditions as described in the step above occur (see [Stop]); instead of stopping the motor, the inverter is put in 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 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 inverter performs DC braking.	

23.2.11 C235 Motor speed at the end of Power Down

C235	Range	0 ÷ 5000	0 ÷ 5000 rpm
Motor speed at the end of Power Down	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 inverter is put in 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.	

24 SPEED SEARCHING MENU

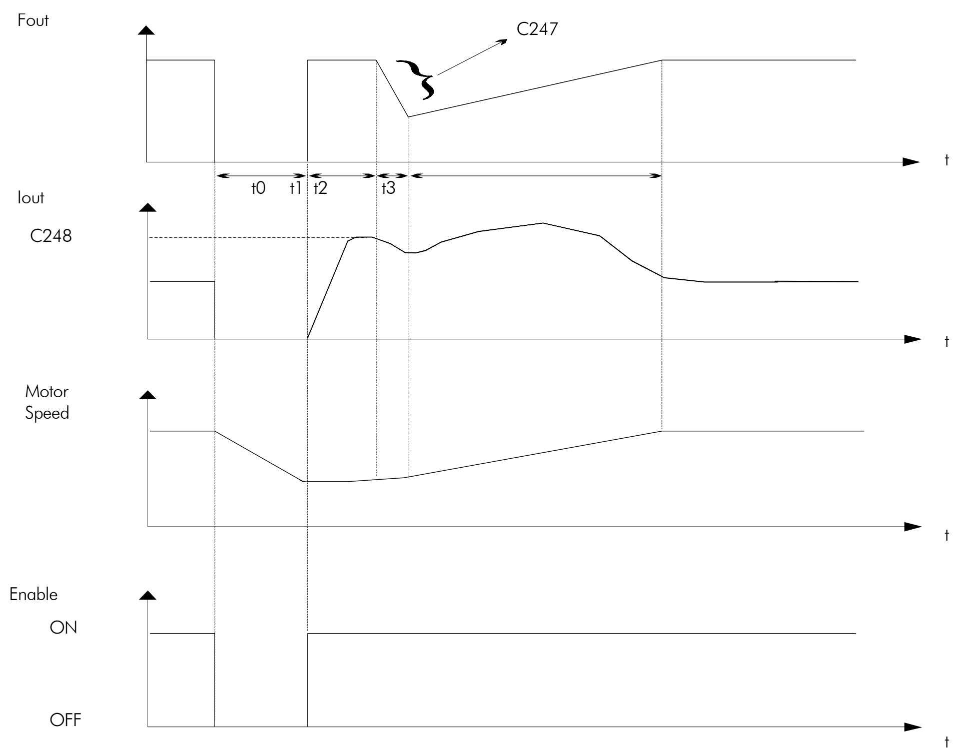
24.1 Overview

When a command is sent to disable the inverter, the motor starts idling. When the inverter activates again, the Speed Searching function allows the inverter 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. The Speed Searching parameters are used for IFD control.
The Speed Searching function is active when parameter C245 is set to [YES] (factory-setting).
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) (see Fig. 43);
– disable the DC Braking command before the DC braking preset time is over (see 'DC Braking Menu');
– reset any alarm tripped (with reference other than 0) before t_{SSdis} is over (see Fig.44).

Speed searching does not take place when the inverter turns off due to a mains loss.
If the inverter 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 is set to zero, speed searching (if enabled with C245) occurs when the inverter restarts (RUN).
The figures below show output frequency and motor rpm during speed searching.

Fig. 43 – 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.

After time t_0 for rotor demagnetization, speed searching occurs as follows (3 steps):



Time t_1	The inverter output frequency corresponds to the last value which was active before disabling the inverter; output current matches with the value set in C248;
Time t_2	Output frequency is decremented following the ramp set in C247 for speed searching;
Time t_3	The connected motor accelerates following the acceleration ramp.

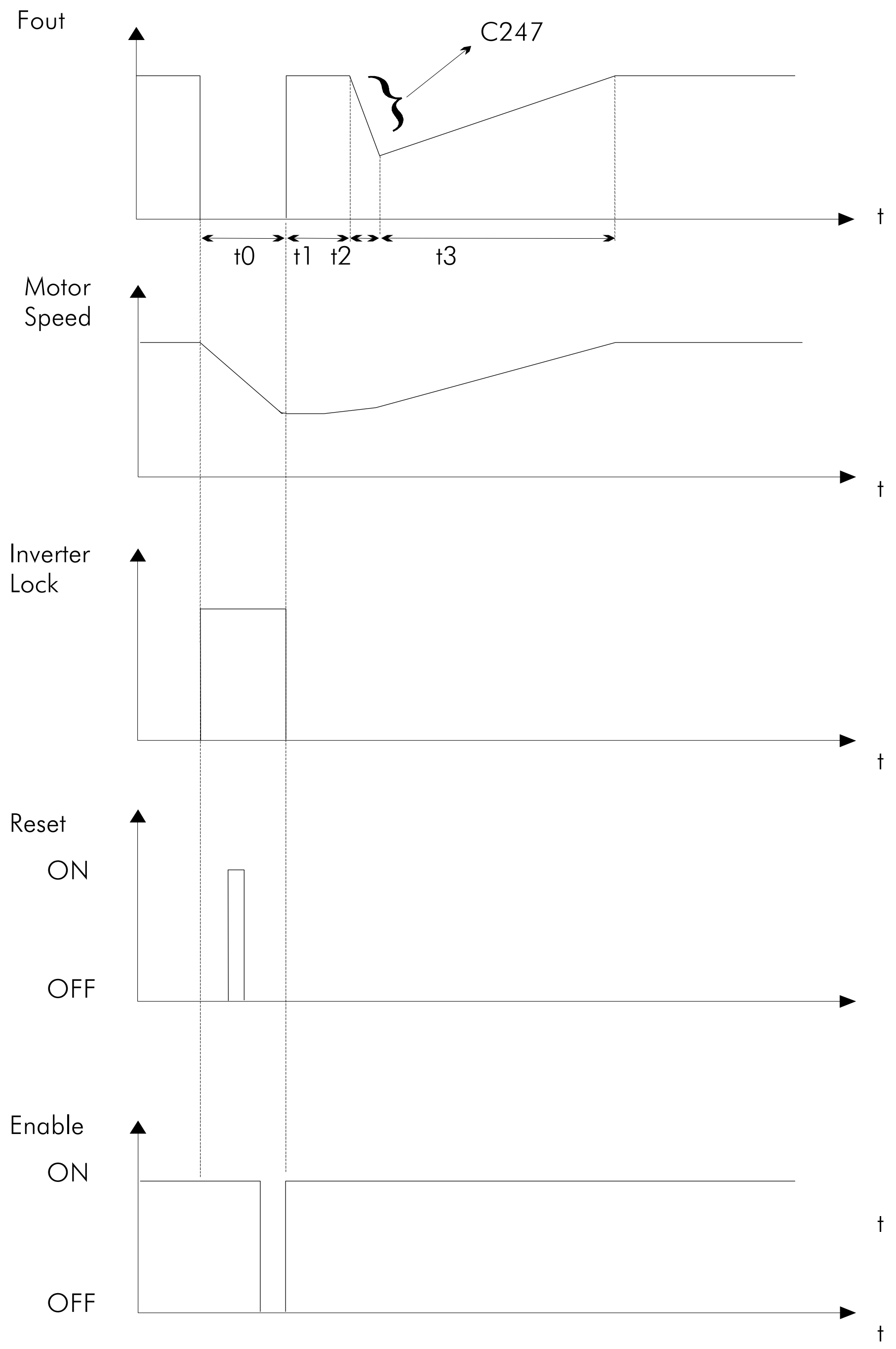


Fig. 44: Frequency, Motor Rpm, Inverter Lock, Reset and Enable during Speed Searching (C245 =[YES]) due to an Alarm Trip $t_{OFF} < t_{SSdis}$ (C246) or C246 = 0.

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.

24.2 Parameter List

Table 72: List of Parameters C245 ÷ C248

Parameter	FUNCTION	Access Level	MODBUS Address
C245	Speed Searching enabling	ENGINEERING	1245
C246	Speed Searching disabling time	ENGINEERING	1246
C247	Speed searching deceleration	ENGINEERING	1247
C248	Speed searching current level	ENGINEERING	1248

24.2.1 C245 Speed Searching Enabling

C245			
	R	No ; Yes	
	D	Yes	
	Level	ENGINEERING	
	Address	1245	
	F	Enables speed searching for IFD control. The Speed Searching function is enabled in the following cases: – when the ENABLE contact is open and closed before time t_{SSdis} (C246) (see Fig. 43); – when the DC Braking command is disabled before the preset time is over (see section DCBXXX); – when an alarm is reset (with a reference other than 0) before time t_{SSdis} (see Fig. 44).	

24.2.2 C246 Speed Searching Disabling Time

C246			
	R	0; 3000 sec.	
	D	1	
	Level	ENGINEERING	
	Address	1246	
	F	Determines the maximum allowable time passing between the inverter disabling and enabling when the Speed Searching function is activated. When the inverter is restarted, output frequency will depend on the preset acceleration ramp. When C246 = 0, speed searching will always occur, independently of the time passing between the inverter disabling and enabling.	

24.2.3 C247 Speed Searching Deceleration

C247	R	1 ; 1000%	
	D	300%	
	Level	ENGINEERING	
	Address	1247	
	F	Determines the deceleration ramp gradient during speed searching.	

24.2.4 C248 Speed Searching Current Level

C248	R	40 ; MIN [105% ; ((inverter Imax /motor Inom.)*100)%]	
	D	100	
	Level	ENGINEERING	
	Address	1248	
	F	Determines the max. current level for speed searching; it is expressed as a percentage of the motor rated current.	

25 AUTORESET MENU

25.1 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 at the inverter power 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 is 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 inverter is turned off when an alarm is active, the alarm trip 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 inverter is turned on (C257 [Yes]). Undervoltage alarm A47 (DC bus voltage below allowable threshold with motor running) or Mains Loss alarm A64 (mains loss when the motor is running and the Power Down function is disabled) are not stored in the fault list when the inverter is powered off (factory-setting). To enable parameter storage, set C258 to [Yes].

25.2 PARAMETER LIST

Table 73 : List of Parameters C255 ÷ C258

Parameter	FUNCTION	Access Level	MODBUS Address
C255	Autoreset attempt number	BASIC	1255
C256	Attempt counting reset time	BASIC	1256
C257	Alarm reset at Power On	BASIC	1257
C258	Enabling saving Undervoltage and Mains Loss alarms	BASIC	1258

25.2.1 C255 Autoreset Attempt Number

C245			
	R	Disable ; 100	
	D	Disable	
	L	BASIC	
	Address	1255	
	F	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 C246. If a time equal to the time set in C246 passes starting from the last alarm tripped, the autoreset attempt count is reset.	

25.2.2 C256 Attempt Counting Reset Time

C256			
	R	0; 1000 sec.	
	D	300 sec	
	L	BASIC	
	Address	1256	
	F	Determines the time that passes from the last alarm tripped to reset the autoreset attempt number.	

25.2.3 C257 Alarm Reset at Power On

C257			
	R	No ;Yes	
	D	No	
	L	BASIC	
	Address	1257	
	F	At power on, this parameter enables the automatic reset of the alarms tripped at the inverter power off.	

25.2.4 C258 Enabling Saving Undervoltage and Mains Loss Alarms

C258	R	No ;Yes	
	D	No	
	L	BASIC	
	Address	1258	
	F	This parameter saves Undervoltage and Mains Loss alarms to the fault list.	

26 MOTOR THERMAL PROTECTION MENU

26.1 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 Thermal protection submenu in the Configuration menu.

NOTE

Each connected motor has its own thermal model.
If the inverter 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 5 modes, that can be selected with parameter C265 (motor 1), C268 (motor 2) and C271 (motor 3).

– [NO] The Motor Thermal Protection function is disabled (factory-setting);
– [YES] The Motor Thermal Protection function is active with pick-up current independent of operating speed;
– [YES A] The Motor Thermal Protection function is active with pick-up current depending on operating speed, with fan-cooled motor derating;
– [YES B] The Motor Thermal Protection function is active; pick-up current depends on operating speed and derating is suitable for motors having a fan keyed to the shaft.
– [PTC] Thermoswitch on analog input AIN2 (for PTC features, see Sinus Penta's Installation Manual)

Heating of a motor where constant current I_O flows depends on current and time:

$$\theta(t) = K \cdot I_O^2 \cdot (1 - e^{-t/T})$$

where T is the motor thermal time constant (Motor 1 ←C267 ; Motor 2 ←C270 ; Motor 3 ←C273).
The motor heating is proportional to the square of RMS current flowing through the motor (I_0^2).
Alarm A75 (Motor overheated) relating to thermal protection modes different from PTC trips when current flowing through the motor makes the motor temperature exceed the allowable asymptotic value set with It (pick up current: Motor 1 ←C266 ; Motor 2 ←C269 ; Motor 3 ←C272). Alarm A75 can be reset after a time depending on the motor thermal constant, allowing for the motor cooling.
In thermal protection mode from PTC, alarm PTC (A87) trips when voltage acquired by input AIN2 used as a PTC signal input exceeds a preset threshold value when characteristic temperature is attained. Alarm A87 can be reset only if temperature decreases by 5°C with respect to trip temperature.

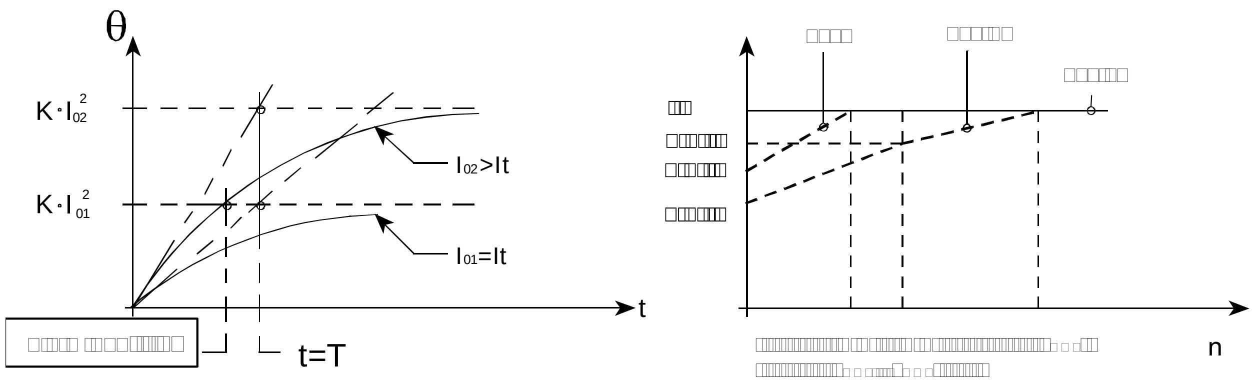


Fig. 3.14: Motor Heating with Two Different Current Values (I_{01} and I_{02}) That Are Kept Constant in Time and Pick-Up Current It of Thermal Protection Depending on Speed Output Based on Parameter C265 for Motor 1 (C268 for Motor 2 and C271 for Motor 3).

If motor thermal time constant τ is not known, you can enter a value equal to 1/3 of the time when motor temperature is supposed to be kept constant.

26.2 Parameter List

Table 74: List of Parameters C264 ÷ C273

Parameter	FUNCTION	Access Level	MODBUS Address
C264	Heatsink temperature for fan activation	ADVANCED	1264
C265	Activation and type of Motor Thermal Protection 1	ADVANCED	1265
C266	Pick up current for motor 1	ADVANCED	1266
C267	Thermal time constant for motor 1	ADVANCED	1267
C268	Activation and type of Motor Thermal Protection 2	ADVANCED	1268
C269	Pick up current for motor 2	ADVANCED	1269
C270	Thermal time constant for motor 2	ADVANCED	1270
C271	Activation and type of Motor Thermal Protection 3	ADVANCED	1272
C272	Pick-up current for motor 3	ADVANCED	1271
C273	Thermal time constant for motor 3	ADVANCED	1273

26.2.1 C264 Heatsink Temperature for Fan Activation

C264			
	R	0°C ÷ 100°C Always ON	
	D	60°C	
	Level	ADVANCED	
	Address	1264	
	F	Sets the heatsink temperature activating the cooling fans. 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 models where fans are controlled directly by the inverter control board.

26.2.2 C265 Activation and Type of Motor Thermal Protection 1

C265	R	No ; Yes , Yes A , Yes B , PTC	
	D	No	
	Level	ADVANCED	
	Address	1265	
	F	This parameter enables the Motor Thermal Protection for Motor 1. It also selects the type of thermal protection among 3 different patterns and PTC mode.	

26.2.3 C266 Pick-up Current for Motor 1

C266	R	1 ÷ min [120%; [((Imax/Imot)*100) %].	
	D	120%	
	Level	ADVANCED	
	Address	1266	
	F	This parameter determines the thermal protection pick-up current expressed as a percentage of the rated current of motor 1.	

26.2.4 C267 Thermal Time Constant for Motor 1

C267	R	1 ÷ 3600 sec.	
	D	600 sec.	
	Level	ADVANCED	
	Address	1267	
	F	This parameter determines the thermal time constant for motor 1.	

26.2.5 C268 Activation and Type of Motor Thermal Protection 2

C268	R	No ; Yes , Yes A , Yes B , PTC	
	D	No	
	Level	ADVANCED	
	Address	1268	
	F	This parameter enables the Motor Thermal Protection for Motor 2. It also selects the type of thermal protection among 3 different patterns and PTC mode.	

26.2.6 C269 Pick-up Current for Motor 2

C269	R	1 ÷ min [120%; ((Imax/Imot)*100) %].	
	D	120%	
	Level	ADVANCED	
	Address	1269	
	F	This parameter determines the thermal protection pick-up current expressed as a percentage of the rated current of motor 2.	

26.2.7 C270 Thermal Time Constant for Motor 2

C270	R	1 ÷ 3600 sec.	
	D	600 sec	
	Level	ADVANCED	
	Address	1270	
	F	Determines the thermal time constant for motor 2.	

26.2.8 C271 Activation and Type of Motor Thermal Protection 3

C271	R	No ; Yes , Yes A , Yes B , PTC	
	D	No	
	Level	ADVANCED	
	Address	1271	
	F	This parameter enables the Motor Thermal Protection for Motor 2. It also selects the type of thermal protection among 3 different patterns and PTC mode.	

26.2.9 C272 Pick-up Current for Motor 3

C272	R	1 ÷ min [120%; ((Imax/Imot)*100) %].	
	D	120%	
	Level	ADVANCED	
	Address	1272	
	F	This parameter determines the thermal protection pick-up current expressed as a percentage of the rated current of motor 3.	

26.2.10 C273 Thermal Time Constant for Motor 3

C273	R	1 ÷ 3600 sec.	
	D	600 sec	
	Level	ADVANCED	
	Address	1273	
	F	This parameter determines the thermal time constant for motor 3.	

27 PID CONFIGURATION MENU

27.1 Overview

The Sinus Penta is provided with a PID (Proportional, Integral, Derivative) regulator permitting to perform 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 PID regulator.
Configuration parameters for the PID regulator can be modified only when the inverter is in stand-by. They set the following variables: reference sources, feedback sources and type of PID output implementation.
The programming parameters for the PID regulator, including coefficients of proportional, integral and derivative terms, output saturation, etc., are covered in the PID Parameters Menu.

27.2 Operation and Structure of the PID Regulator

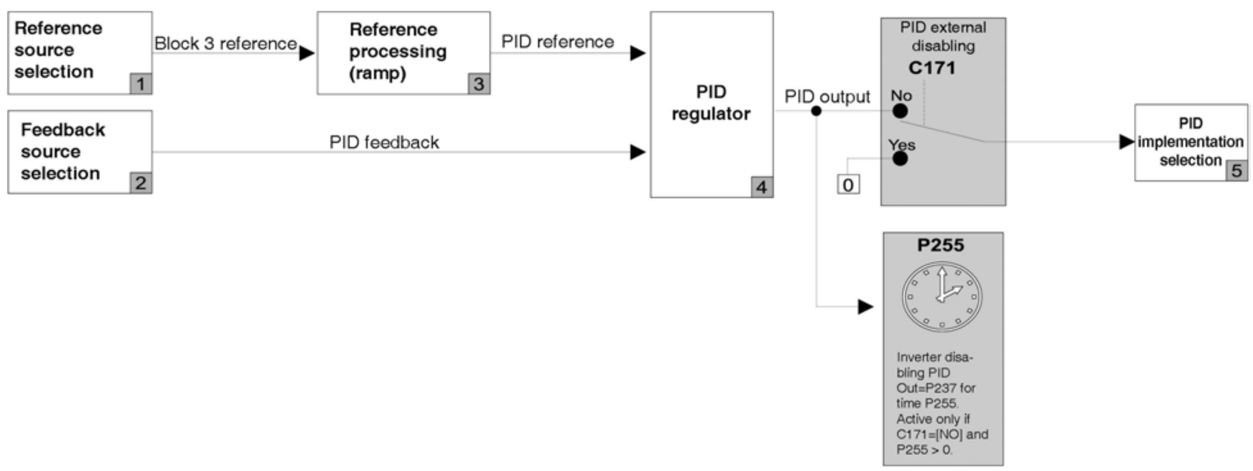


Figure 39: Structure of the PID Regulator

Figure 43 illustrates a block diagram of the PID regulator. Each block will be analyzed in the following sections.
First select the sources for the PID reference (block 1). Three different sources may be configured, which will be summed up. The same is true for the feedback sources (block 2).

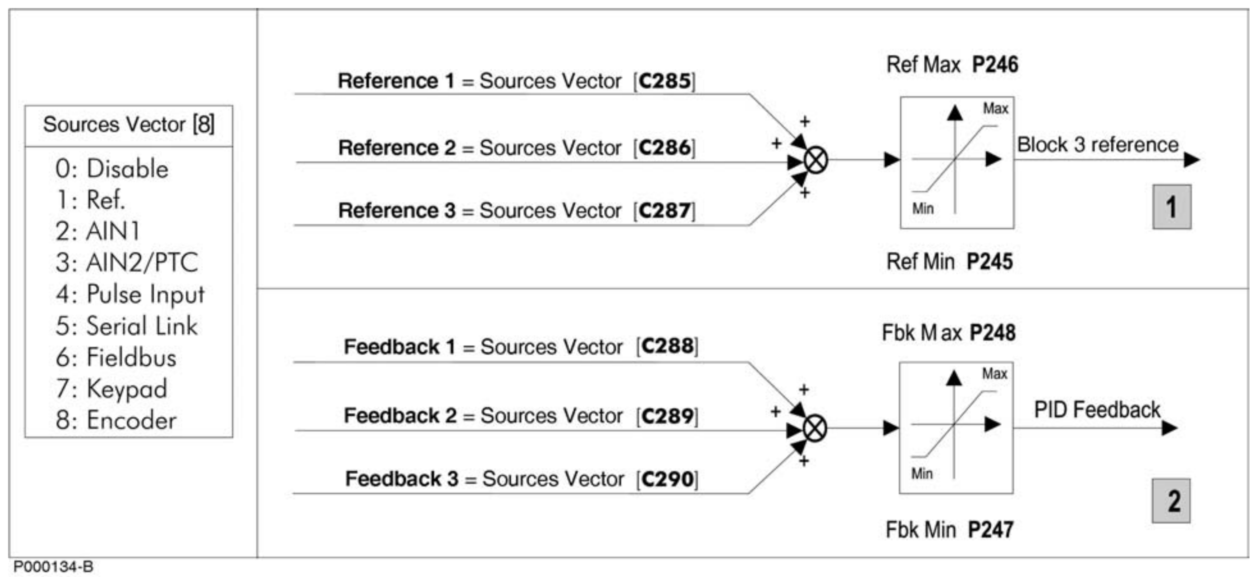


Figure 40: Reference Source and Feedback Source Selection

NOTE Signals selected in the Sources Vector are to be considered as values percent; analog signals are expressed as a percentage of the preset maximum values and minimum values. Example: Ref. is selected as 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 PID feedback, you can select electrical variables Iout (output current), Vout (output voltage) and Vdc (DC bus voltage). Their values percent relate to rated current values and rated voltage values of the selected motor and to 1500VDC.

NOTE In Local mode, the PID regulator is always disabled, unless C294 is programmed as External Out.

Reference Source and Feedback Source Selection

0: Disable	Disabled
1: REF	Analog input REF
2: AIN1	Analog input AIN1
3: AIN2/PTC	Analog input AIN2
4: Pulse Input	Frequency Input
5: Serial Link	Serial Link
6: Fieldbus	Field Bus
7: Keypad	Keypad
8: Encoder	Encoder input selected as feedback
9: Iout	Output current
10: Vout	Output voltage
11: Vdc	DC voltage of DC-link

Note: 9÷11 are available for feedback only.

A ramp (block 3) may be applied to the PID setpoint output of block 1. The processed reference is used by the PID regulator. Parameters of the PID reference ramp are illustrated in Figure 45. The start rounding-off is applied to the reference whenever a new acceleration/deceleration ramp is started; the end reference is applied at the end of each ramp.

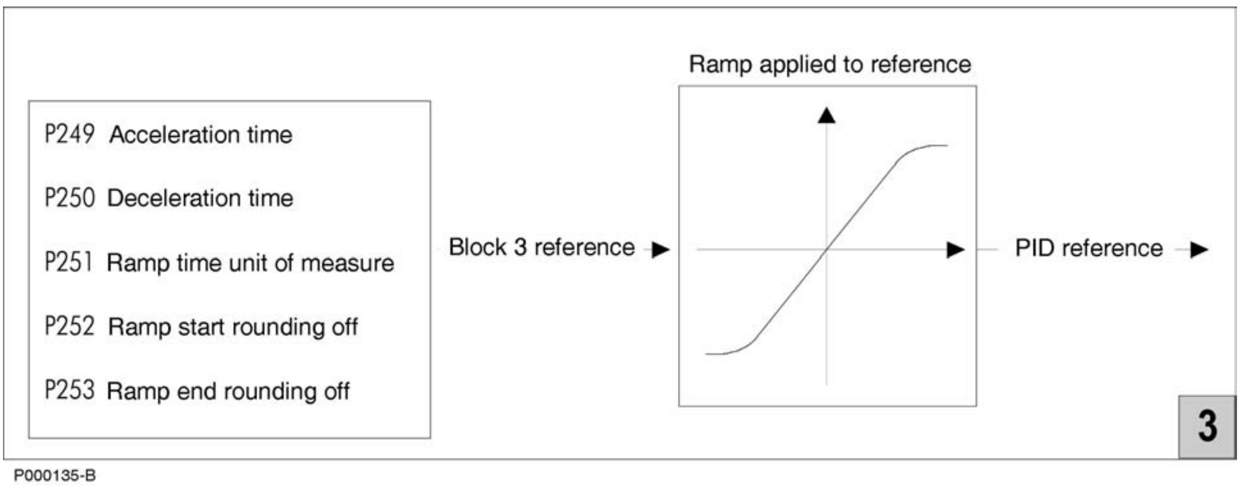


Figure 41: Ramp of the PID Reference

Block 4 is the real PID regulator. The output may be disabled by an external digital command (if properly programmed). If the PID regulator is used as a reference source and P255 is other than zero, the PID output value control is enabled. If the PID output equals the preset minimum value for a time longer than P255, the inverter is automatically put in stand-by. In block 5, the PID output is applied to the function defined by the "Regulator Implementation" parameter (C294).
The PID regulator structure is detailed in Figure 46 below (block 4).

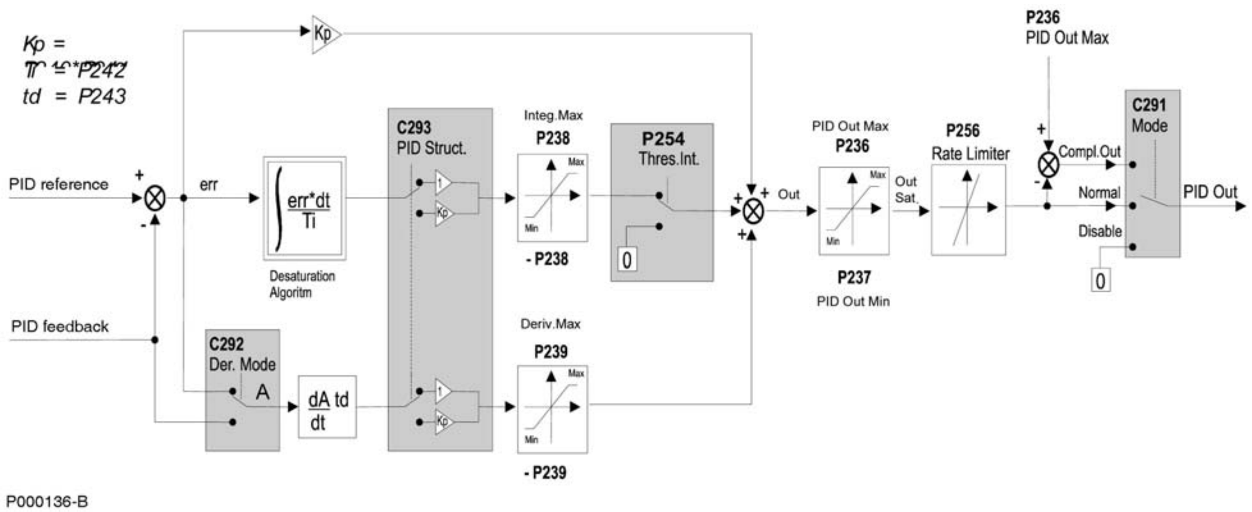


Figure 42: Details of the PID Regulator Structure

The PID regulator output may be used as:

- An external output,
- A speed/torque reference of the inverter,
- A speed/torque reference increase

If IFD control is used, the PID regulator output may be used as

- The correction of the output voltage.

If the PID regulator output is the speed reference of the inverter, the selected speed/torque ramp is applied.

27.3 Parameter List

Table 75: List of Parameters C285 ÷ C294

Parameter	FUNCTION	Access Level	MODBUS Address
C285	PID reference source 1	ENGINEERING	1285
C286	PID reference source 2	ENGINEERING	1286
C287	PID reference source 3	ENGINEERING	1287
C288	PID feedback source 1	ENGINEERING	1288
C289	PID feedback source 2	ENGINEERING	1289
C290	PID feedback source 3	ENGINEERING	1290
C291	PID output computing mode	ENGINEERING	1291
C292	Derivative term computing mode	ENGINEERING	1292
C293	PID regulator structure	ENGINEERING	1293
C294	PID regulator implementation	ENGINEERING	1294

27.3.1 C285 PID Reference Source 1

C285	Range	0 ÷ 8	0: Disable 1: REF 2: AIN1 3: AIN2/PTC 4: Pulse Input 5: Serial Link 6: Fieldbus 7: Keypad 8: Encoder
PID reference source 1	Default	2	2: AIN1
	Level	ENGINEERING	
	Address	1285	
	Function	This parameter selects PID reference source 1 among the eight available reference sources. Sources are expressed as values percent if compared 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).	

27.3.2 C286 PID Reference Source 2

C286	Range	0 ÷ 8	0: Disable 1: REF 2: AIN1 3: AIN2/PTC 4: Pulse Input 5: Serial Link 6: Fieldbus 7: Keypad 8: Encoder
PID reference source 2	Default	0	0: Disable
	Level	ENGINEERING	
	Address	1286	
	Function	This parameter selects PID reference source 2 among the eight available reference sources.	

27.3.3 C287 PID REFERENCE SOURCE 3

C287	Range	0 ÷ 8	0: Disable 1: REF 2: AIN1 3: AIN2/PTC 4: Pulse Input 5: Serial Link 6: Fieldbus 7: Keypad 8: Encoder
PID reference source 3	Default	0	0: Disable
	Level	ENGINEERING	
	Address	1287	
	Function	This parameter selects PID reference source 3 among the eight available reference sources.	

27.3.4 C288 PID FEEDBACK SOURCE 1

C288	Range	0 ÷ 11	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
PID feedback source 1	Default	3	3: AIN2/PTC
	Level	ENGINEERING	
	Address	1288	
	Function	This parameter selects PID feedback source 1. Three feedback sources can be configured among eleven 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 C285 for more details.	

27.3.5 C289 PID Feedback Source 2

C289	Range	0 ÷ 11	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
PID feedback source 2	Default	0	0: Disable
	Level	ENGINEERING	
	Address	1289	
	Function	This parameter selects PID feedback source 2.	

27.3.6 C290 PID Feedback Source 3

C290	Range	0 ÷ 11	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
PID feedback source 3	Default	0	0: Disable
	Level	ENGINEERING	
	Address	1290	
	Function	This parameter selects PID feedback source 3.	

27.3.7 C291 PID Output Computing Mode

C291	Range	0 ÷ 2	0: Disable 1: Normal 2: Compl. Out
PID output computing mode	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: **Compl. Out**. If 0:**Disable** is selected, the PID regulator is inactive and its output is always set to zero. In 1:**Normal** mode, the real PID output is considered. If 2:**Compl.Out** (complemented output) is selected, the output implemented by the PID regulator results by the subtraction between the max. output value set in **P236** and the output obtained by the PID regulator. This operating mode can be used for special applications (see examples at the end of this section).	

27.3.8 C292 Derivative Term Computing mode

C292	Range	0 ÷ 1	0: Measure 1: Error
Derivative term computing mode	Default	0	0: Measure
	Level	ENGINEERING	
	Address	1292	
	Function	This parameter sets the variable used to compute the derivative term. By default, the derivative term is computed based on the feedback measure, but it can also be computed based on the PID error (Error = Reference – Feedback).	

27.3.9 C293 PID Regulator Structure

C293	Range	0 ÷ 1	0: No 1: Yes
PID Regulator Structure	Default	0	0: No
	Level	ENGINEERING	
	Address	1293	
	Function	This parameter sets whether the proportional term is used for the multiplication of the derivative and integral terms as well. 0: No This means that the proportional term DOES NOT multiply the integral term.	

27.3.10 C294 PID REGULATOR IMPLEMENTATION

C294	Range	0 ÷ 3	0: External Out 1: Reference 2: Add Reference 3: Add Voltage Output
PID regulator implementation	Default	0	0: External Out
	Level	ENGINEERING	
	Address	1294	
	Function	This parameter sets the type of implementation for the PID regulator. _C294 = External Out:_ The PID regulator is independent of the inverter 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 outside the equipment, just configure one of the analog outputs as PID Out. _C294 = Reference:_ The PID regulator output is the speed/torque reference of the connected motor; any other reference source which is 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 active motor Mot1 <– Max { | C028 | ; | C029 | } Mot2 <– Max { | C071 | ; | C072 | } Mot3 <– Max { | C114 | ; | C115 | } 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 = Add Reference:_ The PID regulator output is a correction of the speed/torque reference of the active motor. The value percent 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. In that way, the reference sign can never be reversed. _C294 = Add Voltage Output:_ This configuration is active only when the control algorithm of the active motor is "frequency". The PID regulator output is a correction of the output voltage. The value percent of the PID output relates to the voltage instant value. For example, if a motor is controlled in "frequency" mode and at 25 Hz the inverter output voltage is 200V rms with a PID implementation = 0, if the PID implementation drops to –10%, the implemented voltage will be 200 + 200*(–10/100) = 180V.	

27.4 Example: Keeping Fluid Level Constant

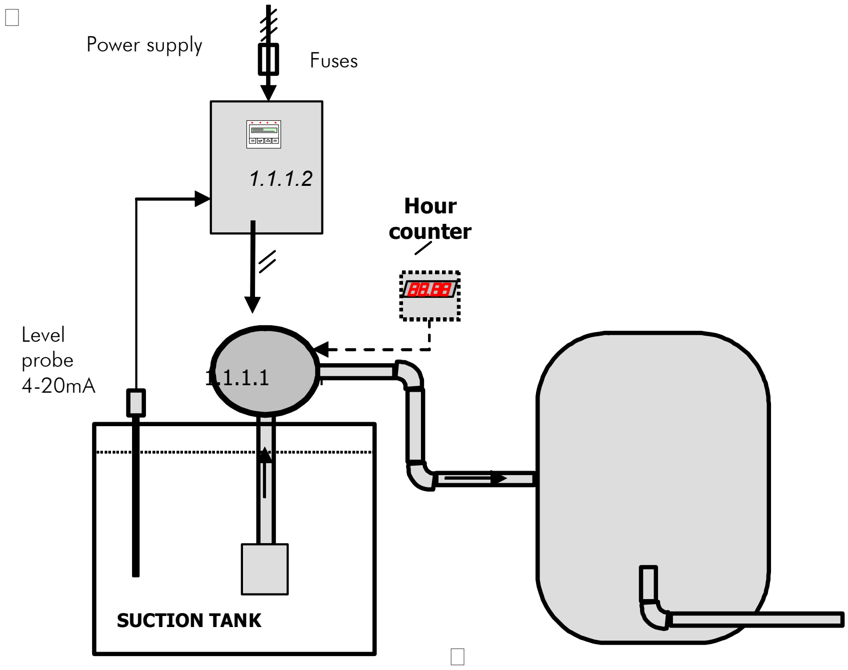


Figure 43: Keeping Fluid Level Constant (Example)

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 with the min. level and 20mA with the max. level. The PID reference is sent from keypad, while the probe feedback is sent to analog input AIN2/PTC, which is configured as follows:

P060-Tipo di riferimento per ingresso AIN2/PTC	2: 4-20mA	
P061-Valore minimo del riferimento per l'ingresso AIN2/PTC	4.0	mA
P062-Valore massimo del riferimento per l'ingresso AIN2/PTC	20.0	mA
P063-Offset dell'ingresso AIN2/PTC	0.000	mA
P064-Costante filtro AIN2/PTC	1	ms

The reference shall be saved from keypad, so it is not to be set up whenever the equipment is shut off.

P068-Memorizzazione riferimento UP/DN e KPD	1: Yes
P069-Escursione riferimento UP/DN e KPD	1: Unipolar

The PID regulator implementation and the PID output computing mode must be set up as well.

C285-Selezione tipo riferimento 1 PID	7: Keypad
C286-Selezione tipo riferimento 2 PID	0: Disable
C287-Selezione tipo riferimento 3 PID	0: Disable
C288-Selezione tipo retroazione 1 PID	3: AIN2/PTC
C289-Selezione tipo retroazione 2 PID	0: Disable
C290-Selezione tipo retroazione 3 PID	0: Disable
C291-Modalità di funzionamento del PID	2: Compl.Out
C292-Selezione grandezza per calcolo del termine derivativo	0: Measure
C293-Kp usato come moltiplicatore termini integrale e derivativo	1: Yes
C294-Azione del PID	1: Reference

The PID regulator parameters are included in the PID Parameters menu below. The configuration above 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 inverter is put in stand by.

P236-Uscita massima del PID	100.00	%	
P237-Uscita minima del PID	0.00	%	
P238-Massimo valore del termine integrale del PID	100.00	%	
P239-Massimo valore del termine derivativo del PID	100.00	%	
P240-Valore del coefficiente proporzionale	5.000		
P241-Fattore moltiplicativo del termine proporzionale	0: 1		
P242-Tempo di ciclo del termine integrale (t sample)	500	ts	Disabled
P243-Tempo di ciclo del termine derivativo (t sample)	0.00	ts	
P244-Tempo di ciclo ts	5	ms	
P245-Valore minimo del riferimento del PID	-100.00	%	
P246-Valore massimo del riferimento del PID	100.00	%	
P247-Valore minimo del feedback del PID	-100.00	%	
P248-Valore massimo del feedback del PID	100.00	%	
P249-Tempo di accelerazione rampa riferimento UP	0.00	s	
P250-Tempo di decelerazione rampa riferimento DOWN	0.00	s	
P251-Unità di misura rampa U \ D	2: 1000 msec		
P252-Arrotondamento iniziale rampa riferimento	0	%	
P253-Arrotondamento finale rampa riferimento	0	%	
P254-Soglia di velocità per abilitazione integratore	0.0	%|Refmax|	
P255-Tempo disabilitazione PID per uscita pari al minimo	1000	ts	Disabled
P256-Tempo impiegato dall'uscita PID da 0% a 100%	1	ms	

When the level 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 increase, the quicker the pump suction. 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 inverter is put in stand by.
.

28 SERIAL LINKS MENU

28.1 Overview

NOTE — Please refer to Sinus Penta's Installation Manual for the description of the serial links and connections.

NOTE — To obtain a greater immunity to communication interference, optoisolated serial board ES822 (optional) can be used instead of serial link RS485. Lines RS232 and RS485 can interface with board ES822.
Please refer to Sinus Penta's Installation Manual for the description of optoisolated board ES822.

Inverters 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 a better immunity to disturbance even on long cable paths, thus reducing 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 threephone connector) connected to the display/keypad.

NOTE — The display/keypad connected through connector RJ45 properly dialogues with the inverter using the default values preset in the parameter set of serial link 1.

The inverter 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:

4. The MODBUS address of the inverter.
5. The inverter response delay to a Master query.
6. The baud rate of the serial link (expressed in bits per second).
7. The time added to the 4 byte–time.
8. The serial link watchdog (which is active if the relevant parameter is other than 0).
9. The type of parity used for serial communications.

NOTE — The parameters in the Serial Links Menu are marked with "R".
Once saved, they are active only when the inverter is turned on again.

28.1.1 WATCHDOG ALARMS

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

Alarms A061 and A062 trip when no legal message is sent from the serial link to the inverter for a time longer than the time set in the relevant watchdog parameters; these alarms are active only if the relevant parameters are other than zero.

Alarm A081 trips only if the display/keypad used as a reference/command source detects a communication loss for a time longer than 2 seconds.

28.1.2 SPECIAL CODES

Code		DESCRIPTION
0x01	ILLEGAL FUNCTION	The function sent by the Master is different from 0x03 (Read Holding Registers) and from 0x10 (Preset Multiple Registers).
0x02	ILLEGAL ADDRESS	The reading/writing address used by the Master is illegal.
0x03	ILLEGAL DATA VALUE	The numerical value written by the Master is not included in the allowable range.
0x06	DEVICE BUSY	The inverter did not acknowledge the Master's written values (for example, because it is running with a Cxxx parameter).
0x07	ANOTHER USER WRITING	Other users are writing values to the same parameter the Master is trying to use (editing through display/keypad or Upload/Download from keypad).
0x09	BAD ACCESS LEVEL	The Master tried to write a parameter which is not included in the current access level (parameter ADVANCED with BASIC level).

28.1.3 PARAMETER LIST

Table 76: List of Parameters R001÷ R013

Parameter	FUNCTION	Access Level	MODBUS Address
R001	Inverter MODBUS address for serial link 0	ENGINEERING	588
R002	Response delay for serial link 0	ENGINEERING	589
R003	Baud Rate for serial link 0	ENGINEERING	590
R004	Time added to 4byte–time for serial link 0	ENGINEERING	591
R005	Watchdog time for serial link 0	ENGINEERING	592
R006	Parity bit for serial link 0	ENGINEERING	593
R008	Inverter MODBUS address for serial link 1	ENGINEERING	595
R009	Response delay for serial link 1	ENGINEERING	596
R010	Baud Rate for serial link 1	ENGINEERING	597
R011	Time added to 4byte–time for serial link 1	ENGINEERING	598
R012	Watchdog time for serial link 1	ENGINEERING	599
R013	Parity bit for serial link 1	ENGINEERING	600

28.1.4 R001 Inverter MODBUS Address for Serial Link 0

R001	Range	1 ÷ 247	
Inverter MODBUS address for serial link 0	Default	1	
	Level	ENGINEERING	
	Address	588	
	Function	This parameter determines the address assigned to the inverter connected through RS485 of serial link 0 (9-pole, male D connector).	

28.1.5 R002 Response Delay for Serial Link 0

R002	Range	1 ÷ 1000	1 ÷ 1000 msec
Response delay for serial link 0	Default	5	5 msec
	Level	ENGINEERING	
	Address	589	
	Function	This parameter determines the inverter response delay after a master query sent through serial link 0 (9-pole, male D connector).	

28.1.6 R003 Baud Rate for Serial Link 0

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
Baud Rate for serial link 0	Default	4	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).	

28.1.7 R004 Time Added to 4–Byte–Time for Serial Link 0

R004	Range	1 ÷ 10000	1 ÷ 10000 msec
Time added to 4–Byte–Time for serial link 0	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 inverter is considered as ended.	

28.1.8 R005 Watchdog Time for Serial Link 0

R005	Range	0 ÷ 65000	0 ÷ 65000 sec
Watchdog time for serial link 0	Default	0	0 sec
	Level	ENGINEERING	
	Address	592	
	Function	If this parameter is other than zero, it determines the limit time after which alarm *A61 WDG Serial 0 Alarm* trips if the inverter does not receive any legal message through serial link 0 (9-pole, male D connector).	

28.1.9 R006 Parity Bit for Serial Link 0

R006	Range	0 ÷ 3	0: Disabled 1 Stop–bit 1: Disabled 2 Stop–bits 2: Even (1 Stop bit) 3: Odd (1 Stop bit)
Parity bit for serial link 0	Default	1	1: Disabled 2 Stop–bits
	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).	

28.1.10 R008 Inverter MODBUS Address for Serial Link 1

R008	Range	1 ÷ 247	
Inverter MODBUS address for serial link 1	Default	1	
	Level	ENGINEERING	
	Address	595	
	Function	This parameter determines the address assigned to the inverter connected to the network through RS485 of serial link 1 (RJ45 connector).	

NOTE The display/keypad connected through connector RJ45 properly dialogues with the inverter using the default values preset in the parameter set of serial link 1.

28.1.11 R009 Response delay for serial link 1

R009	Range	1 ÷ 1000	1 ÷ 1000 msec
Response delay for serial link 1	Default	5	5 msec
	Level	ENGINEERING	
	Address	596	
	Function	This parameter determines the inverter response delay after a master query sent through serial link 1 (RJ45 connector).	

28.1.12 R010 Baud Rate for Serial Link 1

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
Baud Rate for serial link 1	Default	4	6: 38400bps
	Level	ENGINEERING	
	Address	597	
	Function	This parameter determines the baud rate, expressed in bits per second, for serial link 1 (RJ45 connector).	

28.1.13 R011 Time Added to 4–Byte–Time for Serial Link 1

R011	Range	1 ÷ 10000	1 ÷ 10000 msec
Time added to 4–Byte–Time for serial link 1	Default	2	2 msec
	Level	ENGINEERING	
	Address	598	
	Function	This parameter determines the limit time when no character is received from serial link 1 (RJ45 connector) and the message sent from the master to the inverter is considered as ended.	

28.1.14 R012 Watchdog Time for Serial Link 1

R012	Range	0 ÷ 65000	0 ÷ 65000 sec
Watchdog time for serial link 1	Default	0	0 sec
	Level	ENGINEERING	
	Address	599	
	Function	If this parameter is other than zero, it determines the limit time after which alarm *A62 WDG Serial 1 Alarm* trips if the inverter does not receive any legal message through serial link 1 (RJ45 connector).	

28.1.15 R013 Parity Bit for Serial Link 1

R013	Range	0 ÷ 3	0: Disabled 1 Stop–bit 1: Disabled 2 Stop–bits 2: Even (1 Stop bit) 3: Odd (1 Stop bit)
Parity bit for serial link 1	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).	

29 EEPROM MENU

29.1 Overview

The inverter has four different memory zones:

- RAM → Volatile memory containing the current parameterization of the inverter.
- Default Zone → Non-volatile memory that cannot be accessed by the user. It contains the factory-setting of the inverter parameters.
- Work Zone → Non-volatile memory where customized parameters are saved. Whenever the inverter is reset, this parameterization is loaded to RAM.
- Back–up Zone → Non-volatile memory storing a new parameterization of the inverter. Back-up parameters are modified only when the user explicitly saves the back–up zone.

Any parameter can be changed by the user. The inverter will immediately use the new parameter value.
The user may save the parameter value to the Work zone. If no new value is saved for a given parameter, at next power on the inverter will use the parameter value stored in the Work zone.

- "P" parameters can be written at any moment.
- "C" parameters can be written only if the inverter 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 saved, will be used only at next power on. For a prompt use of the new parameter value, just turn off and on the inverter.

The Work zone may be copied to the BACKUP zone through input I012 included in the Eeprom menu and described in the section below.

The same input permits to copy the Backup zone to the WORK zone to restore the parameter values stored in the WORK zone.

I012 also permits to restore the factory-setting for all parameters in the WORK zone.

29.2 Input I012

Table 77: Programmable Input I012

Input	FUNCTION	Access Level	MODBUS Address
I012	EEPROM Control	BASIC	1399

29.2.1 UPL UPLOAD Page

UPL	Range	Neither an input nor a parameter.
UPLOAD Page	*Default*	*Neither an input nor a parameter.*
	Level	BASIC
	Address	Cannot be accessed via MODBUS.
	Function	This page performs the user interface for the WORK zone parameter **upload** from the inverter to the keypad. When **UPLOAD** is performed, all parameters in the WORK zone are read by the inverter and stored to non-volatile memory of the inverter keypad.

To access the UPLOAD page, hold down the **MENU** and **Tx/Rx** keys.
In the UPLOAD page, the MENU key is disabled.
Press **Tx/Rx** again to switch to the DOWNLOAD page. In the DOWNLOAD page, the MENU key is enabled.

UPLOAD page display:

```
>CFG>EEPROM  1/3
Param.   UPLOAD
from Inverter
ESC  UP  DN  EXE
```

Press **SAVE** to perform uploading; confirmation is required:

```
>CFG>EEPROM  1/3
    CONFIRM
from   Inverter
NO           YES
```

Press **PROG** to cancel confirmation, press **SAVE** to perform the parameter UPLOAD: a flashing warning (W08 UPLOADING) is displayed and the Rx LED comes on.

If parameters are successfully uploaded, the following warning is displayed:
W11 UPLOAD OK

29.2.2 DNL DOWNLOAD PAGE

DNL		
DOWNLOAD page	Range	Neither an input nor a parameter.
	Default	*Neither an input nor a parameter.*
	Level	BASIC
	Address	Cannot be accessed via MODBUS.
	Function	This page performs the user interface for the WORK zone parameter download from the keypad to the inverter. When DOWNLOAD is performed, all parameters in the WORK zone are read by non-volatile memory of the keypad and are written to the inverter memory. If parameters are successfully downloaded, the user shall store all WORK parameters.

DOWNLOAD page display:

```
>CFG>EEPROM   2/3
Param. DOWNLOAD
to Inverter
ESC  UP  DN  EXE
```

Press SAVE to perform downloading; confirmation is required:

```
>CFG>EEPROM   2/3
    CONFIRM
to      Inverter
NO           YES
```

Press PROG to cancel confirmation, press SAVE to perform the parameter DOWNLOAD. The keypad will check consistency of WORK parameters stored to its non-volatile memory; a flashing warning (W07 DOWNLOADING) is displayed and the Tx LED comes on.

If parameters are successfully downloaded, the following warning is displayed:
W09 DOWNLOAD OK

29.2.3 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
EEPROM Control	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 whole parameter set that can be accessed by the user: **2: Restore Backup**: Parameters stored in the Backup zone are copied and stored to the WORK zone. They represent the new RAM parameterization; the previous RAM parameters are cleared. **Backup → RAM → Work** **4: Save Backup**: Parameters stored in the WORK zone are stored to a copy of the Backup zone. **Work → Backup** **5: Save Work**: The current values of the parameters stored to RAM are saved to non-volatile memory to the Work zone. All parameters are saved at a time. **RAM → Work** **11: Restore Default**: factory-setting values are restored for all parameters; factory-setting is stored to non-volatile memory to the Work zone. **Default → RAM → Work**	

30 ALARMS AND WARNINGS

CAUTION

If a protection trips or the inverter enters the emergency mode, the inverter is locked and the motor starts idling!

30.1 What Happens When a Protection Trips?

NOTE

Carefully read and understand this section and the following section (What To Do When an Alarm Trips) before operating the inverter in emergency condition.

The inverter alarms are detailed in the sections below.

When a protection or an alarm trips, the ALARM LED in the keypad comes on and the page displayed is the first page of the ALARM LOG.

Factory-setting: at power on, the inverter is still in emergency condition if the alarm tripped at power off was not reset.
If the inverter is in emergency mode at power on, this could be due to an alarm tripped before the inverter was shut off.
To avoid storing the alarms tripped before the inverter shut off, set parameter C257 in the Autoreset Menu accordingly.

The inverter stores the moment when an alarm trips to the ALARM LOG (supply–time and operation–time). Also the inverter status when the alarm tripped, as well as some measures sampled when the alarm tripped are stored to the alarm log.

The fault–list can be very useful to detect the cause responsible for the alarm trip and its possible solution
(see also ALARM LOG in the Measure Menu described in this manual).

NOTE

Alarms A001 ~ A039 relate to the main microcontroller (DSP Motorola) of control board ES821, which detected a fault in the control board. No fault–list is available for Alarms A001 ~ A039 and no Reset command can be sent via serial link; alarms can be reset through the RESET terminal in the terminal board or the RESET key in the keypad. The software for the keypad interface is not available; the inverter parameters and measures cannot be accessed via serial link.
Alarms A033 and A039 indicate that flash memory is not provided with a proper software; the only way to reset alarms A033 and A039 is to download a proper software for the inverter flash memory.

See section below.

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 open and closed.

30.2 What To Do When an Alarm Trips

CAUTION

If a protection trips or the inverter is in emergency condition, the inverter is locked and the motor starts idling!

CAUTION

Before resetting an alarm, disable the ENABLE signal on terminal MDI2 to disable the inverter 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 inverter and to lock the motor, 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 open and closed.

2. If the motor is idling, wait until it stops. See the ALARM LOG stating any information about the alarm tripped, in order to determine the cause responsible for the alarm and its possible solutions.
Any information stored in the ALARM LOG is also required when contacting Elettronica Santerno's After-sales service.

3. In the following sections, look for the code of the alarm tripped and follow the instructions given to reset the alarm.

4. Try to solve any problem external to the equipment and responsible for the protection trip.

5. If you entered wrong parameter values, set new allowable values and save them.

6. Reset the alarm.

7. If the alarm condition persists, please contact Elettronica Santerno's After-sales service.

A RESET command must be sent to reset an alarm. Do one of the following:

- Enable signal on terminal RESET MDI3 of the hardware terminal board.
- Press the RESET key in the keypad.
- Enable the RESET MDI3 signal in one of the virtual terminal boards enabled as remote control sources (see Control Method Menu).

To activate the Autoreset function, enable parameter C255 in the Autoreset Menu: the inverter will automatically try to reset the alarms tripped.

30.3 List of the Alarm Codes

Table 78: Alarm List

Alarm Code	Alarm Message	Description
A001 ÷ A032	…	*Control board failure*
A033	TEXAS VERS KO	Incompatible Texas Software Version
A039	FLASH KO	Texas Flash not programmed
A040	USER ALARM	Alarm caused by the user
A041	IGBT FAULT Side A	Generic alarm IGBT Hardware, side A
A043	FALSE SOFTWARE INTERRUPT	*Control board failure*
A044	OVERCURRENT	Software overcurrent
A045	BYPASS FAULT	Fault of the precharge By–Pass
A047	UNDERVOLTAGE	Dc bus voltage lower than Vdc_min
A048	OVERVOLTAGE	Dc bus voltage exceeding Vdc_max
A050	IGBT FAULT A	Hardware Fault from IGBT converter, side A
A051	OVERCURRENT Hw A	Hardware overcurrent, side A
A053	NOT PWONA	Hardware failure, IGBT A power on impossible
A059	ENCODER FAULT	Error of motor speed measure
A060	NO CURR FAULT	Current is null in FOC control
A061	SERIAL n.0 WDG	Watchdog tripped in serial link 0
A062	SERIAL n.1 WDG	Watchdog tripped in serial link 1
A063	GENERIC MOTOROLA	*Control board failure*
A064	MAINS LOSS	No power is supplied from the mains
A065	AUTOTUNE KO	Autotune failed
A066	INPUT REF < 4mA	Current input REF (4÷20mA) lower than 4mA
A067	INPUT AIN1 < 4mA	Current input AIN1 (4÷20mA) lower than 4mA
A068	INPUT AIN2 < 4mA	Current input AIN2 (4÷20mA) lower than 4mA
A069	SLAVE MODE KO	Slave mode selected with IFD control
A074	OVERLOAD	Inverter thermal protection tripped
A075	MOTOR OVERHEATED	Motor thermal protection tripped
A076	LIMIT SPEED	Motor speed too high
A078	MMI KO	*Control board failure*
A079	ENCODER NOT ENABLED	FOC control but Encoder not enabled
A080	SPEED TRACKING	Encoder speed tracking error
A081	KEYPAD WATCHDOG	Communication watchdog via keypad
A082	ENCODER CONFIGURATION	Functions programmed for MDI6 and MDI7 or encoder B selected and encoder board not detected.
A083	EXTERNAL ALARM n.1	External alarm 1
A084	EXTERNAL ALARM n.2	External alarm 2
A085	EXTERNAL ALARM n.3	External alarm 3
A087	PTC ALARM	External PTC tripped
A088	ADC NOT TUNED	*Control board failure*
A092	MOTOROLA SOFTWARE VERSION	*Control board failure*
A093	PRECHARGE: BYPASS OPEN	ByPass relay open
A094	HEATSINK OVERTEMPERATURE	IGBT heatsink temperature too high
A095	ENCODER DIRECTION KO	Wrong direction of rotation of the encoder
A096	FAN FAULT	Fan alarm
A097	MOTOR CABLES KO	Motor not connected?
A098	ILLEGAL MOTOR	Motor 2 and motor 3 are both selected
A099	SENSOR 2 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 ÷ A127	…	*Control board failure*

30.3.1 A001÷A032 Control Board Failure

A001÷A032		
...	Description	Hardware board failure
	Event	The board autodiagnostics constantly checks its operating conditions. Multiple causes may trip alarms A001÷A032.
	Possible cause	• Electromagnetic disturbance or radiated interference. • Possible failure of the microcontroller or other circuits in the control board.
	Solution	1. Reset the alarm: send a RESET command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's After-sales service.

30.3.2 A033 Texas Vers Ko

A033		
TEXAS VER KO	Description	Incompatible Texas Software Version
	Event	At power 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 software version. 2. Please contact ELETTRONICA SANTERNO's After-sales service.

30.3.3 A039 Texas Flash not Programmed

A039		
FLASH KO	Description	Texas Flash not programmed
	Event	At power on, DSP Motorola detected that Flash Texas is not correctly programmed.
	Possible cause	A prior attempt to download DSP Texas software failed.
	Solution	1. Try to download DSP Texas software again. 2. Please contact ELETTRONICA SANTERNO's After-sales service.

30.3.4 A040 User Alarm

A040	Description	Alarm trip caused by the user
User alarm	Event	Alarm trip caused by the user
	Possible cause	Value 1 was entered to address MODBUS 1400 via serial link
	Solution	Reset the alarm: send a RESET command.

30.3.5 A041 IGBT Fault Side A

A041	Description	Generic alarm IGBT Hardware, side A
IGBT FAULT Side A	Event	Power converter A generated a generic 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 After-sales service.

30.3.6 A043 False Software Interrupt

A043	Description	Hardware board failure
FALSE SW Interrupt	Event	The board autodiagnostics constantly checks its operating conditions. Multiple causes may trip alarm A043.
	Possible cause	• Electromagnetic disturbance or radiated interference. • Possible failure of the microcontroller or other circuits in the control board.
	Solution	3. Reset the alarm: send a RESET command. 4. If the alarm persists, please contact ELETTRONICA SANTERNO's After-sales service.

30.3.7 A044 Overcurrent

A044		
OVERCURRENT	Description	SW overcurrent
	Event	Instant current limit tripped.
	Possible cause	• Abrupt variations of the connected load • Output short-circuit or ground short-circuit • 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.
	Solution	1. Check that the inverter 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 inverter (terminals U, V, W). (Remove voltage from the motor, set IFD control and operate the inverter in no-load conditions.) 3. Check that the command signals are sent to the inverter using screened cables where required (see Sinus Penta's Installation Manual). Detect external sources for electromagnetic disturbance, check wiring and make sure that antidisturbance filters are installed on the coils of contactors and solenoid valves (if fitted inside the cabinet). 4. Set longer acceleration times (see Ramps Menu). 5. Set longer deceleration times (see Ramps Menu) 6. If need be, decrease the value of max. absolute torque (C047 or C047 for motor 1 or equivalent parameters for motors 2 and 3).

30.3.8 A045 Bypass Fault

A045	Description	Fault of precharge By–Pass
BYPASS FAULT	Event	The inverter imposed to close its relay or contactor for the short-circuit of precharge resistors in DC-link capacitors (DC bus), but it did not detect the relevant closing signal.
	Possible cause	• Disconnection of auxiliary signal. • Precharge relay/contactor failure.
	Solution	1. Reset the alarm: send a **RESET** signal. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's After-sales service.

30.3.9 A047 Undervoltage

A047	Description	DC bus Voltage lower than Vdc_min
UNDERVOLTAGE	Event	Voltage measured in DC bus capacitors has dropped below the min. value allowed for a proper operation of the inverter class being used.
	Possible cause	• Supply voltage has dropped below 200Vac–25% (class 2T), 380V–35% (class 4T), 500V – 15% (class 5T), or 600Vac – 15% (class 6T). • Alarm A047 can trip even when voltage temporarily drops below the allowable min. value, e.g. direct starting of the connected load. • If the inverter 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 **ALARM LOG** when the alarm tripped. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's AFTER SALES service.

30.3.10 A048 OVERVOLTAGE

A048	Description	Overvoltage in DC bus (voltage in DC-link).
OVERVOLTAGE	Event	Voltage measured in DC bus (DC-link) capacitors has exceeded the max. value allowed for a proper operation of the inverter 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 with very inertial loads and when the deceleration ramp is too short (see **Ramps Menu**). • Alarm A048 can trip even when the motor is pulled by the load (eccentric load). • If the inverter 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 **ALARM LOG** 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 After-sales service.

30.3.11 A050 IGBT FAULT A

A050	Description	Hardware fault from IGBT converter, side A
IGBT FAULT A	Event	IGBT drivers of power converter A detected an IGBT failure
	Possible cause	• Electromagnetic disturbance or radiated interference. • Overcurrent, Overtemperature, IGBTs, IGBT fault.
	Solution	3. Reset the alarm: send a **RESET** command. 4. If the alarm persists, please contact ELETTRONICA SANTERNO's After-sales service.

30.3.12 A051 Overcurrent Hw A

A051	Description	Hardware overcurrent side A
OVERCURRENT (Hardware)	Event	Hardware overcurrent detected by the inverter output current circuit
	Possible cause	• Abrupt variations of the connected load • Output short-circuit or ground short-circuit • Electromagnetic disturbance or radiated interference. *If alarm A051 tripped while accelerating:* • Too short acceleration ramp. *If alarm A051 tripped while decelerating:* • Too short deceleration ramp.
	Solution	1. Check that the inverter 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 ground outgoing from the inverter (terminals U, V, W). (Remove voltage from the motor, set IFD control and operate the inverter in no-load conditions). 3. Check that the command signals are sent to the inverter using screened cables where required (see Sinus Penta's Installation Manual). Detect external sources for electromagnetic disturbance, check wiring and make sure that antidisturbance filters are installed on the coils of contactors and solenoid valves (if fitted inside the cabinet). 4. Set longer acceleration times (see Ramps Menu). 5. Set longer deceleration times (see Ramps Menu) 6. If need be, decrease the value of max. absolute torque (C047 or C047 for motor 1 or equivalent parameters for motors 2 and 3).

30.3.13 A053 Not PWONA

A053	Description	Hardware failure; IGBT A power on failure
NOT PWONA	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 After-sales service.

30.3.14 A059 Encoder Fault

A059	Description	Motor speed measure error
ENCODER FAULT	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	• Wrong parameterization of the encoder concerning the type and number of pulses/rev. • Voltage removed from one of the two encoders. • Wrong mounting of the encoders. • Encoder failure.
	Solution	1. Check that the encoder parameters are correct (see **Encoder Menu**). 2. Check that both encoders are properly connected. 3. Check mounting of the encoders. 4. With an oscilloscope, check that the encoder signals are correct.

30.3.15 A060 No Curr Fault

A060	Description	Error detected in FOC control by the current loop exceeds the max. allowable value.
NO CURR FAULT	Event	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 **FOC Regulators** Menu). Perform a new current regulator autotune (see **Autotune Menu**). 3. If the alarm persists, please contact ELETTRONICA SANTERNO's After-sales service.

30.3.16 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
WATCHDOG SERIAL link 0 and SERIAL link 1	Event	The serial link watchdog has tripped. Communication failure: no reading/writing query to serial link for a time longer than the time set in the parameters relating to serial link watchdog (see **Serial Links** Menu).
	Possible cause	• Serial link is disconnected. • Communication failure on remote master side. • Too short watchdog operating times.
	Solution	1. Check serial link. 2. Make sure that the remote master constantly sends reading/writing 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).

30.3.17 A064 Mains Loss

A064	Description	Mains loss.
MAINS LOSS	Event	Mains loss.
	Possible cause	• One feeder cable is disconnected. • Too weak supply mains. • 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 ALARM LOG when the alarm tripped. 2. This protection may be disabled or delayed (Power Down Menu).

30.3.18 A065 Autotune Ko

A065	Description	Autotune failed.
AUTOTUNE KO	Event	Autotune aborted or failed.
	Possible cause	• The ENABLE contact 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 Motor Control Menu) and perform a new autotune procedure. 3. If the alarm persists, please contact ELETTRONICA SANTERNO's After-sales service.

30.3.19 A066,A067,A068 Current Input < 4mA

A066 A067 A068	Description	A066: Current input REF (4÷20mA) lower than 4mA A067: Current input AIN1 (4÷20mA) lower than 4mA A068: Current input AIN2 (4÷20mA) lower than 4mA
INPUT REF<4mA INPUT AIN1<4mA INPUT AIN2<4mA	Event	A current value lower than 4 mA has been detected over input (REF, AIN1, AIN2) set with the following range: 4÷20mA.
	Possible cause	• Wrong setting of switch SW1 on control board ES821. • Signal cable disconnected. • Failure in the current signal source.
	Solution	1. Check setting of switch SW1. 2. Check that the signal cable is properly connected to its terminal. 3. Check the current signal source.

30.3.20 A069 Slave Mode Ko

A069	Description	Slave mode selected with IFD control.
SLAVE MODE KO	Event	SLAVE mode enabled with IFD control; IFD control does not allow torque references.
	Possible cause	• Wrong parameterization (type of control or master/slave mode). • Erroneous enabling of digital input SLAVE.
	Solution	1. Check parameterization. 2. Check status of digital command SLAVE.

30.3.21 A074 Overload

A074	Description	Inverter thermal protection tripped.
OVERLOAD	Event	Output current has been exceeding the inverter rated current for a long time.
	Possible cause	• Current equal to: Imax + 20% for 3 seconds • Current equal to: Imax for 120 seconds (S05÷S30) • Imax for 60 seconds (S40÷S70)
	Solution	1. Check the inverter current output during ordinary operation (M026 in the Measure Menu); check the mechanical conditions of the connected load (load locked or overload).

30.3.22 A075 Motor Overheated

A075	Description	Motor thermal protection tripped
MOTOR OVERHEATED	Event	Software thermal protection of the motor tripped. Output current has been exceeding the motor rated current for a long time.
	Possible cause	• Bad 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 Thermal Protection Menu.

30.3.23 A076 Limit Speed

A076	Description	Motor speed is too high.
LIMIT SPEED	Event	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	• Correct value of parameter C031 (for motor 1, or equivalent parameters for motors 2 and 3). • Torque reference too high for SLAVE mode.
	Solution	1. Check the value of parameter C031. 2. In SLAVE mode, check the torque reference value.

30.3.24 A079 ENCODER NOT ENABLED

A079	Description	FOC control, but encoder not enabled
ENCODER NOT ENABLED	Event	• 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 Encoder/Frequency Input Menu).
	Possible cause	• C012 = 0 (for motor 1, or equivalent parameters for motors 2 and 3). See Motor Control Menu. • The value set in C189 does not enable any encoder for speed measure. • FOC control has been improperly enabled.
	Solution	1. Properly set the parameters concerned.

30.3.25 A080 SPEED TRACKING

A080	Description	Encoder speed measure error
SPEED TRACKING	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 other than zero.
	Possible cause	• Wrong setting in parameters C192, C193, C194 (see Encoder 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. Properly set parameters C192, C193. 2. Check torque limit value (see References Menu, 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.

30.3.26 A081 Keypad Watchdog

A081	Description	Watchdog for communication with the keypad.
KEYPAD WATCHDOG	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. • Electromagnetic disturbance or radiated interference. • Keypad failure. • Wrong setting in parameters relating to serial link 1 (see Serial Links Menu).
	Solution	1. Check the connection of the keypad cable. 2. Make sure that the keypad cable connectors are intact (on both inverter side and keypad side). 3. Check communication parameters of serial link 1.

30.3.27 A082 Encoder Configuration

A082	Description	Functions programmed for MDI6 and MDI7, or Encoder B selected and encoder board not detected.
ENCODER CONFIGURATION	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	• Wrong setting in parameter C189. • Wrong programming of digital input functions. • Optional board for Encoder B is not fitted, has been improperly mounted or is faulty. Possible connector failure as well.
	Solution	1. Check and adjust the value set in C189 (see Encoder Menu). 2. Check and adjust control function programming for digital inputs MDI6 and MDI7 (see Digital Inputs Menu). 3. Check if optional encoder board is fitted and if it is properly mounted.

30.3.28 A083, A084, A085 External Alarm

A083 A084 A085	Description	A083: External alarm 1 A084: External alarm 2 A085: External alarm 3
EXTERNAL ALARM	Event	The External Alarm (1, 2, 3) functionality has been programmed, but the relevant digital input is disabled (see Digital Inputs Menu). If multiple digital command sources are programmed, alarms A083-85 trip if one of the terminals in the active sources is disabled (see Control Method Menu).
	Possible cause	• The cause responsible for the alarm does not depend on the inverter; check for the reason why the contact connected to terminal MDIx (where the External Alarm function is programmed) opens.
	Solution	1. Check external signal.

30.3.29 A087 PTC Alarm

A087	Description	External PTC tripped
PTC ALARM	Event	• PTC connected to AIN2 opens.
	Possible cause	• PTC opens due to motor overtemperature. • PTC not properly connected. • Wrong setting of hardware switch SW1 on control board (see Sinus Penta's Installation Manual).
	Solution	1. Wait for the motor cooling, then reset the alarm. 2. Check that PTC is properly connected to analog input AIN2 (see Sinus Penta's Installation Manual). 3. Check that hardware switch SW1 is properly set up.

30.3.30 A093 Precharge: Bypass open

A093	Description	ByPass relay open
PRECHARGE: BYPASS OPEN	Event	• The control board imposes to close 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).
	Possible cause	• Failure in the relay control circuit or in the aux signal circuit detecting relay closing.
	Solution	1. Reset the alarm: send a RESET command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's After-sales service.

30.3.31 A094 Heatsink Overtemperature

A094	Description	IGBT heatsink temperature is too high
Heatsink overtemperature	Event	• IGBT power heatsink overheated even if the cooling fan is on.
	Possible cause	• Ambient temperature exceeding 40 °C. • Motor overcurrent. • Excessive carrier frequency for the application required (IFD control only).
	Solution	1. Check ambient temperature. 2. Check motor current. 3. IFD control: decrease IGBT carrier frequency (see Carrier Frequency Menu).

30.3.32 A095 ENCODER DIRECTION KO

A095	Description	Opposite sign of encoder speed measure.
ENCODER DIRECTION KO	Event	During the encoder tuning, the system measured a direction of rotation opposite to the voltage direction imposed to the motor.
	Possible cause	• Encoder phases (A and B) are reversed on terminals MDI6-MDI7 (encoder A), or on the terminals of the optional board for encoder B. • Two motor phases are reversed on terminals U, V, W. • Disconnection of one of the encoder phases; encoder faulty; encoder not coupled to the motor shaft.
	Solution	1. Check connection of phases A and B of the encoder and reverse them if required (see Sinus Penta's Installation Manual). 2. Check connection of the motor phases to terminals U, V, W. With a positive reference, the connected motor rotates in the direction desired (see Sinus Penta's Installation Manual). When IFD control is selected, if the motor rotates in the right direction, do not reverse the motor phases, but reverse phases A and B of the encoder. 3. Use an oscilloscope to check signals A and B of the encoder.

30.3.33 A096 FAN FAULT

A096	Description	Fan fault.
FAN FAULT	Event	• Power heatsink overheated; fan locked.
	Possible cause	• Fan locked or faulty.
	Solution	1. Replace fan.

30.3.34 A097 Motor Cables KO

A097	Description	Motor not connected.
MOTOR CABLES KO	Event	• This protection trips during autotune or DC Brake if the motor is not connected to the inverter or if its current value is not compatible with the inverter size.
	Possible cause	• One cable of the motor is disconnected. • The motor size is too small if compared to the inverter 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).

30.3.35 A098 Illegal Motor

A098	Description	Commands for motor 2 and motor 3 are both active, or a disabled motor has been selected.
ILLEGAL MOTOR	Event	• Digital commands enabled both motor 2 and motor 3; alarm A098 trips because only one motor can be selected. • Motor 2 is enabled, but only 1 motor can be enabled: C009=1 (see Motor Control 1 Menu). • Motor 3 is enabled, but only 1 motor can be enabled: C009=2 (see Motor Control 1 Menu).
	Possible cause	• Wrong setting in parameter C009. • Wrong setting of the digital input parameters enabling the selection functions for motor 2 (C173) and/or motor 3 (C174). • The digital command selecting motor 2 and the digital command selecting motor 3 are both active (see Digital Inputs Menu). They can be activated even in transient stage; check the input status stored in the Alarm log. Wrong selection sequence of motor 2-motor 3 or viceversa: clear both selected values, then select the desired motor.
	Solution	1. Enter a proper value for C009. 2. Enter a proper 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.

30.3.36 A099 Sensor 2 Fault

A099	Description	Failure of fan sensor 2.
SENSOR 2 FAULT	Event	• Power heatsink overheated with fan off.
	Possible cause	• Failure in temperature control device and/or cooling system.
	Solutions	1. Please contact ELETTRONICA SANTERNO's After-sales service.

30.3.37 A100 MDI6 Illegal Configuration

A100	Description	Function programmed to MDI6 along with frequency input A
MDI6 ILLEGAL CONFIGURATION	Event	• Terminal MDI6 is programmed with both a digital function command and as frequency input A.
	Possible cause	• Wrong programming of a command function for MDI6, because frequency input A is already set up in C189 (FinA) (see Digital Inputs Menu and Encoder Menu).
	Solution	1. Check and adjust programming of the digital input functions and of parameter C189.

30.3.38 A101 MDI8 Illegal Configuration

A101	Description	Function programmed to MDI8 along with frequency input B
MDI8 ILLEGAL CONFIGURATION	Event	• Terminal MDI8 is programmed with both a digital function command and as frequency input B.
	Possible cause	• Wrong programming of a command function for MDI8, because frequency input A is already set up in C189 (FinA) (see Digital Inputs Menu and Encoder Menu).
	Solution	2. Check and adjust programming of the digital input functions and of parameter C189.

30.3.39 A063, A078, A088, A092, A102÷A127 CONTROL BOARD FAILURE

A063 A078 A088 A092 A102 ÷ A127	Description	Hardware board failure
...	Event	The board autodiagnostics constantly checks its operating conditions. Multiple causes may trip alarms A063, A078, A088, A092 and A102÷A127.
	Possible cause	• Electromagnetic disturbance or radiated interference. • Possible failure of the microcontroller or other circuits in the control board.
	Solution	5. Reset the alarm: send a RESET command. 6. If the alarm persists, please contact ELETTRONICA SANTERNO's After-sales service.

30.4 Warnings

Warning messages are displayed in the display/keypad. They are flashing messages appearing in the first two lines of the display.

NOTE Warnings are neither protections nor alarms, and are not stored to the alarm log.

Some warnings simply state what's happening or suggest what to do when using the keypad.

However, most part of the warning messages are Coded warnings: they are displayed with letter "W" followed by two digits stating which warning is active at that moment.

Example:

W	3	2		O	P	E	N			E	n	a	b	l	e

Warning messages are detailed in the following section.

30.5 List of Coded Warnings

Table 79: List of Coded Warnings

Warning	Message	Description
W03	SEARCHING..	The user interface is searching the data of the next page to display.
W04	DATA READ OK	
W05	WRITE KO	
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 inverter the WORK zone parameters saved to its own Flash.
W08	UPLOADING	The keypad is **reading** from the inverter the WORK zone parameters that will be saved to its own Flash.
W09	DOWNLOAD OK	Parameters were successfully downloaded to the inverter (parameter **writing**).
W10	DOWNLOAD KO	Parameter download to the inverter has failed (parameter **writing** failed).
W11	UPLOAD OK	Parameters were successfully uploaded from the inverter (parameter **reading**).
W12	UPLOAD KO	Parameter upload from the inverter has failed (parameter **reading** failed).
W13	NO DOWNLOAD	A Download procedure was queried, but no parameter is saved to flash memory.
W16	PLEASE WAIT	Wait until the system accomplishes the operation required.
W18	PARAMS LOST	Parameters download to the inverter has failed (parameter **writing** failed). Not all parameters have been updated (inconsistent parameters). **Shut off the inverter or try to perform a new parameter download**.
W19	NO PARS LOAD	UPLOAD impossible.
W20	NOT NOW	The function required is not available at the moment.
W21	CONTROL ON	The function required is inhibited because the inverter is running: **ENABLE** is active.
W23	DOWNLD VerKO	Download failed because parameters saved to keypad memory relate to a software version or product ID incompatible with the inverter Sw version or product ID.
W24	VERIFY DATA	Download preliminary operation; the system is checking the integrity and compatibility of the parameters saved to keypad memory.
W25	PREC BYPASS	Precharge failed because an alarm tripped (alarm concerning the by–pass circuit of the precharge resistors of DC bus capacitors).
W28	OPEN START	Open and close the **START** (**MDI1**) signal to start the equipment.
W31	Encoder OK !	Encoder tuning procedure over: the encoder is properly connected.
W32	OPEN ENABLE	Open and close the **ENABLE** (**MDI2**) signal to enable the inverter.
W33	Write Impos.	Writing procedure impossible.
W34	Illegal Data	Illegal value entered.
W35	Write Impos.	Writing procedure impossible because Control is active and the inverter is running: **ENABLE** is active.
W36	Illegal Address	Illegal address, operation failed.
W37	ENABLE LOCK	The inverter is disabled and does not acknowledge the Enable command because it is writing a "C" parameter. **Caution: the inverter starts as soon as writing is over!!!**
W38	P000 == NO	Editing mode cannot be accessed because parameter modification is disabled: P000 is set to 0 (NO).
W39	KEYPAD DISAB	Editing mode cannot be accessed because the keypad is disabled.