

**VACON<sup>®</sup> 20 CP/X**  
AC DRIVES

**SOLAR PUMP  
APPLICATION MANUAL**

**VACON<sup>®</sup>**



**INDEX**

Document ID: DPD01601F

Version release date: 9.1.20

Corresponds to application package ACIT1163V203.vcx

|   |           |
|---|-----------|
| <b>1. Safety</b> .....  | <b>4</b>  |
| 1.1 Danger.....   | 4         |
| 1.2 Warnings.....   | 4         |
| <b>2. Solar pump application</b> .....                          | <b>5</b>  |
| 2.1 Specific functions of VACON® Solar pump application.....    | 5         |
| 2.2 Example of control connections.....                         | 6         |
| 2.3 Optional boards.....  | 8         |
| 2.3.1 Option board installation.....                            | 10        |
| <b>3. Description of groups</b> .....                           | <b>14</b> |
| 3.1 Keypad Reference: Menu REF.....                             | 14        |
| 3.2 Monitor group: menu MON.....                                | 15        |
| 3.2.1 Drive Monitors.....                                       | 15        |
| 3.2.2 Solar Monitors.....                                       | 16        |
| 3.3 Parameter Groups: Menu PAR.....                             | 17        |
| 3.3.1 Group Basic Parameters: Menu PAR G1.....                  | 18        |
| 3.3.2 Group Advanced Settings: Menu PAR G2.....                 | 20        |
| 3.3.3 Group Analogue inputs: Menu PAR G3.....                   | 21        |
| 3.3.4 Group Digital inputs: Menu PAR G4.....                    | 22        |
| 3.3.5 Group Digital outputs: Menu PAR G5.....                   | 24        |
| 3.3.6 Group Analogue outputs: Menu PAR G6.....                  | 25        |
| 3.3.7 Group Supervisions: Menu PAR G7.....                      | 26        |
| 3.3.8 Group Motor Control: Menu PAR G8.....                     | 27        |
| 3.3.9 Group Protections: Menu PAR G9.....                       | 29        |
| 3.3.10 Group Autoreset: Menu PAR G10.....                       | 32        |
| 3.3.11 Group Fieldbus: Menu PAR G11.....                        | 33        |
| 3.3.12 Group PID Control: Menu Par G12.....                     | 34        |
| 3.3.13 Group Solar: Menu PAR G14.....                           | 36        |
| 3.3.14 Group Flow meter: Menu PAR G15.....                      | 37        |
| 3.4 System parameters, Faults and History faults: Menu FLT..... | 38        |
| <b>4. Parameter description</b> .....                           | <b>41</b> |
| 4.1 Basic Parameters.....                                       | 41        |
| 4.2 Advanced settings.....                                      | 44        |
| 4.3 Analogue inputs.....  | 49        |
| 4.4 Digital inputs.....   | 54        |
| 4.5 Digital outputs.....  | 56        |
| 4.6 Analogue Output.....  | 58        |
| 4.7 Supervisions.....   | 59        |
| 4.8 Motor control.....  | 60        |
| 4.9 Protections.....  | 64        |
| 4.10 Autoreset.....   | 70        |
| 4.11 Fieldbus.....  | 71        |
| 4.11.1 Fieldbus mapping.....                                    | 72        |
| 4.12 PID Control.....   | 75        |
| 4.13 Solar.....   | 77        |
| 4.13.1 Start Settings.....                                      | 77        |
| 4.13.2 MPPT.....  | 77        |
| 4.14 Flow meter.....  | 82        |
| <b>5. Fault tracing</b> .....                                   | <b>83</b> |

## 1. SAFETY

This manual contains clearly marked warning information which is intended for your personal safety and to avoid any unintentional damage to the product or connected appliances.

**Before installing, commissioning or using the frequency converter, please read the warning information contained in VACON® 20X Installation Manual.**

**Please read the following additional safety instructions carefully.**

**Only VACON® authorized, trained and qualified personnel are allowed to install, operate and maintain the drive.**

### 1.1 DANGER

These warnings are intended to personnel responsible for grounding the frequency converter.



Ignoring the following instructions can be **extremely dangerous and may cause death or severe injury.**



Ground the frequency converter to ensure personnel **safety and to reduce electromagnetic interference.**



**After disconnecting** the AC drive from the mains or from the DC input supply, **wait** until the indicators on the keypad go out (if no keypad is attached, see the indicators on the cover). Wait an additional 30 seconds before starting any work on the connections of VACON® 20X Drive. After expiration of this time, use measuring equipment to absolutely ensure that no voltage is present. **Always ensure absence of voltage before starting any electrical work!**

### 1.2 WARNINGS



The **touch current** of VACON® 20X drives exceeds 3.5mA AC. According to standard EN61800-5-1, **a reinforced protective ground connection** must be ensured. See VACON® 20X Installation Manual for further information.



**Never work on the photovoltaic generator** or frequency converter and its input/output cables when the frequency converter is connected to the mains or to the photovoltaic generator.



**Before performing any measurement on the frequency converter**, disconnect or isolate the mains supply voltage or the DC input supply.



**Do not touch the components on the frequency converter** or on the string box cabinet that have high DC voltage.



The photovoltaic generator **cells exposed to light supply DC voltage** even at low light intensity.

## 2. SOLAR PUMP APPLICATION

The VACON® 20 CP/X drive contains a preloaded application for instant use.

The parameters of this application are listed in chapter 3.3 of this manual and explained in more detail in chapter 4.

### 2.1 SPECIFIC FUNCTIONS OF VACON® SOLAR PUMP APPLICATION

The VACON® Solar Pump allows flexible use of VACON® 20 CP/X frequency converters. This dedicated application SW was developed to drive a Solar Pump with an optimized MPPT (Maximum Power Point Tracking) for 20X supplied by Solar Panels.

The MPPT is based on 4 parallel algorithms:

- Feed-Forward Controller (to follow the radiation variations)
- Correction Controller (to compensate the temperature variations)
- Oscillation Damping Regulator (to prevent the panel entering in the “current source” branch of the characteristic)
- Local Maxima logic (to prevent the regulator from being trapped in a local maximum lower than absolute maximum)

#### Features

The MPP Tracker controls DC voltage reference in order to find the maximum power.

The drive can be controlled through I/O terminals, a fieldbus or the optional keypad. Two programmable control places and sources for the frequency reference are available, for easy local/remote control.

Frequency reference can be direct (analogue input, preset speeds or fieldbus) or controlled by the internal PID regulator.

All the functionalities can be controlled through a fieldbus.

The motor identification function allows automatic optimization of the voltage/frequency curve, for an optimal torque response also at low motor speed.

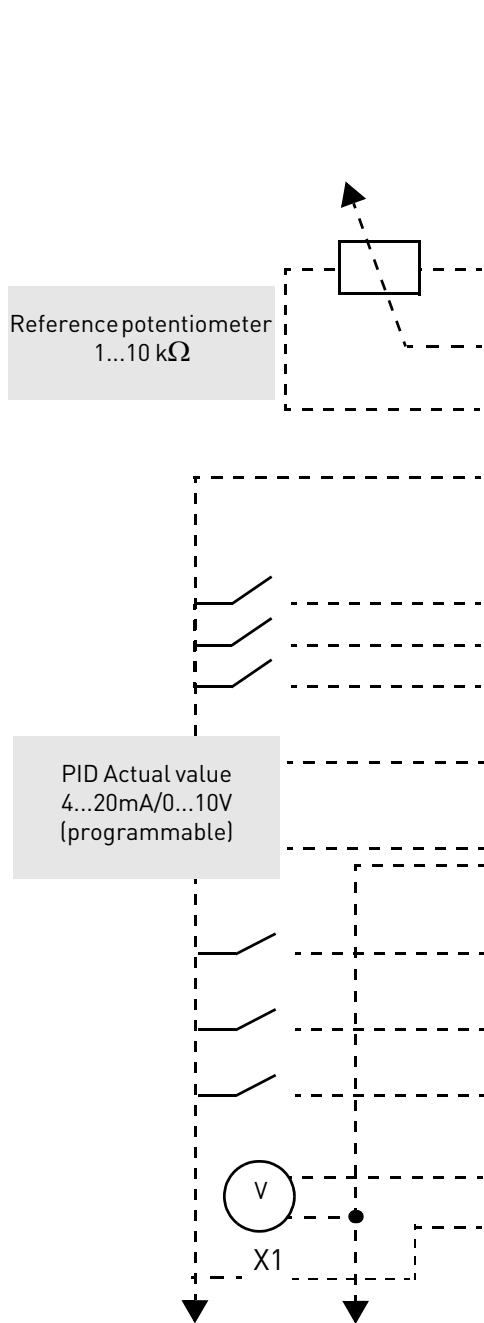
It is possible to install one optional board for I/O expansion.

Underload protection can be managed by measuring Motor torque (standard sensorless mode) or by measuring the water flow with a flow meter sensor. This sensor can be an analogue signal or a digital input. With this sensor it is possible to measure the water flow [litres/min] and the total volume of the water flow [m<sup>3</sup>].

Sleep mode can be enabled or disabled with a parameter.

Digital inputs can be used to measure water levels (minimum and maximum).

2.2 EXAMPLE OF CONTROL CONNECTIONS

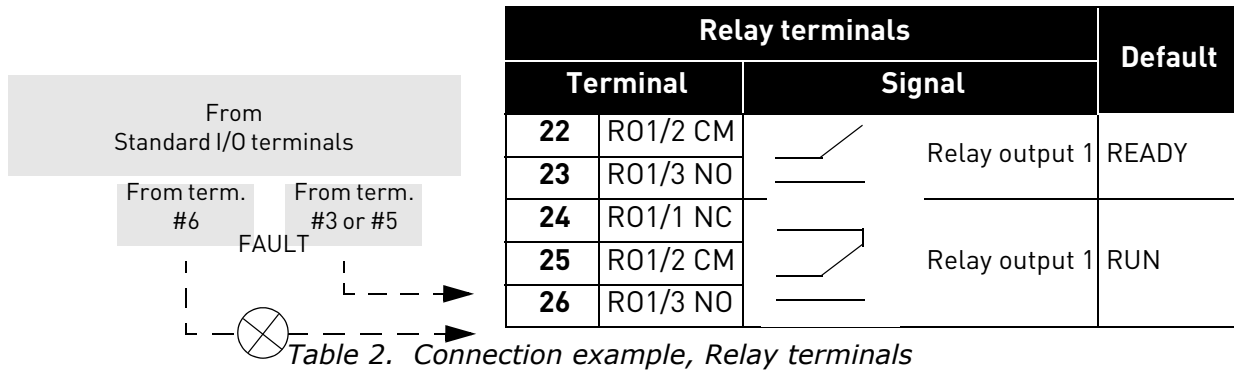


| Standard I/O terminals |          |                                     |                   |
|------------------------|----------|-------------------------------------|-------------------|
| Terminal               |          | Signal                              | Default           |
| A                      | RS485    | Serial bus, negative                |                   |
| B                      | RS485    | Serial bus, positive                |                   |
| 1                      | +10 Vref | Reference output                    |                   |
| 2                      | AI1+     | Analogue input, voltage or current* | (default Voltage) |
| 3                      | AI1-/GND | Analogue input common (current)     | Freq. Reference   |
| 6                      | 24Vout   | 24V aux. voltage                    |                   |
| 7                      | DIN COM  | Digital input common                |                   |
| 8                      | DI1      | Digital input 1                     | Start 1           |
| 9                      | DI2      | Digital input 2                     | Start 2           |
| 10                     | DI3      | Digital input 3                     | Fault reset       |
| 4                      | AI2+     | Analogue input, voltage or current* | (def. Current)    |
| 5                      | AI2-/GND | Analogue input common (current)     | PID feedback      |
| 13                     | DO1-     | Digital Output Common               |                   |
| 14                     | DI4      | Digital input 4                     | Preset Speed B0   |
| 15                     | DI5      | Digital input 5                     | Ext. fault Closed |
| 16                     | DI6      | Digital input 6                     | Not used          |
| 18                     | AO1+     | Analogue signal (+output)           | Output frequency  |
| 20                     | DO1+     | Digital output +                    | Fault             |

\*Selectable with DIP switches, see VACON® 20 CP/X Installation Manual

Table 1. Connection example, standard I/O terminals.

To Relay terminals 1 or 2



## 2.3 OPTIONAL BOARDS

One optional I/O expansion board can be installed into the slot on the right side of the drive. The following boards are supported:

### **OPTB1: 6 Digital Inputs-Outputs**

The first 3 terminals are reserved as digital inputs (DIN7, DIN8, DIN9). The second 3 terminals can be used as inputs (DIN10, DIN11, DIN12) or digital outputs (E01, E02, E03). The number of terminals used as input must be declared in parameter P2.24 (hidden if the board is not installed). This number determines the higher value for the selection of the digital input connected to a certain logical function. It also changes the visibility of parameters for the selection of digital outputs function (P5.9, P5.10, P5.11).

### **OPTB2: 1 Thermistor Input, 2 Relays Outputs**

Response to thermistor fault can be programmed with parameter P9.16. Relays functions can be programmed with parameters P5.9, P5.10 (hidden if the board is not installed).

### **OPTB5: 3 Relays Outputs**

Relays functions can be programmed with parameters P5.9, P5.10, P5.11 (hidden if the board is not installed).

### **OPTB9: 5 Digital Inputs, 1 Relay Output**

The higher value for the selection of the digital input (DIN7, DIN8, DIN9, DIN10, DIN11) connected to a certain logical function is set to 11. Relay functions can be programmed with parameters P5.9 (hidden if the board is not installed).

### **OPTBF: 1 Analogue Output, 1 Digital Output, 1 Relay Output**

The digital output can be programmed with parameter P5.12. The digital output can be programmed with parameter P5.9. Parameters are hidden if the board is not installed.

### **OPTC3/E3: Profibus DPV1 fieldbus board**

VACON® 20CP/X frequency converters can be connected to the PROFIBUS DP network using a fieldbus board. The converter can then be controlled, monitored and programmed from the Host system. OPTC3 option board also supports connection from DP Master (class 2) if DP-V1 is enabled. In this case, the Master class 2 can initiate a connection, read and write parameters using the PRO-Fldrive Parameter Access service, and close the connection. The PROFIBUS DP fieldbus is connected to the OPTC3 board using a 5-pin pluggable bus connector. The only difference between OPTC3 and OPTC5 boards is the fieldbus connector.

### **OPTC4 LonWorks fieldbus board**

VACON® 20CP/X frequency converters can be connected to the LonWorks® network using a fieldbus board. The converter can then be controlled, monitored and programmed from the Host system.

### **OPTC5/E5: Profibus DPV1 fieldbus board (D-type connector)**

VACON® 20CP/X frequency converters can be connected to the PROFIBUS DP network using a fieldbus board. The converter can then be controlled, monitored and programmed from the Host system. OPTC5 option board also supports connection from DP Master (class 2) if DP-V1 is enabled. In this case, the Master class 2 can initiate a connection, read and write parameters using the PRO-Fldrive Parameter Access service, and close the connection. The PROFIBUS DP fieldbus is connected to the OPTC5 board using a 9-pin female sub-D-connector. The only difference between OPTC3 and OPTC5 boards is the fieldbus connector.

### **OPTC6/E6: CanOpen fieldbus board**

VACON® 20CP/X frequency converters can be connected to the CanOpen system using a fieldbus board. The converter can then be controlled, monitored and programmed from the Host system. VACON® CanOpen Board is connected to the fieldbus through a 5-pin pluggable bus connector (board NXOPTC6/E6).

### **OPTC7/E7: DeviceNet fieldbus board**



VACON® 20CP/X frequency converters can be connected to the DeviceNet using a fieldbus board. The converter can then be controlled, monitored and programmed from the Host system. VACON® DeviceNet Board is connected to the fieldbus through a 5-pin pluggable bus connector (board OPTC7/E7).

#### **OPTCI: Modbus TCP fieldbus board**

VACON® 20CP/X frequency converters can be connected to Ethernet using an Ethernet fieldbus board OPTCI. Every appliance connected to an Ethernet network has two identifiers; a MAC address and an IP address. The MAC address (Address format: xx:xx:xx:xx:xx:xx ) is unique to the appliance and cannot be changed. The Ethernet board's MAC address can be found on the sticker attached to the board or by using the VACON® IP tool software NCIPConfig. Please find the software installation at [www.vacon.com](http://www.vacon.com). In a local network, IP addresses can be defined by the user as long as all units connected to the network are given the same network portion of the address. For more information about IP addresses, contact your Network Administrator. Overlapping IP addresses cause conflicts between appliances.

#### **OPTCP: Profinet fieldbus board**

VACON® 20CP/X frequency converters can be connected to Ethernet using an Ethernet fieldbus board OPTCP. Every appliance connected to an Ethernet network has two identifiers; a MAC address and an IP address. The MAC address (Address format: xx:xx:xx:xx:xx:xx ) is unique to the appliance and cannot be changed. The Ethernet board's MAC address can be found on the sticker attached to the board or by using the VACON® IP tool software NCIPConfig. You can find the software installation at [www.vacon.com](http://www.vacon.com). In a local network, IP addresses can be defined by the user as long as all units connected to the network are given the same network portion of the address. For more information about IP addresses, contact your Network Administrator. Overlapping IP addresses cause conflicts between appliances.

#### **OPTCQ: Ethernet IP fieldbus board**

VACON® 20CP/X frequency converters can be connected to Ethernet using an EtherNet/IP fieldbus board OPT-CQ. Every appliance connected to an Ethernet network has two identifiers; a MAC address and an IP address. The MAC address (Address format: xx:xx:xx:xx:xx:xx) is unique to the appliance and cannot be changed. The EtherNet/IP board's MAC address can be found on the sticker attached to the board or by using the VACON® IP tool software NCIPConfig. Please find the software installation at [www.vacon.com](http://www.vacon.com). In a local network, IP addresses can be defined by the user as long as all units connected to the network are given the same network portion of the address. For more information about IP addresses, contact your Network Administrator. Overlapping IP addresses cause conflicts between appliances.

### 2.3.1 OPTION BOARD INSTALLATION



**NOTE!** It is not allowed to add or replace option boards or fieldbus boards on an AC drive with the power switched on. This may damage the boards.

**1**

- Open the cover of the drive.

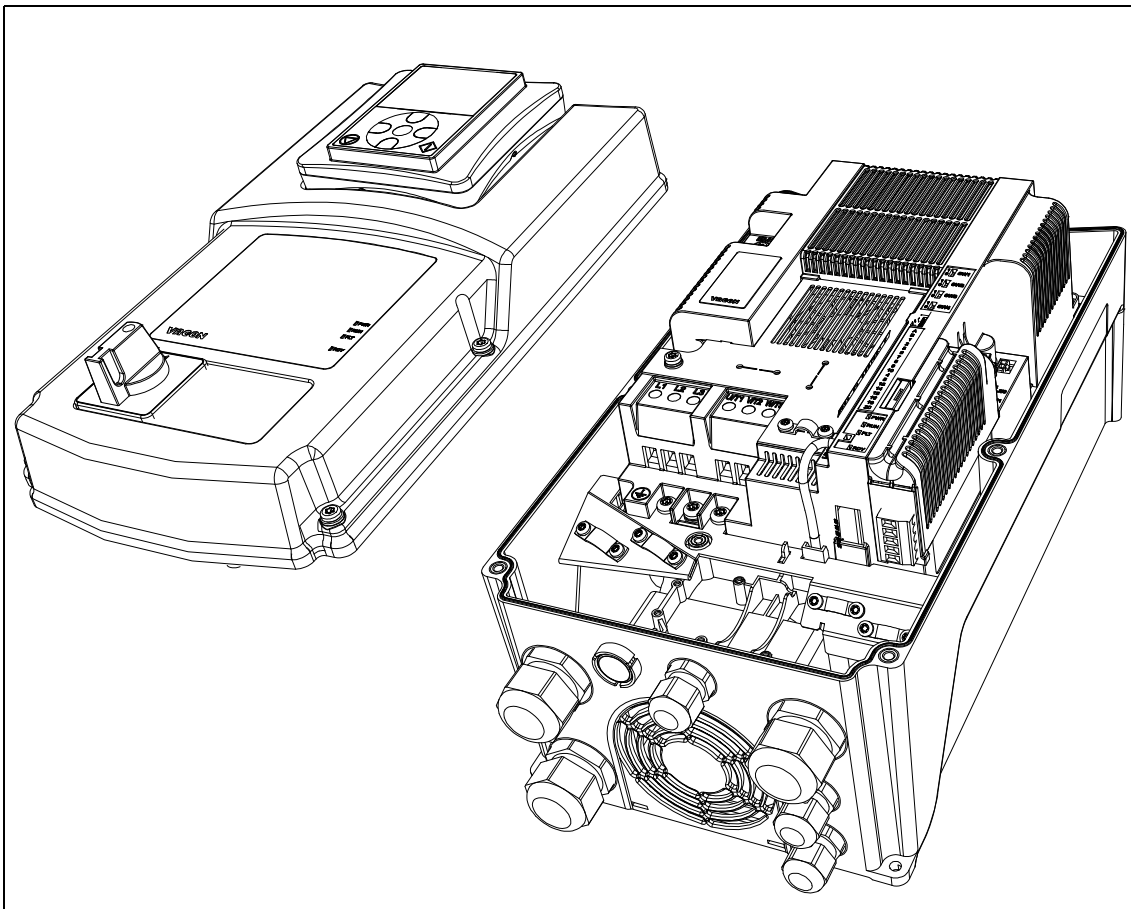


Figure 1. Opening the main cover, MU3 example.



The relay outputs and other I/O-terminals may have a dangerous control voltage present even when the drive is disconnected from mains.

**2**

- Remove the option slot cover.

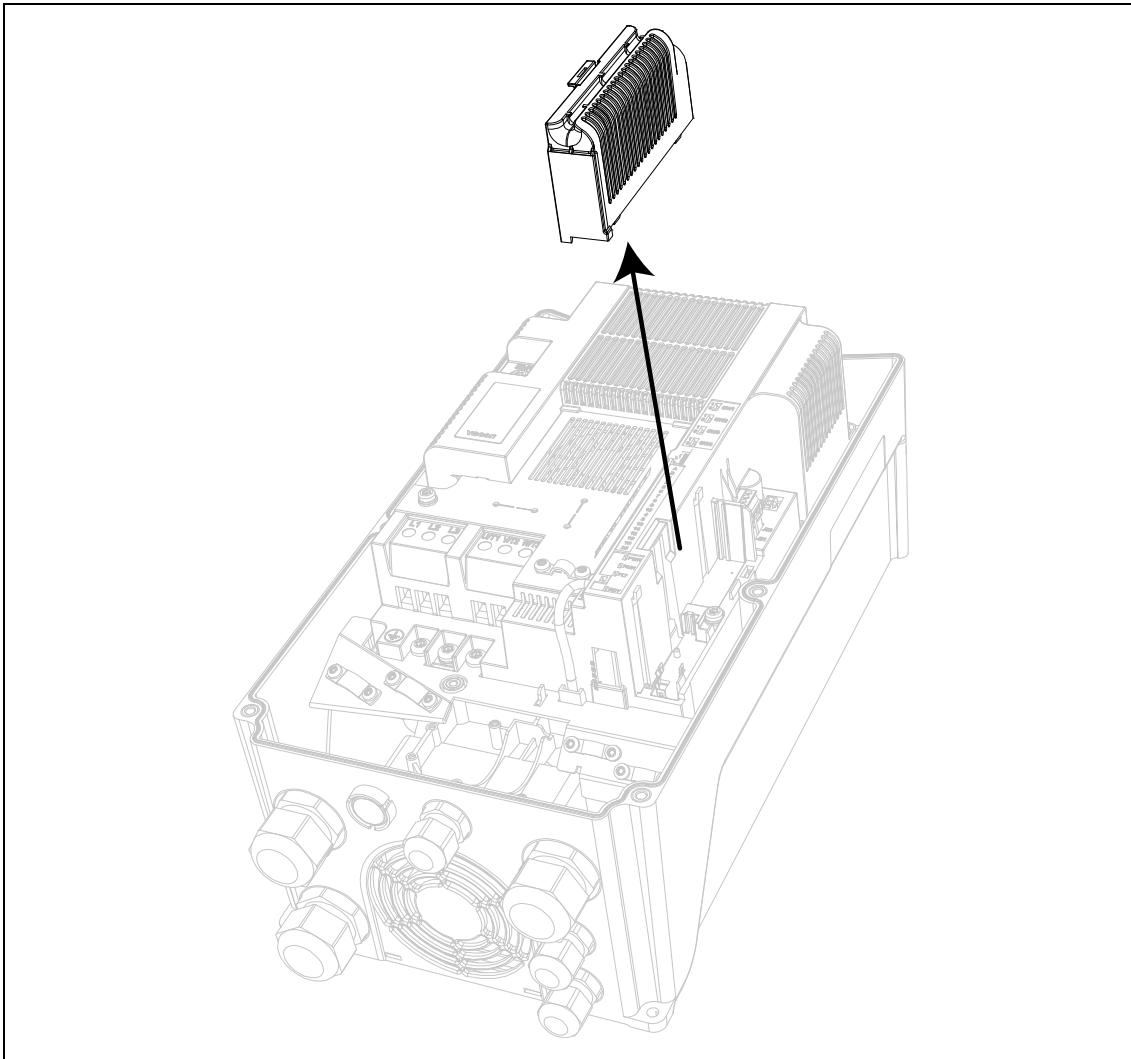
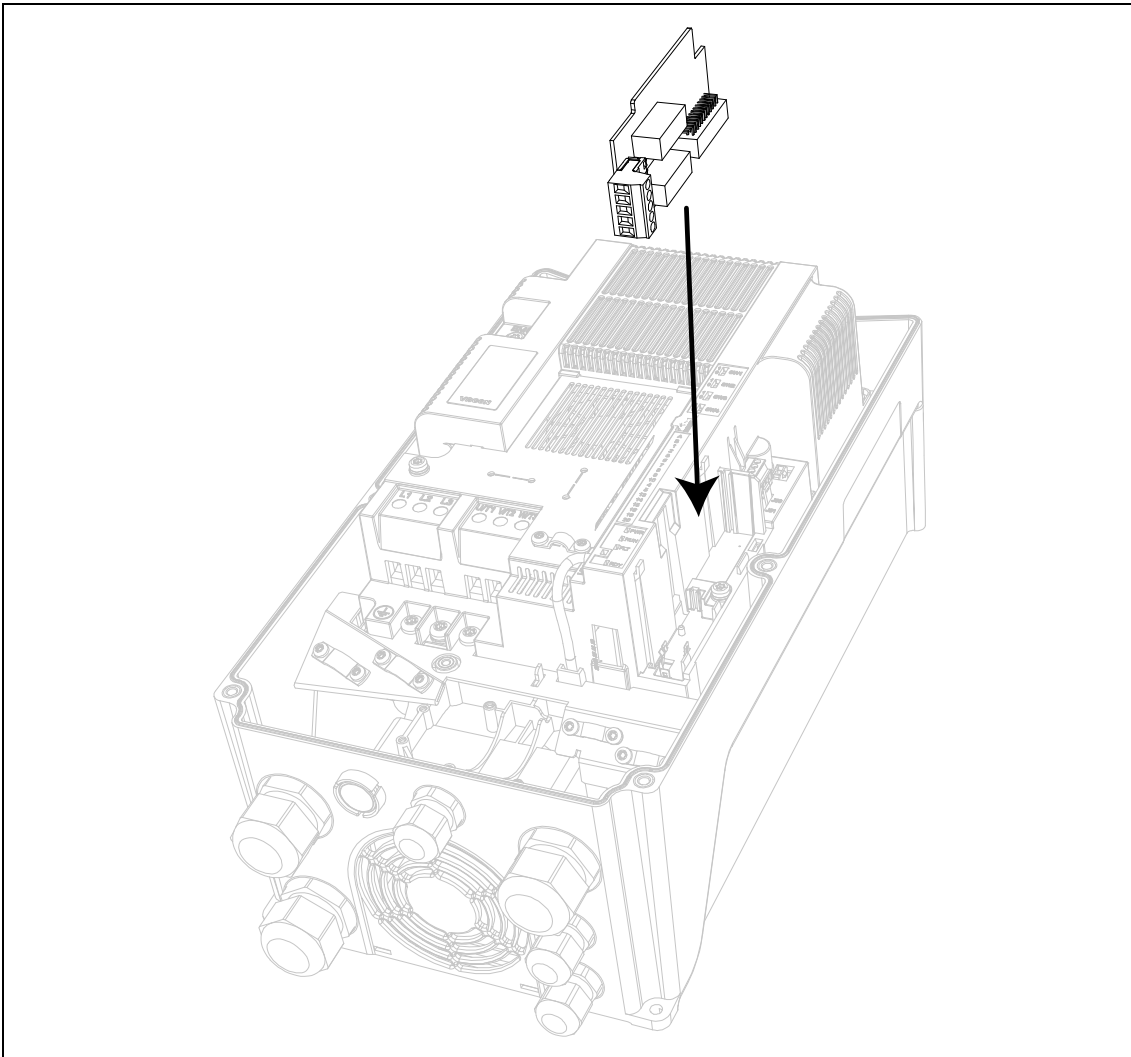


Figure 2. Removing the option slot cover.

|   |   |
|---|---|
| 3 | <ul style="list-style-type: none"> <li>Make sure that the sticker on the connector of the board says “dv” (dual voltage). This indicates that the board is compatible with VACON® 20CP/X. See below:</li> </ul> <div style="text-align: center;"> <p style="text-align: right;">9116.emf</p> </div> <ul style="list-style-type: none"> <li><b>NOTE:</b> Incompatible boards cannot be installed on VACON® 20CP/X. Compatible boards have a slot coding that enable the placing of the board (see above).</li> </ul> |
|---|---|

**4**

- Install the option board into the slot as shown in the picture below.



*Figure 3. Option board installation.*

**5**

- Mount the option slot cover.

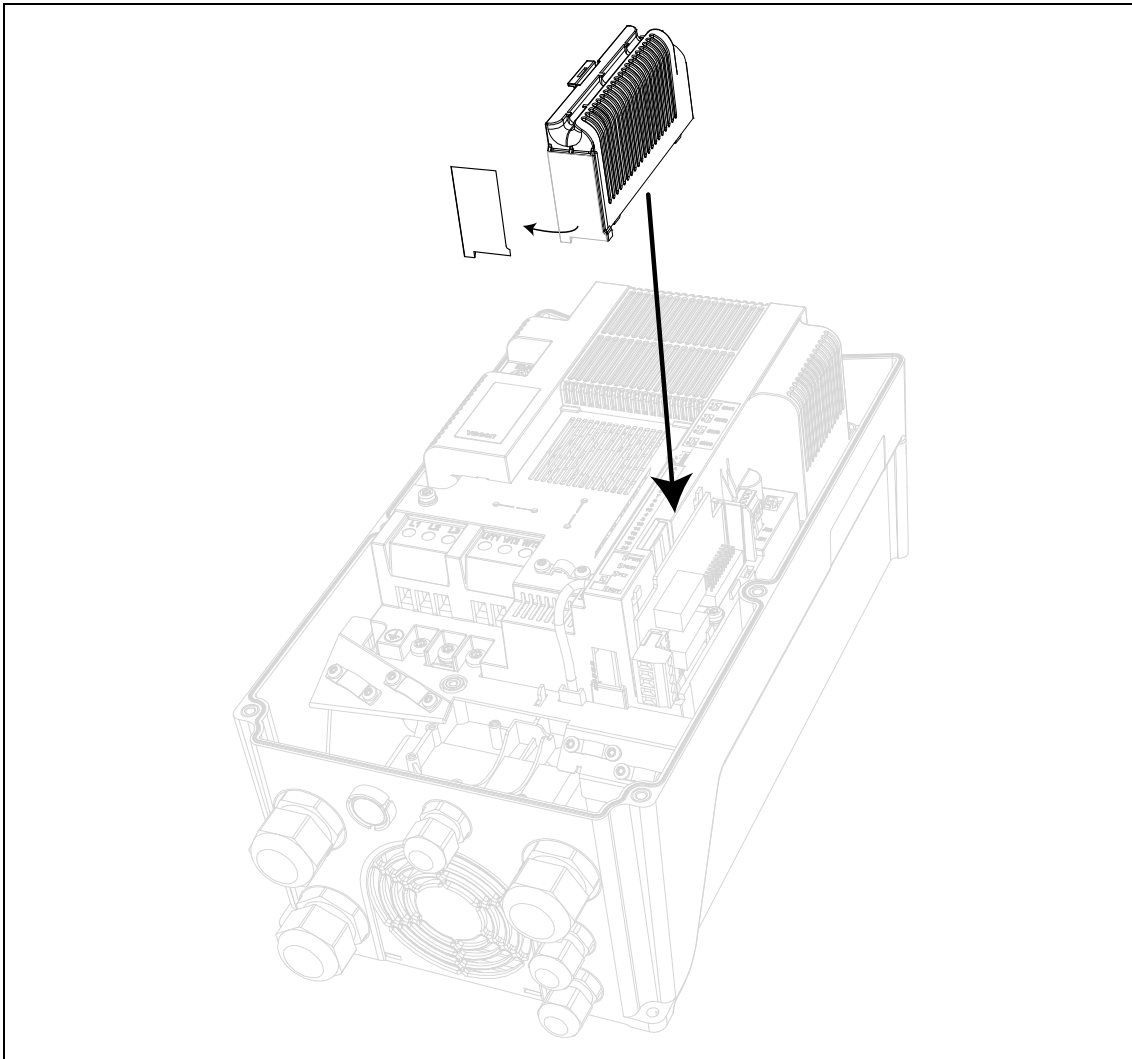


Figure 4. Mounting of option slot cover: remove the plastic opening for option board terminals.

### **3. DESCRIPTION OF GROUPS**

#### **3.1 KEYPAD REFERENCE: MENU REF**

This menu is automatically entered when pressing the LOC/REM keypad and shows the frequency reference in Local control mode.

The reference is also active when selected as main reference (P1.12=4) or as secondary reference (P2.15=4).

Value is limited between min frequency P1.1 and max frequency P1.2.

In Local mode, or when keypad is the active control place (P1.11=1 or P2.14=1), direction of rotation is determined with P2.23 or by pressing the left or right arrow button.

### 3.2 MONITOR GROUP: MENU M0N

VACON® 20 CP/X AC drive provides you with a possibility to monitor the actual values of parameters and signals as well as statuses and measurements. See Table in which the basic monitoring values are presented.

#### 3.2.1 DRIVE MONITORS

| Code  | Monitoring value    | Unit                            | ID   | Description  |
|-------|---------------------|---------------------------------|------|--|
| V1.1  | Output frequency    | Hz                              | 1    | Output frequency to motor                            |
| V1.2  | Frequency reference | Hz                              | 25   | Frequency reference to motor control                 |
| V1.3  | Motor shaft speed   | rpm                             | 2    | Motor speed in rpm                                   |
| V1.4  | Motor Current       | A                               | 3    |  |
| V1.5  | Motor Torque        | %                               | 4    | Calculated shaft torque                              |
| V1.6  | Motor Power         | %                               | 5    | Total power consumption of AC drive                  |
| V1.7  | Motor Voltage       | V                               | 6    |  |
| V1.8  | Motor temperature   | %                               | 9    | Calculated motor temperature                         |
| V1.9  | DC-link voltage     | V                               | 7    |  |
| V1.10 | Unit temperature    | °C                              | 8    | Heatsink temperature                                 |
| V1.11 | Board temperature   | °C                              | 1825 | Power board temperature                              |
| V1.12 | Analogue input 1    | %                               | 13   | Analogue input AI1                                   |
| V1.13 | Analogue input 2    | %                               | 14   | Analogue input AI2                                   |
| V1.14 | Analogue output     | %                               | 26   | Analogue output                                      |
| V1.15 | DI1, DI2, DI3       |                                 | 15   | Digital inputs status                                |
| V1.16 | DI4, DI5, DI6       |                                 | 16   | Digital inputs status                                |
| V1.19 | RO1, RO2, DO        |                                 | 17   | Digital outputs status                               |
| V1.21 | Process variable    |                                 | 29   | Scaled process variable See P7.10                    |
| V1.22 | PID setpoint        | %                               | 20   |  |
| V1.23 | PID feedback        | %                               | 21   |  |
| V1.24 | PID error value     | %                               | 22   |  |
| V1.25 | PID output          | %                               | 23   |  |
| V1.26 | Actual Flow         | litres/<br>min                  | 1956 | Actual flow, measured by transducer defined in P15.1 |
| V1.27 | Volume counter 1*   | m <sup>3</sup>                  | 1955 | Cumulative water volume counter.                     |
| V1.28 | Volume counter 2*   | m <sup>3</sup> x10 <sup>4</sup> | 1962 | Cumulative water volume counter.                     |

Table 3: Monitor values.

|              |  |
|--------------|--|
| <b>NOTE!</b> | Values V1.22-25 are hidden when PID output is not used as frequency reference.         |
| <b>NOTE!</b> | * The total volume of water in [m <sup>3</sup> ] is given by: V1.27 + (V1.28 x 10000). |

**3.2.2 SOLAR MONITORS**

| <b>Code</b> | <b>Monitoring value</b> | <b>Unit</b> | <b>ID</b> | <b>Description</b>   |
|-------------|-------------------------|-------------|-----------|--|
| V2.1        | Vmp Ref                 | V           | 1934      | DC voltage reference for MPP regulation                        |
| V2.2        | Vmp Ref correct         | V           | 1942      | Present correction on DC voltage reference (P&O + oscillation) |
| V2.3        | Power                   | kW          | 1936      | Motor shaft power  |
| V2.4        | Energy counter          | MWh         | 1935      | Counter of energy taken by the supply                          |

*Table 4. Solar motor values.*




### 3.3 PARAMETER GROUPS: MENU PAR

The Solar Pump Application embodies the following parameter groups:

| Menu and Parameter group             | Description                          |
|--------------------------------------|--------------------------------------|
| Group Basic Parameters: Menu PAR G1  | Basic settings                       |
| Group Advanced Settings: Menu PAR G2 | Advanced parameter settings          |
| Group Analogue inputs: Menu PAR G3   | Analogue input programming           |
| Group Digital inputs: Menu PAR G4    | Digital input programming            |
| Group Digital outputs: Menu PAR G5   | Digital output programming           |
| Group Analogue outputs: Menu PAR G6  | Analogue outputs programming         |
| Group Supervisions: Menu PAR G7      | Prohibit frequencies programming     |
| Group Motor Control: Menu PAR G8     | Motor control and U/f parameters     |
| Group Protections: Menu PAR G9       | Protections configuration            |
| Group Autoreset: Menu PAR G10        | Auto reset after fault configuration |
| Group Fieldbus: Menu PAR G11         | Fieldbus data out parameters         |
| Group PID Control: Menu Par G12      | PID controller parameters            |
| Group Solar: Menu PAR G14            | Solar specific parameters.           |
| Group Flow meter: Menu PAR G15       | Flow meter parameters.               |

*Table 5. Parameter groups*

#### Column explanations:

- Code = Location indication on the keypad; Shows the operator the parameter number.
- Parameter= Name of parameter
- Min = Minimum value of parameter
- Max = Maximum value of parameter
- Unit = Unit of parameter value; Given if available
- Default = Value preset by factory
- ID = ID number of the parameter
- Description= Short description of parameter values or its function
-  = The parameter may be changed only in Stop state

3.3.1 GROUP BASIC PARAMETERS: MENU PAR G1

| Code  | Parameter                  | Min                  | Max                | Unit | Default        | ID   | Description   |
|-------|----------------------------|----------------------|--------------------|------|----------------|------|---|
| P1.1  | Min frequency              | 0.00                 | P1.2               | Hz   | 20.00          | 101  | Minimum allowed frequency reference   |
| P1.2  | Max frequency              | P1.1                 | 320.00             | Hz   | 50.00          | 102  | Maximum allowed frequency reference   |
| P1.3  | Acceleration time          | 0.1                  | 3000.0             | s    | 3.0            | 103  | Defines the time required for the output frequency to increase from zero frequency to maximum frequency   |
| P1.4  | Deceleration time          | 0.1                  | 3000.0             | s    | 3.0            | 104  | Defines the time required for the output frequency to decrease from maximum frequency to zero frequency   |
| P1.5  | Current limit              | 0.2 x I <sub>H</sub> | 2 x I <sub>H</sub> | A    | I <sub>H</sub> | 107  | Maximum motor current from AC drive   |
| P1.6  | Motor nominal voltage      | 180                  | 500                | V    | 400            | 110  | Find this value U <sub>n</sub> on the rating plate of the motor. This parameter sets the voltage at the field weakening point to 100% * U <sub>nMotor</sub> . Note also used connection (Delta/Star). |
| P1.7  | Motor nominal frequency    | 8.00                 | 320.00             | Hz   | 50.00          | 111  | Find this value f <sub>n</sub> on the rating plate of the motor.  |
| P1.8  | Motor nominal speed        | 24                   | 20000              | rpm  | 1440           | 112  | Find this value n <sub>n</sub> on the rating plate of the motor.  |
| P1.9  | Motor nominal current      | 0.2 x I <sub>H</sub> | 2 x I <sub>H</sub> | A    | I <sub>H</sub> | 113  | Find this value I <sub>n</sub> on the rating plate of the motor.  |
| P1.10 | Motor cos φ                | 0.30                 | 1.00               |      | 0.85           | 120  | Find this value on the rating plate of the motor  |
| P1.11 | Control Place              | 0                    | 2                  |      | 0              | 125  | Run and direction control:<br>0 = I/O terminals<br>1 = Keypad<br>2 = Fieldbus   |
| P1.12 | Frequency reference source | 0                    | 7                  |      | 0              | 1819 | Selection of reference source:<br>0 = AI1<br>1 = AI2<br>2 = PID reference<br>3 = not used<br>4 = Keypad<br>5 = Fieldbus<br>6 = AI1+AI2<br>7 = Max Frequency   |
| P1.13 | Start function             | 0                    | 1                  |      | 0              | 505  | 0=Ramping<br>1=Flying start   |
| P1.14 | Stop function              | 0                    | 2                  |      | 0              | 506  | 0: coasting<br>1: ramp to min frequency<br>2: ramp to zero frequency  |
| P1.15 | Torque boost               | 0                    | 1                  |      | 0              | 109  | 0 = Not active<br>1 = Auto torque boost   |

Table 6. Basic parameters.

|       |                       |   |   |  |   |      |   |
|-------|-----------------------|---|---|--|---|------|---|
| P1.16 | Show parameters       | 0 | 1 |  | 0 | 115  | 0 = only Basic<br>1 = All groups                |
| P1.17 | Energy counter reset  | 0 | 1 |  | 0 | 1933 | Value 1 resets energy counter V2.4.             |
| P1.18 | Volume counters reset | 0 | 1 |  | 0 | 1961 | Value 1 resets volume counters V1.27 and V1.28. |

*Table 6. Basic parameters.*

3.3.2 GROUP ADVANCED SETTINGS: MENU PAR G2

| Code  | Parameter                    | Min  | Max    | Unit | Default | ID   | Description  |
|-------|------------------------------|------|--------|------|---------|------|--|
| P2.1  | Start/Stop logic             | 0    | 4      |      | 0       | 300  | <b>Logic = 0:</b><br>Start sign 1 = Start Forward<br>Start sign 2 = Start Backward<br><b>Logic = 1:</b><br>Start sign 1 = Start<br>Start sign 2 = Reverse<br><b>Logic = 2:</b><br>Double Start<br><b>Logic = 3:</b><br>Start sign 1 + Analogue sign<br><b>Logic = 4:</b><br>Solar only |
| P2.2  | Preset speed 1               | 0.00 | P1.2   | Hz   | 10.00   | 105  | Multistep speed 1  |
| P2.3  | Preset speed 2               | 0.00 | P1.2   | Hz   | 15.00   | 106  | Multistep speed 2  |
| P2.4  | Preset speed 3               | 0.00 | P1.2   | Hz   | 20.00   | 126  | Multistep speed 3  |
| P2.9  | Start acceleration time      | 0.1  | 3000.0 | s    | 1.0     | 502  | Time from 0 to min frequency   |
| P2.14 | Control place 2              | 0    | 2      |      | 0       | 1806 | Alternative control place:<br>0: I/O terminals<br>1: Keypad<br>2: Fieldbus   |
| P2.15 | Frequency reference source 2 | 0    | 7      |      | 1       | 1820 | Selection of reference source:<br>0 = AI1<br>1 = AI2<br>2 = PID reference<br>3 = not used<br>4 = Keypad<br>5 = Fieldbus<br>6 = AI1+AI2<br>7 = Max Frequency  |
| P2.22 | Stop button active           | 0    | 1      |      | 1       | 114  | 0 = Limited function of Stop button<br>1 = Stop button always enabled  |
| P2.23 | Keypad Reverse               | 0    | 1      |      | 0       | 123  | Direction of motor rotation when control place is keypad<br>0 = Forward<br>1 = Reverse   |
| P2.24 | OPTB1 Digital inputs         | 3    | 6      |      | 6       | 1829 | Number of terminals used as digital inputs.<br>The parameter is visible only when OPTB1 board is installed   |

Table 7. Advanced settings group.

|              |   |
|--------------|---|
| <b>NOTE!</b> | Visibility of the group depends on P1.16.<br>P2.18 - P2.21 are available only with Mains connected. |
|--------------|---|

## 3.3.3 GROUP ANALOGUE INPUTS: MENU PAR G3

| Code  | Parameter          | Min     | Max    | Unit | Default | ID   | Description  |
|-------|--------------------|---------|--------|------|---------|------|--|
| P3.1  | AI1 signal range   | 0       | 1      |      | 0       | 379  | 0 = 0...10V / 0...20mA<br>1 = 2...10V / 4...20mA   |
| P3.2  | AI1 custom min     | -100.00 | 100.00 | %    | 0.00    | 380  | Custom range min setting<br>20% = 4-20 mA/2-10 V   |
| P3.3  | AI1 custom max     | -100.00 | 300.00 | %    | 100.00  | 381  | Custom range max setting   |
| P3.4  | AI1 filter time    | 0.0     | 10.0   | s    | 0.1     | 378  | Filter time for analogue input 1   |
| P3.5  | AI2 signal range   | 0       | 1      |      | 1       | 390  | 0 = 0...10V / 0...20mA<br>1 = 2...10V / 4...20mA   |
| P3.6  | AI2 custom min     | -100.00 | 100.00 | %    | 0.00    | 391  | See P3.2   |
| P3.7  | AI2 custom max     | -100.00 | 300.00 | %    | 100.00  | 392  | See P3.3   |
| P3.8  | AI2 filter time    | 0.0     | 10.0   | s    | 0.1     | 389  | See P3.4   |
| P3.9  | Star signal select | 0       | 1      |      | 0       | 1810 | 0 = AI1<br>1 = AI2   |
| P3.10 | Start level        | 0.00    | 100.00 | %    | 10.00   | 1857 | Not scaled analogue signal<br>If P3.10 < P3.11:<br>Start below this level<br>If P3.10 > P3.11:<br>Start above this level |
| P3.11 | Stop Level         | 0.00    | 100.00 | %    | 60.00   | 1856 | Not scaled analogue signal<br>If P3.11 > P3.10:<br>Stop above this level<br>If P3.11 < P3.10:<br>Stop below this level   |

Table 9. Analogue inputs group.

|              |   |
|--------------|---|
| <b>NOTE!</b> | Visibility of the group depends on P1.16. |
|--------------|---|

3.3.4 GROUP DIGITAL INPUTS: MENU PAR G4

| Code  | Parameter              | Min | Max | Unit | Default | ID   | Description  |
|-------|------------------------|-----|-----|------|---------|------|--|
| P4.1  | Start signal 1         | 0   | 6*  |      | 1       | 403  | Start signal 1 when control place is I/O 1 (FWD)<br>See P2.1 for function.<br>0 = not used<br>1 = DIN1<br>2 = DIN2<br>3 = DIN3<br>4 = DIN4<br>5 = DIN5<br>6 = DIN6 |
| P4.2  | Start signal 2         | 0   | 6*  |      | 2       | 404  | Start signal 2 when control place is I/O 1 (REV).<br>See P2.1 for function.<br>See P4.1 for selections.  |
| P4.3  | Reverse                | 0   | 6*  |      | 0       | 412  | Independent from P2.1<br>See P4.1 for selections   |
| P4.4  | External fault close   | 0   | 6*  |      | 5       | 405  | Fault if signal high<br>See P4.1 for selections  |
| P4.5  | External fault open    | 0   | 6*  |      | 0       | 406  | Fault is signal low<br>See P4.1 for selections   |
| P4.6  | Fault reset            | 0   | 6*  |      | 3       | 414  | Resets all active faults   |
| P4.7  | Run enable             | 0   | 6*  |      | 0       | 407  | Must be on to set drive in Ready state   |
| P4.8  | Preset speed B0        | 0   | 6*  |      | 4       | 419  | Binary selector for Preset speeds  |
| P4.9  | Preset speed B1        | 0   | 6*  |      | 0       | 420  | Binary selector for Preset speeds  |
| P4.14 | Sel. control place 2   | 0   | 6*  |      | 0       | 1813 | Activates control place 2<br>See P4.1 for selections   |
| P4.15 | Sel. freq. reference 2 | 0   | 6*  |      | 0       | 1814 | Activates reference 2<br>See P4.1 for selections   |
| P4.16 | Sel. PID setpoint 2    | 0   | 6*  |      | 0       | 431  | Activates setpoint 2<br>See P4.1 for selections  |
| P4.17 | Mains connected        | 0   | 6*  |      | 0       | 1931 | Digital input is high when mains supply is connected   |
| P4.18 | Energy counter reset   | 0   | 6*  |      | 0       | 1932 | Reset of Energy counter  |
| P4.19 | Flowmeter pulse        | 0   | 6*  |      | 5       | 1953 | Digital input for pulse flow meter (P15.1 = 1)   |
| P4.20 | Total flow reset       | 0   | 6*  |      | 6       | 1957 | Digital input for flow counter reset   |
| P4.21 | Minimum water level    | 0   | 6*  |      | 0       | 1963 | Digital input for water level  |

Table 10. Digital inputs group.

|       |                     |   |    |  |   |      |  |
|-------|---------------------|---|----|--|---|------|--|
| P4.22 | Minimum level logic | 0 | 1  |  | 0 | 1965 | <p>Selections for minimum water level logic:<br/> 0 = water level is ok when digital input for Minimum water level is high<br/> 1 = water level is ok when digital input for Minimum water level is low</p> <p>The drive trips with F63 (Low water level) when water level is not ok. The fault is reset with autoreset logic of Underload (see P10.4 - 7) when level is restored. Min level signal/fault refers to level in a well from which water is taken.</p>             |
| P4.23 | Maximum water level | 0 | 6* |  | 0 | 1966 | Digital input for water level  |
| P4.24 | Maximum level logic | 0 | 1  |  | 0 | 1967 | <p>Selections for maximum water level logic:<br/> 0 = water level is ok when digital input for Maximum water level is high<br/> 1 = water level is ok when digital input for Maximum water level is low</p> <p>The drive trips with F64 (Max water level) when water level is not ok. The fault is reset with autoreset logic of Underload (see P10.4 - 7) when level is restored. Max level signal/fault refers to level in a possible tank where pumped water is stored.</p> |

Table 10. Digital inputs group.

|              |  |
|--------------|--|
| <b>NOTE!</b> | (*)The maximum value is higher when an optional board with digital inputs is installed. Parameter is automatically reset if value is greater than present limit. |
| <b>NOTE!</b> | Visibility of the group depends on P1.16.  |

## 3.3.5 GROUP DIGITAL OUTPUTS: MENU PAR G5

| Code  | Parameter                | Min  | Max    | Unit | Default | ID   | Description  |
|-------|--------------------------|------|--------|------|---------|------|--|
| P5.1  | Relay output 1 content   | 0    | 13     |      | 1       | 313  | Function selection for R01:<br>0 = Not used<br>1 = Ready<br>2 = Run<br>3 = General fault<br>4 = General fault inverted<br>5 = Warning<br>6 = Reversed<br>7 = At speed<br>8 = Output freq. supervision<br>9 = Output current superv.<br>10 = Analogue input superv.<br>11 = Fieldbus 1<br>12 = Fieldbus 2<br>13 = Fault/Warning |
| P5.2  | Relay output 2 content   | 0    | 13     |      | 2       | 314  | See P5.1   |
| P5.3  | Digital output content   | 0    | 13     |      | 3       | 312  | See P5.1   |
| P5.4  | Relay output 1 on delay  | 0.00 | 320.00 | s    | 0.00    | 458  | ON delay for relay   |
| P5.5  | Relay output 1 off delay | 0.00 | 320.00 | s    | 0.00    | 459  | OFF delay for relay  |
| P5.6  | Relay output 1 inversion | 0    | 1      |      | 0       | 1804 | 0 = no inversion<br>1 = inverted   |
| P5.7  | Relay output 2 on delay  | 0.00 | 320.00 | s    | 0.00    | 460  | See P5.4   |
| P5.8  | Relay output 2 off delay | 0.00 | 320.00 | s    | 0.00    | 461  | See P5.5   |
| P5.9  | Exp. E01 output content  | 0    | 13     |      | 0       | 1826 | Parameter visible when a I/O expansion board is installed. See P5.1 for selection  |
| P5.10 | Exp. E02 output content  | 0    | 13     |      | 0       | 1827 | See P5.9   |
| P5.11 | Exp. E03 output content  | 0    | 13     |      | 0       | 1828 | See P5.9   |
| P5.12 | Exp. E04 output content  | 0    | 13     |      | 0       | 1872 | See P5.9   |

Table 11. Digital outputs group.

|              |   |
|--------------|---|
| <b>NOTE!</b> | <p>Visibility of the group depends on P1.16.</p> <p>P5.9 is visible when OPTB2, OPTB5, OPTB9 or OPTBF is installed (first relay E01).</p> <p>P5.10 is visible when OPTB2 or OPTB5 is installed (second relay E02).</p> <p>P5.11 is visible when OPTB5 is installed (third relay E03).</p> <p>P5.12 is visible when OPTBF is installed (digital output E04).</p> |
|--------------|---|



## 3.3.6 GROUP ANALOGUE OUTPUTS: MENU PAR G6

| Code | Parameter                   | Min  | Max    | Unit | Default | ID  | Description  |
|------|-----------------------------|------|--------|------|---------|-----|--|
| P6.1 | Analogue output function    | 0    | 8      |      | 2       | 307 | 0 = Not used (fixed 100%)<br>1 = Freq. reference (0-fmax)<br>2 = Output freq. (0 -fmax)<br>3 = Motor speed (0 - Speed max)<br>4 = Output current (0-I <sub>nMotor</sub> )<br>5 = Motor torque (0-T <sub>nMotor</sub> )<br>6 = Motor power (0-P <sub>nMotor</sub> )<br>7 = PID output (0-100%)<br>8 = Fieldbus(0-10000) |
| P6.2 | Analogue output minimum     | 0    | 1      |      | 0       | 310 | 0 = 0V<br>1 = 2V   |
| P6.3 | Analogue output scale       | 0,0  | 1000,0 | %    | 100.0   | 311 | Scaling factor   |
| P6.4 | Analogue output filter time | 0.00 | 10.00  | s    | 0.10    | 308 | Filtering time of analogue output signal.<br>0 = No filtering  |

Table 12. Analogue outputs group.

3.3.7 GROUP SUPERVISIONS: MENU PAR G7

| Code  | Parameter                     | Min  | Max                | Unit | Default | ID   | Description   |
|-------|-------------------------------|------|--------------------|------|---------|------|---|
| P7.1  | Frequency supervision 1       | 0    | 2                  |      | 0       | 315  | 0 = not used<br>1 = Low limit<br>2 = High limit   |
| P7.2  | Frequency supervision value 1 | 0.00 | P1.2               | Hz   | 0.00    | 316  | Output frequency supervision threshold value  |
| P7.3  | Current supervision value     | 0.00 | 2 x I <sub>H</sub> | A    | 0.00    | 1811 | Current supervision threshold value   |
| P7.4  | AnalogIn Supv Signal          | 0    | 1                  |      | 0       | 356  | 0 = AI1<br>1 = AI2  |
| P7.5  | AnalogIn Supv ON level        | 0.00 | 100.00             | %    | 80.00   | 357  | ON threshold AI supervision   |
| P7.6  | AnalogIn Supv OFF level       | 0.00 | 100.00             | %    | 40.00   | 358  | OFF threshold AI supervision  |
| P7.10 | Process Source Select         | 0    | 5                  |      | 2       | 1036 | Selection of variable proportional to process:<br>0 = PID feedback value<br>1 = Output frequency<br>2 = Motor speed<br>3 = Motor torque<br>4 = Motor power<br>5 = Motor current |
| P7.11 | Process Val Decim Digits      | 0    | 3                  |      | 1       | 1035 | Decimals on process display variable  |
| P7.12 | Process Max Value             | 0.0  | 3276.7             |      | 100.0   | 1034 | Process display max value (it depends on P7.11: with zero decimal digit the max value is 32767; with 1 decimal digit the max value is 3276.7)                                   |

Table 13. Supervisions group.

|              |  |
|--------------|--|
| <b>NOTE!</b> | Visibility of the G6 and G7 groups depends on P1.16. |
|--------------|--|

## 3.3.8 GROUP MOTOR CONTROL: MENU PAR G8

| Code  | Parameter                                  | Min                  | Max                | Unit | Default        | ID   | Description   |
|-------|--|----------------------|--------------------|------|----------------|------|---|
| P8.1  | Motor control mode(*)                      | 0                    | 1                  |      | 0              | 600  | 0 = Frequency control<br>1 = Speed control  |
| P8.2  | Field Weakening Point                      | 30.00                | 320.00             | Hz   | 50.00          | 602  | Field weakening point frequency   |
| P8.3  | Voltage at Field Weakening Point           | 10.00                | 200.00             | %    | 100.00         | 603  | Voltage at FWP as % of Motor nominal voltage  |
| P8.4  | U/f ratio selection(*)                     | 0                    | 2                  |      | 0              | 108  | 0 = linear<br>1 = quadratic<br>2 = programmable   |
| P8.5  | U/f curve midpoint frequency(*)            | 0.00                 | P8.2               | Hz   | 50.00          | 604  | Midpoint frequency for programmable U/f curve   |
| P8.6  | U/f curve midpoint voltage(*)              | 0.00                 | P8.3               | %    | 100.00         | 605  | Midpoint voltage for programmable U/f curve   |
| P8.7  | Output voltage at zero frequency (*)       | 0.00                 | 40.00              | %    | 0.00           | 606  | Voltage at 0,00 Hz as % of Motor nominal voltage  |
| P8.8  | Switching frequency                        | 1.5                  | 16.0               | kHz  | 6.0            | 601  | Switching frequency of the IGBTs  |
| P8.11 | DC braking current                         | 0.3 x I <sub>H</sub> | 2 x I <sub>H</sub> | A    | I <sub>H</sub> | 507  | Defines the current injected into the motor during DC-braking.<br>0 = Disabled                      |
| P8.12 | DC braking time at stop                    | 0.00                 | 600.00             | s    | 0.00           | 508  | Determines if braking is ON or OFF and the braking time of the DC-brake when the motor is stopping. |
| P8.13 | Frequency to start DC braking at ramp stop | 0.10                 | 10.00              | Hz   | 1.50           | 515  | The output frequency at which the DC-braking is applied.  |
| P8.14 | DC braking time at start                   | 0.00                 | 600.00             | s    | 0.00           | 516  | This parameter defines the time for how long DC current is fed to motor before acceleration starts. |
| P8.15 | Motor stator voltage drop(*)               | 0.00                 | 100.00             | %    | 0.00           | 662  | Voltage drop on the motor windings as % of Motor nominal voltage                                    |
| P8.16 | Motor Identification                       | 0                    | 1                  |      | 0              | 631  | 0 = not active<br>1 = standstill identification (to activate, RUN command within 20s)               |
| P8.17 | Motor Type                                 | 0                    | 1                  |      | 0              | 650  | 0 = Induction motor<br>1 = Permanent magnet motor   |
| P8.18 | Disable undervoltage regulator             | 0                    | 1                  |      | 0              | 1854 | 0 = Enabled<br>1 = Disabled   |
| P8.19 | Disable switching freq regulator           | 0                    | 1                  |      | 0              | 1855 | 0 = Enabled<br>1 = Disabled   |
| P8.20 | Output Sine Filter                         | 0                    | 1                  |      | 0              | 1968 | 0 = not present<br>1 = present  |

Table 14. Motor control group.

**NOTE!**

(\*) Parameter is automatically set by motor identification.

|              |   |
|--------------|---|
| <b>NOTE!</b> | Visibility of the group depends on P1.16. |
|--------------|---|

### 3.3.9 GROUP PROTECTIONS: MENU PAR G9

|              |   |
|--------------|---|
| <b>NOTE!</b> | Visibility of the group depends on P1.16. |
|--------------|---|



#### Parameters of Motor thermal protection (P9.11 to P9.14 and P9.21-P9.22)

The motor thermal protection is to protect the motor from overheating. The drive is capable of supplying higher than nominal current to the motor. If the load requires this high current there is a risk that the motor will be thermally overloaded. This is the case especially at low frequencies. At low frequencies the cooling effect of the motor is reduced as well as its capacity. If the motor is equipped with an external fan the load reduction at low speeds is small.

The motor thermal protection is based on a calculated model and it uses the output current of the drive to determine the load on the motor.


The motor thermal protection can be adjusted with parameters. The thermal current  $I_T$  specifies the load current above which the motor is overloaded. This current limit is a function of the output frequency.

The thermal stage of the motor can be monitored on the control keypad display. See chapter 2.

|   |  |
|---|--|
|  | <p>If you use long motor cables (max. 100m) together with small drives (<math>\leq 1.5</math> kW) the motor current measured by the drive can be much higher than the actual motor current due to capacitive currents in the motor cable.</p> <p>Consider this when setting up the motor thermal protection functions.</p> |
|  | <p>The calculated model does not protect the motor if the airflow to the motor is reduced by blocked air intake grill. The model starts from zero if the control board is powered off.</p>   |

#### Parameters of Stall protection (P9.4 to P9.6)

The motor stall protection protects the motor from short time overload situations such as one caused by a stalled shaft. The reaction time of the stall protection can be set shorter than that of motor thermal protection. The stall state is defined with two parameters, P9.5 (*Stall time*) and P9.6 (*Stall frequency limit*). If the current is as high as the P1.5 (Current Limit) and the current limiter has reduced the output frequency below the P9.6 for the time P9.5 than the set limit the stall state is true. There is actually no real indication of the shaft rotation. Stall protection is a type of overcurrent protection.


|   |  |
|---|--|
|  | <p>If you use long motor cables (max. 100m) together with small drives (<math>\leq 1.5</math> kW) the motor current measured by the drive can be much higher than the actual motor current due to capacitive currents in the motor cable.</p> <p>Consider this when setting up the motor thermal protection functions.</p> |
|---|--|

**Parameters of Underload protection (P9.7 to P9.10)**

The purpose of the motor underload protection is to ensure that there is load on the motor when the drive is running. If the motor loses its load there might be a problem in the process, e.g. a broken belt or a dry pump.

Motor underload protection can be adjusted by setting the underload curve with parameters P9.8 (Underload protection: Field weakening area load) and P9.9 (*Underload protection: Zero frequency load*), see below. The underload curve is a squared curve set between the zero frequency and the field weakening point. The protection is not active below 5Hz (the underload time counter is stopped).

The torque values for setting the underload curve are set in percentage which refers to the nominal torque of the motor. The motor's name plate data, parameter motor nominal current and the drive's nominal current  $I_L$  are used to find the scaling ratio for the internal torque value. If other than nominal motor is used with the drive, the accuracy of the torque calculation decreases.

|   |  |
|---|--|
|  | <p>If you use long motor cables (max. 100m) together with small drives (<math>\leq 1.5</math> kW) the motor current measured by the drive can be much higher than the actual motor current due to capacitive currents in the motor cable.</p> <p>Consider this when setting up the motor thermal protection functions.</p> |
|---|--|

| Code | Parameter                               | Min  | Max    | Unit | Default | ID   | Description   |
|------|---|------|--------|------|---------|------|---|
| P9.1 | Response to 4mA reference fault (< 4mA) | 0    | 4      |      | 1       | 700  | 0 = No action<br>1 = Warning<br>2 = Fault<br>3 = Warning if Start active<br>4 = Fault if Start active   |
| P9.2 | 4mA fault detection time                | 0.0  | 10.0   | s    | 0.5     | 1430 | Time limit  |
| P9.3 | Earth fault protection                  | 0    | 2      |      | 2       | 703  | 0 = No action<br>1 = Warning<br>2 = Fault   |
| P9.4 | Motor stall protection                  | 0    | 2      |      | 1       | 709  | See P9.3  |
| P9.5 | Motor stall delay                       | 0.0  | 300.0  | s    | 5.0     | 711  | This is the maximum time allowed for a stall stage.   |
| P9.6 | Motor stall min freq.                   | 0.10 | 320.00 | Hz   | 15.00   | 712  | For a stall state to occur, the output frequency must have remained below this limit for a certain time.  |
| P9.7 | Underload protection                    | 0    | 2      |      | 2       | 713  | See P9.3 for the fault response.<br>See P9.23 for the underload mode. When P9.23 = 0, Underload is determined by P9.8 - P9.10. When P9.23 = 1, the fault is related to P9.24. |
| P9.8 | Underload load curve at nominal freq.   | 10.0 | 150.0  | %    | 90.0    | 714  | This parameter gives the value for the minimum torque allowed when the output frequency is above the field weakening point.   |

Table 15. Protections group.

|       |                                    |     |       |            |      |      |   |
|-------|------------------------------------|-----|-------|------------|------|------|---|
| P9.9  | Underload load curve at min freq.  | 0.0 | 150.0 | %          | 0.0  | 715  | This parameter gives value for the minimum torque allowed with zero frequency.  |
| P9.10 | Underload time                     | 1   | 300   | m          | 20   | 716  | This is the maximum time allowed for an underload state to exist.   |
| P9.11 | Thermal protection of the motor    | 0   | 2     |            | 2    | 704  | See P9.3  |
| P9.12 | Motor ambient temperature          | -20 | 100   | °C         | 40   | 705  | Ambient temperature in °C   |
| P9.13 | Motor cooling factor at zero speed | 0.0 | 150.0 | %          | 40.0 | 706  | Defines the cooling factor at zero speed in relation to the point where the motor is running at nominal speed without external cooling. |
| P9.14 | Motor thermal time constant        | 1   | 200   | min        | 45   | 707  | The time constant is the time within which the calculated thermal stage has reached 63% of its final value.                             |
| P9.15 | Response to fieldbus fault         | 0   | 2     |            | 2    | 733  | See P9.3  |
| P9.17 | Parameter lock                     | 0   | 1     |            | 0    | 1805 | Lock parameter editing.<br>0 = Edit enabled<br>1 = Edit disabled  |
| P9.18 | Response to STO disable            | 0   | 3     |            | 1    | 1876 | 0 = No action<br>1 = Warning<br>2 = Fault, not stored in history menu<br>3 = Fault, stored in history menu                              |
| P9.19 | Response to input phase fault      | 0   | 2     |            | 0    | 1877 | See P9.3  |
| P9.20 | Input phase fault max ripple       | 0   | 75    |            | 0    | 1893 | Sensitivity of input phase fault detector.<br>0 = internal value<br>1 = max sensitivity -><br>75 = min sensitivity                      |
| P9.21 | Motor temp initial mode            | 0   | 2     |            | 0    | 1891 | 0 = start from minimum<br>1 = start from constant value<br>2 = start from last value  |
| P9.22 | Motor temp initial value           | 0   | 100   | %          | 33   | 1892 | Initial value(P9.21 = 1) or factor for last previous value(P9.21 = 2)   |
| P9.23 | UnderloadDetectMode                | 0   | 1     |            | 0    | 1950 | 0 = Motor Torque<br>1 = Flowmeter (transducer defined by P15.1)   |
| P9.24 | Minimum Flow                       | 1   | 65500 | litres/min | 300  | 1951 | Value to determine underload fault if P9.23 is 1  |

Table 15. Protections group.

## 3.3.10 GROUP AUTORESET: MENU PAR G10

| Code  | Parameter              | Min  | Max    | Unit | Default | ID   | Description   |
|-------|------------------------|------|--------|------|---------|------|---|
| P10.1 | Automatic fault reset  | 0    | 1      |      | 0       | 731  | 0 = Disabled<br>1 = Enabled                               |
| P10.2 | Wait time              | 0.10 | 10.0   | m    | 1.0     | 717  | Wait time before the first reset is executed.             |
| P10.3 | Automatic reset tries  | 1    | 10     |      | 5       | 759  | NOTE: Total number of trials (irrespective of fault type) |
| P10.4 | Underload reset Time 1 | 0.1  | 1200.0 | m    | 2.0     | 1927 |   |
| P10.5 | Underload reset Time 2 | 0.1  | 1200.0 | m    | 30.0    | 1928 |   |
| P10.6 | Underload reset Time 3 | 0.1  | 1200.0 | m    | 300.0   | 1929 |   |
| P10.7 | Underload Tries T1,T2  | 1    | 10     |      | 2       | 1930 |   |

Table 16. Autoreset group.

|              |   |
|--------------|---|
| <b>NOTE!</b> | Visibility of the group depends on P1.16. |
|--------------|---|



## 3.3.11 GROUP FIELDBUS: MENU PAR G11

| Code   | Parameter                      | Min | Max | Unit | Default | ID   | Description   |
|--------|--------------------------------|-----|-----|------|---------|------|---|
| P11.1  | FB DataOut 1 Sel               | 0   | 17  |      | 0       | 852  | Variable mapped on PD1:<br>0 = Output frequency<br>1 = Motor speed<br>2 = Motor current<br>3 = Motor voltage<br>4 = Motor torque<br>5 = Motor power<br>6 = DC-link voltage<br>7 = Active fault code<br>8 = Analogue AI1<br>9 = Analogue AI2<br>10 = Digital inputs state<br>11 = PID feedback value<br>12 = PID setpoint<br>13 = Power kW<br>14 = Energy<br>15 = Flow<br>16 = Volume 1<br>17 = Volume 2 |
| P11.2  | FB DataOut 2 Sel               | 0   | 17  |      | 1       | 853  | Variable mapped on PD2. See P11.1   |
| P11.3  | FB DataOut 3 Sel               | 0   | 17  |      | 2       | 854  | Variable mapped on PD3. See P11.1   |
| P11.4  | FB DataOut 4 Sel               | 0   | 17  |      | 3       | 855  | Variable mapped on PD4. See P11.1   |
| P11.5  | FB DataOut 5 Sel               | 0   | 17  |      | 4       | 856  | Variable mapped on PD5. See P11.1   |
| P11.6  | FB DataOut 6 Sel               | 0   | 17  |      | 5       | 857  | Variable mapped on PD6. See P11.1   |
| P11.7  | FB DataOut 7 Sel               | 0   | 17  |      | 6       | 858  | Variable mapped on PD7. See P11.1   |
| P11.8  | FB DataOut 8 Sel               | 0   | 17  |      | 7       | 859  | Variable mapped on PD8. See P11.1   |
| P11.9  | FB Aux CW selection            | 0   | 5   |      | 0       | 1821 | PDI for Aux CW<br>0 = Not used<br>1 = PDI1<br>2 = PDI2<br>3 = PDI3<br>4 = PDI4<br>5 = PDI5  |
| P11.10 | FB PID setpoint selection      | 0   | 5   |      | 1       | 1822 | PDI for PID Setpoint<br>See P11.9   |
| P11.11 | FB PID actual selection        | 0   | 5   |      | 2       | 1823 | PDI for PID Feedback<br>See P11.9   |
| P11.12 | FB AnalogueOut cntrl selection | 0   | 5   |      | 3       | 1824 | PDI for Analogue Out CTRL<br>See P11.9  |

Table 17. Fieldbus group.

|              |   |
|--------------|---|
| <b>NOTE!</b> | Visibility of the group depends on P1.16. |
|--------------|---|

3.3.12 GROUP PID CONTROL: MENU PAR G12

| Code   | Parameter                 | Min  | Max    | Unit | Default | ID   | Description  |
|--------|---------------------------|------|--------|------|---------|------|--|
| P12.1  | Setpoint source           | 0    | 3      |      | 0       | 332  | 0 = PID setpoint 1/2<br>1 = AI1<br>2 = AI2<br>3 = Fieldbus   |
| P12.2  | PID setpoint 1            | 0.0  | 100.0  | %    | 50.0    | 167  | Fixed setpoint 1   |
| P12.3  | PID setpoint 2            | 0.0  | 100.0  | %    | 50.0    | 168  | Fixed setpoint 2   |
| P12.4  | Feedback source           | 0    | 3      |      | 0       | 334  | 0 = AI2<br>1 = AI1<br>2 = Fieldbus<br>3 = AI1- AI2   |
| P12.5  | Feedback minimum          | 0.0  | 50.0   | %    | 0.0     | 336  | Value at minimum signal  |
| P12.6  | Feedback maximum          | 10.0 | 300.0  | %    | 100.0   | 337  | Value at maximum signal  |
| P12.7  | PID controller P gain     | 0.0  | 1000.0 | %    | 100.0   | 118  | If the value of the parameter is set to 100% a change of 10% in the error value causes the controller output to change by 10%.             |
| P12.8  | PID controller I-time     | 0.00 | 320.00 | s    | 10.00   | 119  | If this parameter is set to 1,00 second a change of 10% in the error value causes the controller output to change by 10.00%/s.             |
| P12.9  | PID controller D-time     | 0.00 | 10.00  | s    | 0.00    | 132  | If this parameter is set to 1,00 second a change of 10% in the error value during 1.00 s causes the controller output to change by 10.00%. |
| P12.10 | Error value inversion     | 0    | 1      |      | 0       | 340  | 0 = Normal (Feedback < Setpoint -> Increase PID output)<br>1 = Inverted (Feedback < Setpoint -> Decrease PID output)                       |
| P12.11 | PID error limit           | 0.0  | 100.0  | %    | 100.0   | 1812 | Limit on error   |
| P12.12 | Sleep frequency           | 0.00 | 200.0  | Hz   | 0.00    | 1016 | Drive goes to sleep mode when the output frequency stays below this limit for a time greater than that defined by parameter P12.13.        |
| P12.13 | Sleep time delay          | 0    | 3600   | s    | 30      | 1017 | The minimum amount of time the frequency has to remain below the Sleep level before the drive is stopped.                                  |
| P12.14 | Wake-up limit             | 0.0  | 100.0  | %    | 5.0     | 1018 | Defines the level for the PID feedback value wake-up.  |
| P12.15 | Feedback Superv. Response | 0    | 2      |      | 2       | 1894 | Response to feedback supervision:<br>0 = No action<br>1 = Alarm<br>2 = Fault   |
| P12.16 | Min feedback level        | 0.0  | 100.0  | %    | 50.0    | 1895 | Min variation between setpoint and feedback to activate the Feedback Superv. Response  |
| P12.17 | Min feedback time         | 1    | 300    | s    | 8       | 1896 | To activate Feedback Superv. Response, the variation between setpoint and feedback must have remained below P12.16 for this time.          |

Table 18. PID control group.

|        |                    |       |       |   |       |      |   |
|--------|--------------------|-------|-------|---|-------|------|---|
| P12.18 | Max feedback level | 100.0 | 300.0 | % | 150.0 | 1897 | Max variation between setpoint and feedback to activate the Feedback Superv. Response   |
| P12.19 | Max feedback time  | 1     | 300   | s | 8     | 1898 | To activate Feedback Superv. Response, the variation between setpoint and feedback must have remained above P12.18 for this time. |

*Table 18. PID control group.*

|              |  |
|--------------|--|
| <b>NOTE!</b> | This group is hidden when PID output is not used as frequency reference. |
|--------------|--|

3.3.13 GROUP SOLAR: MENU PAR G14

| Code                  | Parameter                 | Min   | Max    | Unit | Default | ID   | Description   |
|-----------------------|---------------------------|-------|--------|------|---------|------|---|
| <b>Start Settings</b> |                           |       |        |      |         |      |   |
| P14.1                 | Start DC Voltage          | 400   | 800    | V    | 650     | 1916 | DV voltage threshold level to activate Run enable   |
| P14.2                 | Short restart delay       | 0.1   | 5.0    | m    | 1.0     | 1917 | Delay time to restart   |
| P14.3                 | Short restart delay tries | 1     | 10     |      | 5       | 1918 | Number of restart tries   |
| P14.4                 | Long restart delay        | 6.0   | 30.0   | m    | 10.0    | 1919 | Long delay time to restart  |
| <b>MPPT</b>           |                           |       |        |      |         |      |   |
| P14.5                 | Vmp at 100% power         | 400   | 800    | V    | 600     | 1920 |   |
| P14.6                 | Vmp at 10% power          | 400   | 700    | V    | 540     | 1921 |   |
| P14.7                 | Panel/Motor ratio         | 50.00 | 100.00 | %    | 100.00  | 1922 |   |
| P14.8                 | P gain                    | 0.000 | 1.000  |      | 0.050   | 1923 | Gain for internal PI regulator. The internal frequency reference keeps the panels working on MPP. |
| P14.9                 | I gain                    | 0.000 | 1.000  |      | 0.050   | 1924 | Integration time.   |
| P14.10                | Acceleration time         | 0.1   | 60.0   | s    | 1.0     | 1925 | Time from minimum to maximum frequency  |
| P14.11                | Deceleration time         | 0.1   | 60.0   | s    | 1.0     | 1926 | Time from maximum to minimum frequency  |
| P14.12                | P&O update time           | 2     | 6      | s    | 3       | 1939 |   |
| P14.13                | P&O voltage step          | 3     | 10     | V    | 5       | 1940 |   |
| P14.14                | P&O power variation       | 0.2   | 5.0    | %    | 1.0     | 1941 |   |
| P14.15                | P&O local max step        | 0     | 60     | V    | 30      | 1945 |   |
| P14.16                | P&O local max time        | 1     | 60     | m    | 10      | 1946 |   |
| P14.17                | P&O local max freq        | 0.00  | 20.00  | Hz   | 10.00   | 1947 |   |
| P14.18                | Damping sensitivity       | 5     | 50     | V    | 10      | 1943 | Amplitude of oscillation to be recognized   |
| P14.19                | Damping time              | 3     | 10     | s    | 4       | 1944 | Time for the oscillations on DC voltage   |
| P14.20                | Sleep in solar mode       | 0     | 1      |      | 0       | 1964 | 0 = Sleep disabled<br>1 = Sleep according to P12.12 and P12.13                                    |

Table 19. Solar group.

|              |   |
|--------------|---|
| <b>NOTE!</b> | Visibility of the group depends on P1.16.   |
| <b>NOTE!</b> | Sleep in solar mode can be managed according to P12.12 and P12.13<br>When P14.20 =1, the drive will stop if the output frequency is below the value in P12.12, for the time in P12.13. It will restart as after a stop due to low power.<br>Sleep function allows to program a minimum frequency P1.1 that is below the efficient range of the pump. MPPT can reach this low value, leading to a minimum output power and avoiding to stop the drive in case of temporary reduced irradiation. If the condition persists, sleep logic will then stop the drive. |

## 3.3.14 GROUP FLOW METER: MENU PAR G15

| Code  | Parameter               | Min | Max   | Unit             | Default | ID   | Description  |
|-------|-------------------------|-----|-------|------------------|---------|------|--|
| P15.1 | Flowmeter signal        | 0   | 3     |                  | 0       | 1958 | Selections:<br>0 = not used<br>1 = Digital pulse<br>2 = AI1<br>3 = AI2   |
| P15.2 | Flow at max anlg signal | 0   | 65500 | litres/<br>min   | 1000    | 1960 | Considered when flow meter signal is from analogue signal (AI1 or AI2). It is the flow level at maximum analogue signal. |
| P14.3 | Pulse output volume     | 0   | 10000 | litres/<br>pulse | 100     | 1954 | Considered when flow meter signal is from digital input. It is the total volume of water for each pulse.                 |

Table 20. Flow meter parameters.

3.4 SYSTEM PARAMETERS, FAULTS AND HISTORY FAULTS: MENU FLT

| Code  | Parameter                  | Min | Max | Unit | Default | ID   | Description  |
|---|----------------------------|-----|-----|------|---------|------|--|
| V1.1  | API system SW ID           |     |     |      |         | 2314 |  |
| V1.2  | API system SW version      |     |     |      |         | 835  |  |
| V1.3  | Power SW ID                |     |     |      |         | 2315 |  |
| V1.4  | Power SW version           |     |     |      |         | 834  |  |
| V1.5  | Application ID             |     |     |      |         | 837  |  |
| V1.6  | Application Ver.           |     |     |      |         | 838  |  |
| V1.7  | System load                |     |     |      |         | 839  |  |
| <b>When no fieldbus board has been installed, the following values are visible:</b> |                            |     |     |      |         |      |  |
| V2.1  | Communication status       |     |     |      |         | 808  | Status of Modbus communication.<br>Format: xx.yyy<br>where xx = 0 - 64 (Number of error messages) yyy = 0 - 999 (Number of good messages)  |
| V2.9  | Last communication fault   |     |     |      |         | 816  | The fault code related to the last counted bad messages is shown:<br>1 = Illegal function<br>2 = Illegal address<br>3 = Illegal data value<br>4 = Illegal slave device<br>53 = USART receive fault (parity error/ frame error/ USART buffer overflow)<br>90 = Receive buffer overflow<br>100 = Frame CRC Error<br>101 = Ring buffer overflow |
| P2.2  | FB Protocol Status         | 0   | 1   |      | 0       | 809  | 0 = Not used<br>1 = Modbus used  |
| P2.3  | Slave address              | 1   | 255 |      | 1       | 810  |  |
| P2.4  | Baud rate                  | 0   | 8   |      | 5       | 811  | 0 = 300<br>1 = 600<br>2 = 1200<br>3 = 2400<br>4 = 4800<br>5 = 9600<br>6 = 19200<br>7 = 38400<br>8 = 57800  |
| P2.6  | Parity type                | 0   | 2   |      | 0       | 813  | Parity type:<br>0 = None<br>1 = Even<br>2 = Odd<br>Stop bit:<br>- 2-bits with parity type "None";<br>- 1-bit with parity type "Even" and "Odd".  |
| P2.7  | Communication time out     | 0   | 255 | s    | 0       | 814  |  |
| P2.8  | Reset communication status | 0   | 1   |      | 0       | 815  |  |

Table 21. System parameters, Faults and History faults.

| When OPTE6 (CANopen) option board has been installed, the following values are visible:    |                                    |    |     |  |     |       |   |
|--|------------------------------------|----|-----|--|-----|-------|---|
| V2.1   | CANopen communication status       |    |     |  |     | 14004 |   |
| P2.2   | CANopen operation mode             | 1  | 2   |  | 1   | 14003 |   |
| P2.3   | CANopen Node ID                    | 1  | 127 |  | 1   | 14001 |   |
| P2.4   | CANopen baud rate                  | 1  | 8   |  | 6   | 14002 |   |
| When OPTE7 (DeviceNet) option board has been installed, the following values are visible:  |                                    |    |     |  |     |       |   |
| V2.1   | DeviceNet communication status     |    |     |  |     | 14014 |   |
| P2.2   | Output assembly type               | 20 | 111 |  | 21  | 14012 |   |
| P2.3   | MAC ID                             | 0  | 63  |  | 63  | 14010 |   |
| P2.4   | Baud Rate                          | 1  | 3   |  | 1   | 14011 |   |
| P2.5   | Input assembly type                | 70 | 117 |  | 71  | 14013 |   |
| When OPTE3/E5(Profibus) option board has been installed, the following values are visible: |                                    |    |     |  |     |       |   |
| V2.1   | Profibus communication status      |    |     |  |     | 14022 |   |
| P2.2   | Fieldbus protocol                  |    |     |  |     | 14023 |   |
| P2.3   | Active protocol                    |    |     |  |     | 14024 |   |
| P2.4   | Active baud rate                   |    |     |  |     | 14025 |   |
| P2.5   | Telegram type                      |    |     |  |     | 14027 |   |
| P2.6   | Operate mode                       | 1  | 3   |  | 1   | 14021 |   |
| P2.7   | Slave address                      | 2  | 126 |  | 126 | 14020 |   |
| When OPTEC (EtherCAT) option board has been installed, the following values are visible:   |                                    |    |     |  |     |       |   |
| V2.1   | Version number                     |    |     |  | 0   |       | Version number of the board software  |
| V2.2   | Board status                       |    |     |  | 0   |       | Status of OPTEC board   |
| When OPTC4 (LonWorks) option board has been installed, the following values are visible:   |                                    |    |     |  |     |       |   |
| P2.1   | Service PIN                        | 0  |     |  | 0   | 14217 | Broadcasts a service pin message to the network.  |
| When OPTBH option board has been installed, the following values are visible:              |                                    |    |     |  |     |       |   |
| P2.1   | Sensor 1 type                      | 0  | 6   |  | 0   | 14072 | 0 = No Sensor<br>1 = PT100<br>2 = PT1000<br>3 = Ni1000<br>4 = KTY84<br>5 = 2 x PT100<br>6 = 3 x PT100 |
| P2.2   | Sensor 2 type                      | 0  | 6   |  | 0   | 14073 | See P2.1  |
| P2.3   | Sensor 3 type                      | 0  | 6   |  | 0   | 14073 | See P2.1  |
| Other information:   |                                    |    |     |  |     |       |   |
| V3.1   | MWh counter                        |    |     |  |     | 827   |   |
| V3.2   | Power on day counter               |    |     |  |     | 828   |   |
| V3.3   | Power on hour counter              |    |     |  |     | 829   |   |
| V3.4   | RUN day counter                    |    |     |  |     | 840   |   |
| V3.5   | RUN hour counter                   |    |     |  |     | 841   |   |
| V3.6   | Fault counter                      |    |     |  |     | 842   |   |
| V3.7   | Panel parameter set status monitor |    |     |  |     |       | Hidden when PC is connected   |

Table 21. System parameters, Faults and History faults.

|      |                                 |   |      |     |          |     |   |
|------|---------------------------------|---|------|-----|----------|-----|---|
| P4.2 | Restore factory defaults        | 0 | 1    |     | 0        | 831 | 1 = Restore factory defaults for all parameters   |
| P4.3 | Password                        | 0 | 9999 |     | 000<br>0 | 832 |   |
| P4.4 | Time for keypad backlight       | 0 | 99   | min | 5        | 833 |   |
| P4.5 | Save parameters to Keypad       | 0 | 1    |     | 0        |     | 1= Upload all parameters to Keypad<br>Hidden when PC is connected. This function works properly only with drive supplied.   |
| P4.6 | Download parameters from Keypad | 0 | 1    |     | 0        |     | 1= Download all parameters to Keypad<br>Hidden when PC is connected. This function works properly only with drive supplied. |
| F5.x | Active fault menu               | 0 | 9    |     |          |     | Hidden when PC is connected   |
| F6.x | Fault history menu              | 0 | 9    |     |          |     | Hidden when PC is connected   |

Table 21. System parameters, Faults and History faults.



## 4. PARAMETER DESCRIPTION

Due to its user-friendliness and simplicity of use, the most parameters only require a basic description which is given in the parameter tables in chapter 2.2. In this chapter, you will find additional information on certain more advanced parameters. Should you not find the information you need contact your distributor.

### 4.1 BASIC PARAMETERS

#### **P1.1** *MIN FREQUENCY*

Minimum frequency reference.

**NOTE:** When drive is fed by solar power, if available power is not sufficient to maintain dc voltage above the minimum and frequency above the minimum, the drive will be stopped.

**NOTE:** if motor current limit is reached, actual output frequency might be lower than this parameter. If this is not acceptable, stall protection should be activated.

#### **P1.2** *MAX FREQUENCY*

Maximum frequency reference.

#### **P1.3** *ACCELERATION TIME*

Ramp time, referred to variation from zero frequency to max frequency.

A specific acceleration time from zero to minimum frequency is available (P2.9).

Normal acceleration time (P1.3) is active only in case power is from mains supply.

#### **P1.4** *DECELERATION TIME*

Ramp time, referred to variation from max frequency to zero.

Normal deceleration time (P1.4) is active in mains supply and in case the external frequency reference is lowered below the reference of maximum power. It is also active when start command falls and ramping stop is programmed (stop mode is anyway by coasting, when the output frequency is below minimum).

Specific acceleration and deceleration time are used during power regulation. They are available as parameters in MPPT group, but it is suggested not to change them, unless needed because of stability issues.

#### **P1.5** *CURRENT LIMIT*

This parameter determines the maximum motor current from the AC drive. The parameter value range differs from size to size. When the current limit is active the drive output frequency is decreased.

**NOTE:** This is not an overcurrent trip limit.

#### **P1.11** *CONTROL PLACE*

Run and direction control. A second control place is programmable in P2.14.

0: I/O terminals

1: Keypad

2: Fieldbus

**P1.12            FREQUENCY REFERENCE SOURCE**

Defines the source of frequency reference. A second reference source is programmable in P2.15.

- 0: Analogue input AI1
- 1: Analogue input AI2
- 2: PID reference
- 3: Not used
- 4: Keypad
- 5: Fieldbus
- 6: AI1 + AI2
- 7: Max Frequency

External frequency reference is available with the usual logics.

When the drive is fed from solar panels, the external reference is used as the upper limit of the algorithm searching for maximum power. A low external reference can therefore limit the power below the maximum available.

**Note!** the drive will not reach the external reference, if the power from panels is not sufficient.

**P1.13            START FUNCTION**

- 0: Ramping
- 1: Flying start

**P1.14            STOP FUNCTION**

| Selection number | Selection name         | Description   |
|------------------|------------------------|---|
| 0                | Coasting               | The motor is allowed to stop on its own inertia. The control by the drive is discontinued and the drive current drops to zero as soon as the stop command is given. |
| 1                | Ramp to min frequency  | After the Stop command, the speed of the motor is decelerated to minimum frequency according to the set deceleration parameters.                                    |
| 2                | Ramp to zero frequency | After the Stop command, the speed of the motor is decelerated to zero frequency according to the set deceleration parameters.                                       |

**NOTE:** fall of Enable signal, when configured, always determines stop by coasting.

**P1.15            TORQUE BOOST**

- 0: Not used
- 1: Automatic voltage boost (improves motor torque).

**P1.16            SHOW PARAMETERS**

- 0: Only Basic group (and PI Control if function is used)
- 1: All parameters groups are visible.

**P1.17**      **ENERGY COUNTER RESET**

Value 1 resets energy counter.

**P1.18**      **VOLUME COUNTERS RESET**

Value 1 resets volume counters.

## 4.2 ADVANCED SETTINGS

### P2.1 START/STOP LOGIC

These logics are based on Start sign 1 and Start sign 2 signals (defined with P4.1 and P4.2). Usually they are coupled to inputs DIN1 and DIN2.

Values 0...3 offer possibilities to control the starting and stopping of the AC drive with digital signal connected to digital inputs.

| Selection number | Selection name  | Note  |
|------------------|---|---|
| 0                | Start sign 1: Start Forward<br>Start sign 2: Start Backward | The function takes place when one contact is closed. If the other contact is closed while the first is still closed, the drive will stop and issue alarm A55  |
| 1                | Start sign 1: Start Forward<br>Start sign 2: Reverse        | The function takes place when the contacts are closed.  |
| 2                | Double Start  | Run command is set when both Start 1 and Start 2 signals are high. It is reset when both the start signals are low.<br>This can be used for a simple tank level control with hysteresis: if the tank has to be filled, two NC contact sensors will be placed at minimum and maximum levels. The drive will start below the minimum and stop above the maximum.<br>If the tank has to be emptied, two NO contact sensors have to be used. The drive will start above the maximum and stop below the minimum. |
| 3                | Start sign 1 + Analogue                                     | Run command is set when Start 1 signal is high and a selectable analogue input is below (or above) a programmable threshold.<br>This can be used for a tank level control, where the analogue measurement is used for both starting the pump and controlling the speed.   |
| 4                | Solar only  | Run command is always active. Actual running condition is determined by DC voltage level available from the solar array.  |

The used stop mode is *Coasting* in all examples. See mode 0 and 1 examples in the following pages.

| Selection number | Selection name  | Note   |
|------------------|---|--|
| 0                | Start sign 1: Start Forward<br>Start sign 2: Start Backward | The function takes place when the contacts are closed. |

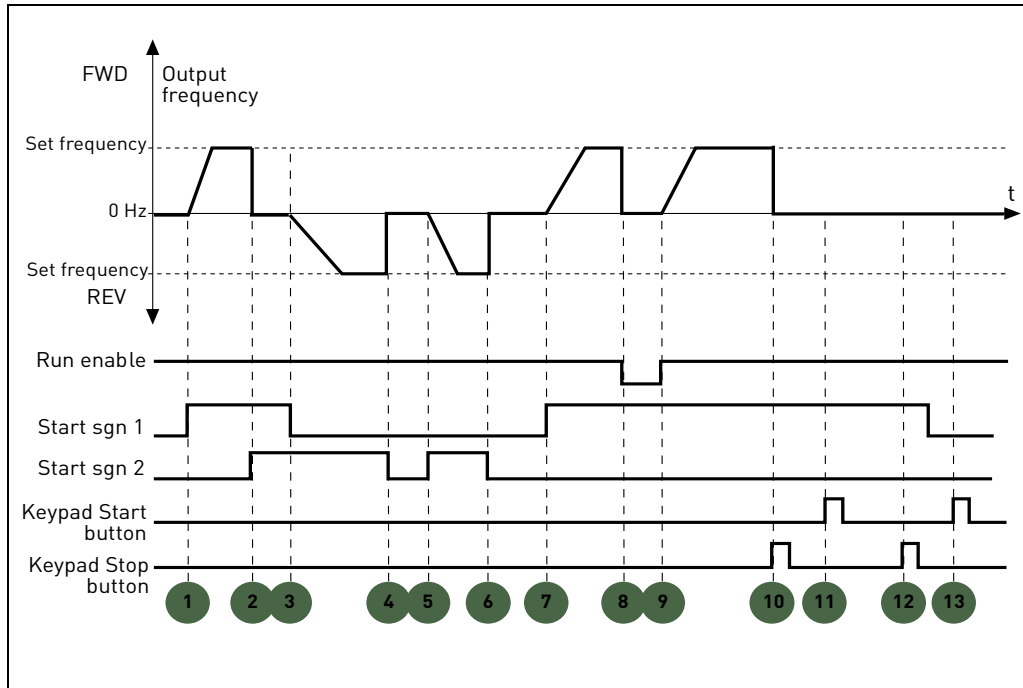


Figure 5. Start/Stop logic = 0.

**Explanations:**

|   |   |    |   |
|---|---|----|---|
| 1 | Start sign 1 activates causing the output frequency to rise. The motor runs forward.  | 8  | Run enable signal is set to FALSE, which drops the frequency to 0. The run enable signal is configured with parameter P4.7.           |
| 2 | Start sign 2 activates causing the motor drops to 0. Warning 55 appears on the keypad.                                      | 9  | Run enable signal is set to TRUE, which causes the frequency to rise towards the set frequency because Start sign 1 is still active.  |
| 3 | Start sign 1 is inactivated which causes the direction to start changing (FWD to REV) because Start sign 2 is still active. | 10 | Keypad stop button is pressed and the frequency fed to the motor drops to 0. (This signal only works if P2.22 Keypad stop button = 1) |
| 4 | Start sign 2 inactivates and the frequency fed to the motor drops to 0.   | 11 | Pushing the Start button on the keypad has no effect on the drive status.   |
| 5 | Start sign 2 activates again causing the motor to accelerate (REV) towards the set frequency.                               | 12 | The keypad stop button is pushed again to stop the drive.   |
| 6 | Start sign 2 inactivates and the frequency fed to the motor drops to 0.   | 13 | The attempt to start the drive through pushing the Start button is not successful even if Start sign 1 is inactive.                   |
| 7 | Start sign 1 activates and the motor accelerates (FWD) towards the set frequency  |    |   |

| Selection number | Selection name                                       | Note   |
|------------------|--|--|
| 1                | Start sign 1: Start Forward<br>Start sign 2: Reverse | The function takes place when the contacts are closed. |

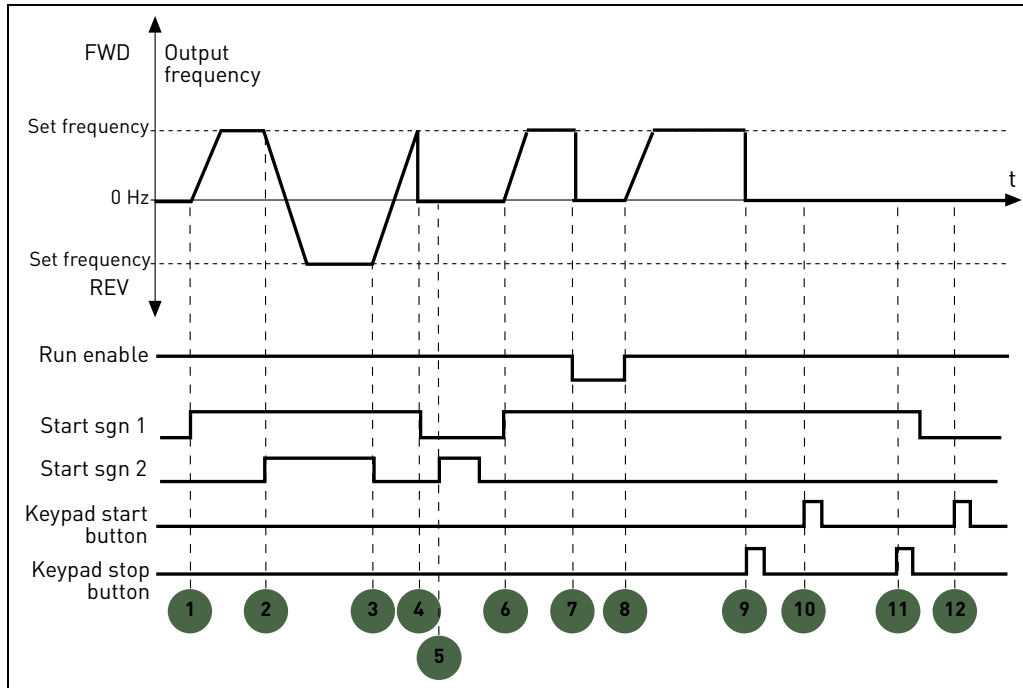


Figure 6. Start/Stop logic = 1.

**Explanations:**

|   |   |    |   |
|---|---|----|---|
| 1 | Start sign 1 activates causing the output frequency to rise. The motor runs forward.  | 7  | Run enable signal is set to FALSE, which drops the frequency to 0. The run enable signal is configured with parameter P4.7.             |
| 2 | Start sign 2 activates which causes the direction to start changing (FWD to REV).   | 8  | Run enable signal is set to TRUE, which causes the frequency to rise towards the set frequency because Start sign 1 is still active.    |
| 3 | Start sign 2 is inactivated which causes the direction to start changing (REV to FWD) because Start sign 1 is still active. | 9  | Keypad stop button is pressed and the frequency fed to the motor drops to 0. (This signal only works if P2.22 Keypad stop button = Yes) |
| 4 | Also Start sign 1 inactivates and the frequency drops to 0.   | 10 | Pushing the Start button on the keypad has no effect on the drive status.   |
| 5 | Despite the activation of Start sign 2, the motor does not start because Start sign 1 is inactive.                          | 11 | The drive is stopped again with the stop button on the keypad.  |
| 6 | Start sign 1 activates causing the output frequency to rise again. The motor runs forward because Start sign 2 is inactive. | 12 | The attempt to start the drive through pushing the Start button is not successful even if Start sign 1 is inactive.                     |

**P2.2 TO****P2.4 PRESET SPEED 1 TO 3**

You can use the preset speed parameters to define certain frequency references in advance. These references are then applied by activating/inactivating digital inputs connected to parameters P4.8 and P4.9 (binary code). The values of the preset speeds are automatically limited between the minimum and maximum frequencies.

| Required action |    | Activated frequency |
|-----------------|----|---------------------|
| B1              | B0 | Preset speed 1      |
| B1              | B0 | Preset speed 2      |
| B1              | B0 | Preset speed 3      |

Table 22. Selection of preset frequencies; ■ = input activated

**P2.9 START ACCELERATION TIME**

A specific acceleration time from zero to minimum frequency is available (P2.9). Normal acceleration time (P1.3) is active only in case power is from mains supply. Normal deceleration time (P1.4) is active in mains supply and in case the external frequency reference is lowered below the reference of maximum power. It is also active when start command falls and ramping stop is programmed (stop mode is anyway by coasting, when the output frequency is below minimum).

Specific acceleration and deceleration time are used when power is from solar panels. They are available as parameters in MPPT group, but it is suggested not to change them, unless needed because of stability issues.

**P2.14 CONTROL PLACE 2**

Alternative Run and direction control. Activated by digital input defined in P4.14.

0: I/O terminals

1: Keypad

2: Fieldbus

**P2.15 FREQUENCY REFERENCE SOURCE 2**

Alternative source of frequency reference. Activated by digital input defined in P4.15 or fieldbus.

0: Analogue input AI1

1: Analogue input AI2

2: PID reference

3: Not used

4: Keypad

5: Fieldbus

6: AI1+AI2

7: Max Frequency

**P2.22 STOP BUTTON ACTIVE**

0: Active only in keypad control mode

1: Always active

**P2.23      *KEYPAD REVERSE***

Effective when control is from keypad

0: Forward

1: Backward



### 4.3 ANALOGUE INPUTS

#### **P3.1 AI1 SIGNAL RANGE**

#### **P3.5 AI2 SIGNAL RANGE**

Range of the electrical signal.

0: 0-100%: 0...10V or 0... 20mA

1: 20-100%: 2...10V or 4... 20mA

#### **P3.4 AI1 FILTER TIME**

#### **P3.8 AI2 FILTER TIME**

Low pass filter time constant, to reduce noise. When this parameter is given a value greater than 0 the function that filters out disturbances from the incoming analogue signal is activated.

**NOTE: Long filtering time makes the regulation response slower!**

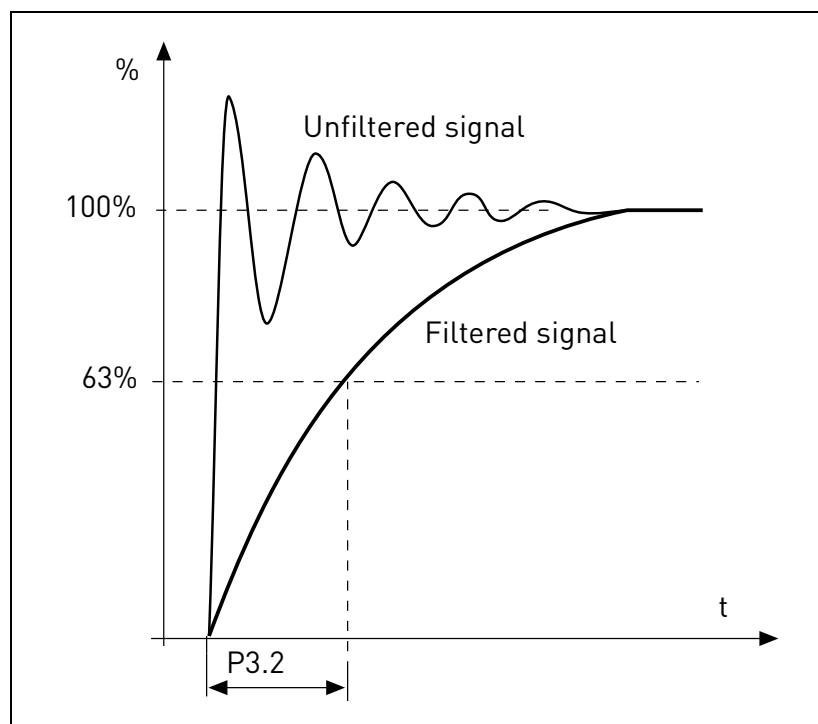


Figure 7.AI1 signal filtering.

#### **P3.2 AI1 CUSTOM MIN**

#### **P3.6 AI2 CUSTOM MIN**

Customized value for minimum signal. Effective when different than 0%

#### **P3.3 AI1 CUSTOM MAX**

#### **P3.7 AI2 CUSTOM MAX**

Customized value for maximum signal. Effective when different than 100%.

**Example of custom range use with analogue input:**

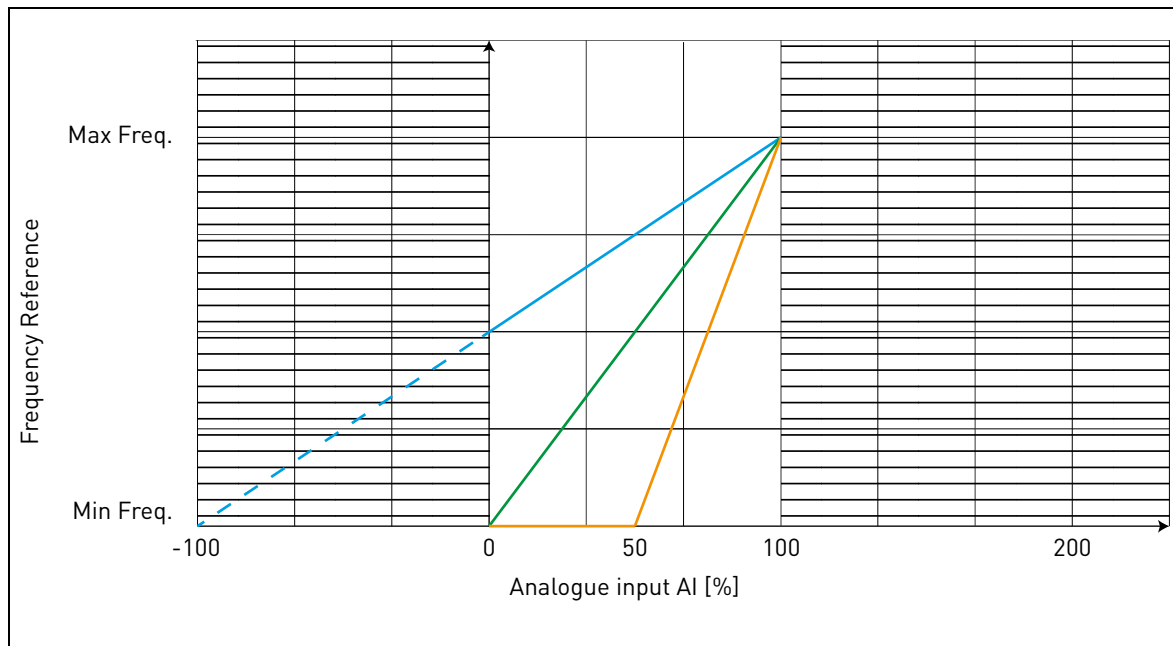


Figure 8.

Description of Figure 8.

Custom min and Custom max parameters configure the input range for analog input that will affect Frequency reference.

Blue line shows an example with Custom Min = -100% and Custom Max = 100%. This settings provides a frequency range between  $(\text{Maximum frequency} - \text{Minimum frequency})/2$  and Maximum frequency. With minimum analogue signal the Frequency reference is at 50% of the set frequency range  $(\text{Max frequency} - \text{Min frequency})/2$ . With maximum analogue signal the Frequency reference is at Maximum frequency.

Green line shows the default settings of custom values: Custom Min =0% and Custom Max = 100%. This settings provides a frequency range between Minimum and Maximum frequency. With minimum analogue signal the Frequency reference is at Minimum frequency while with the maximum level is at Maximum frequency.

Orange line shows an example with Custom min = 50% and Custom Max = 100%. These settings provides a frequency range between Minimum and Maximum frequency. The Frequency reference changes linearly within the frequency range with the analogue signal between 50% and 100% of its range.

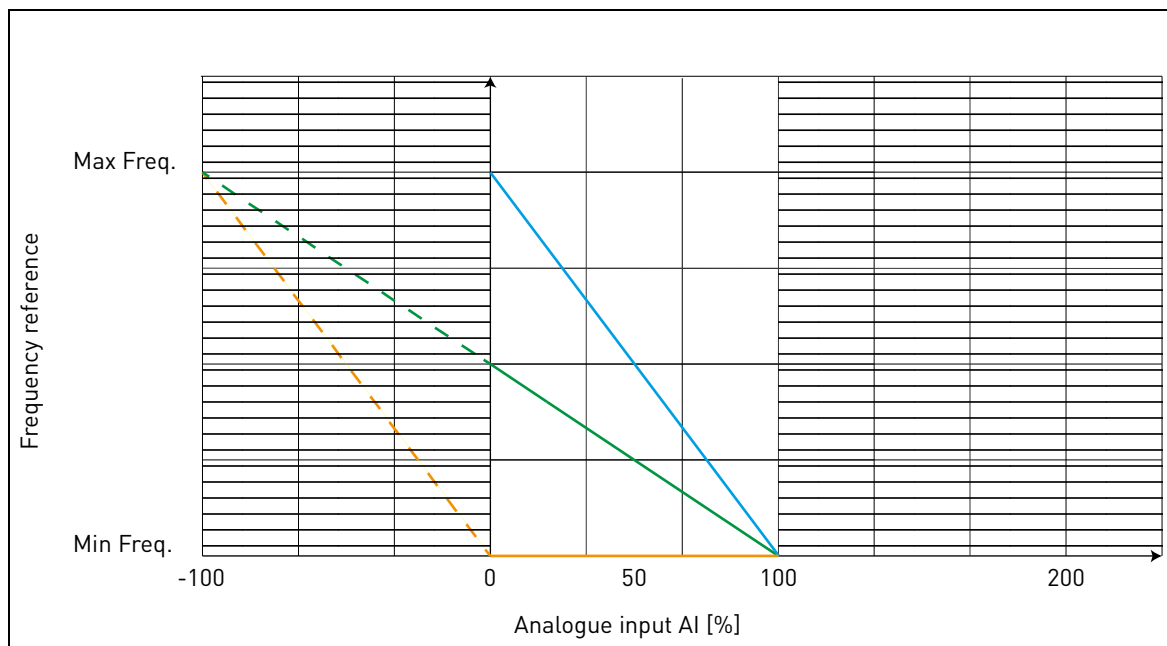


Figure 9.

Description of Figure 9:

Green line shows an example with Custom Min = 100% and Custom Max = -100%. This settings provides a frequency range between Minimum frequency and  $(\text{Maximum frequency} - \text{Minimum frequency})/2$ . With minimum analogue signal the Frequency reference is at 50% of the set frequency range  $(\text{Max frequency} - \text{Min frequency})/2$ , and with maximum analogue signal the Frequency reference is at Minimum frequency.

Blue line shows the inversion of the default settings of custom values: Custom Min =100% and Custom Max = 0%. This settings provides a frequency range between the Minimum frequency and the Maximum frequency. With minimum analogue signal the Frequency reference is Maximum frequency while with the maximum level is Minimum frequency.

Orange line shows an example with Custom min = -100% and Custom Max = 0%. This settings provides a frequency range between Minimum and Maximum frequency. The frequency reference is always at its minimum value (Minimum frequency) within the analogue signal range.

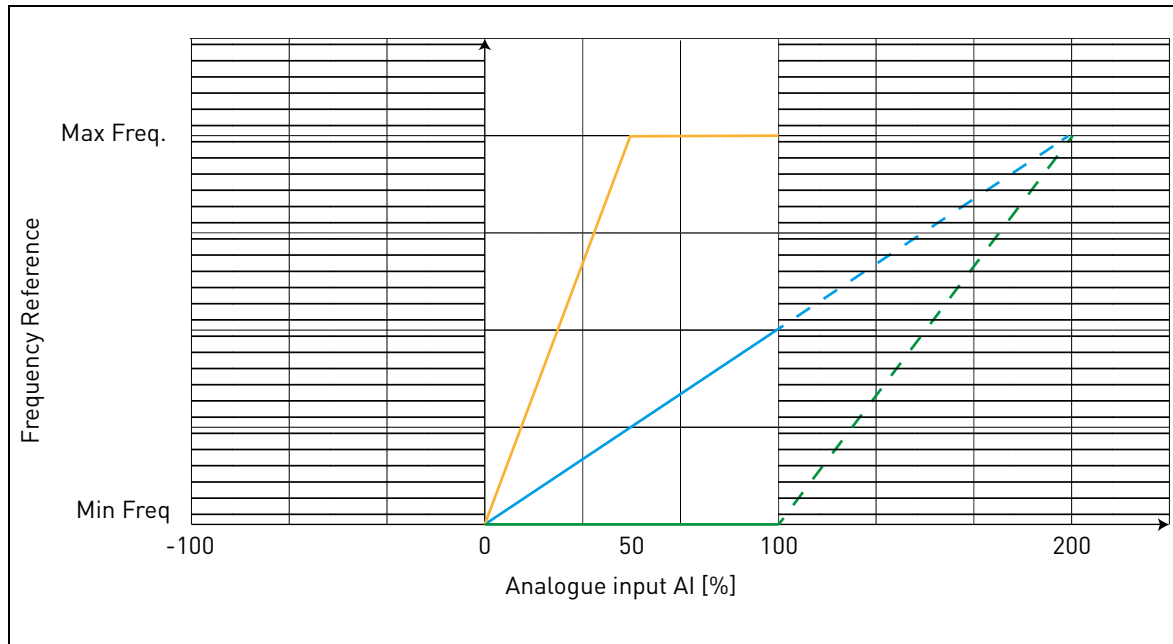


Figure 10.

Description of the Figure 10:

Blue line shows an example with Custom Min = 0% and Custom Max = 200%. This settings provides a frequency range between Minimum frequency and  $(\text{Maximum frequency} - \text{Minimum frequency}) / 2$ . With minimum analogue signal the Frequency reference is at minimum value of the set frequency range (Minimum frequency), and with maximum analogue signal the Frequency reference is at  $(\text{Maximum frequency} - \text{Minimum frequency}) / 2$ .

Green line shows an example with Custom Min = 100% and Custom Max = 200%. This settings provides a frequency range always at Minimum frequency. The Frequency reference is at Minimum frequency within the entire analogue signal range.

Orange line shows an example with Custom min = 0% and Custom Max = 50%. This settings provides a frequency range between Minimum and Maximum frequency. The Frequency reference changes linearly within the frequency range with the analogue signal between the 0% and 50% of its range. With the analogue signal between 50% and 100% of its range, the Frequency reference is always at its maximum value (Maximum frequency).

**P3.9            START SIGNAL SELECT**

Run command is set when Start 1 signal is high and a selectable analogue input is below (or above) a programmable threshold.

This can be used for a tank level control, where the analogue measurement is used for both starting the pump and controlling the speed.

**P3.10           START LEVEL**

Unscaled analogue signal

If  $P3.10 < P3.11$ :

Start below this level

If  $P3.10 > P3.11$ :

Start above this level

**P3.11           STOP LEVEL**

Unscaled analogue signal

If  $P3.11 > P3.10$ :

Stop above this level

If  $P3.11 < P3.10$ :

Stop below this level

#### 4.4 DIGITAL INPUTS

##### **P4.1 START SIGNAL 1**

##### **P4.2 START SIGNAL 2**

Signals for start and direction. Logic is selected with P2.1.

##### **P4.3 REVERSE**

Should be used when Start signal 2 has not the meaning of reverse.

##### **P4.4 EXTERNAL FAULT CLOSE**

Fault is triggered by high digital input.

##### **P4.5 EXTERNAL FAULT OPEN**

Fault is triggered by low digital input.

##### **P4.6 FAULT RESET**

Active on rising edge.

##### **P4.7 RUN ENABLE**

Motor stops by coasting if the signal is missing.

Note: The drive is not in Ready state when Enable is low.

##### **P4.8 PRESET SPEED B0**

##### **P4.9 PRESET SPEED B1**

Digital inputs for preset speed selection, with binary coding.

##### **P4.14 SEL. CONTROL PLACE 2**

Digital input high activates control place 2 (P2.14).

##### **P4.15 SEL. FREQ. REFERENCE 2**

Digital input high activates frequency reference source 2 (P2.15).

##### **P4.16 SEL. PID SETPOINT 2**

Digital input high activates setpoint 2 (P12.3), when P12.1=0.

##### **P4.17 MAINS CONNECTED**

In case the drive is fed by mains supply, the controller knows this situation through a specific digital input.

The functions related to DC voltage (start enable, MPPT) are disabled in this condition.

##### **P4.18 ENERGY COUNTER RESET**

This parameter enables reset of Energy counter.

**P4.19          FLOWMETER PULSE**

Digital input for pulse flow meter (P15.1 = 1).

**P4.20          FLOW COUNTER RESET**

Digital input for flow counter reset.

**P4.21          MINIMUM WATER LEVEL**

Digital input for minimum water level.

**P4.22          MINIMUM LEVEL LOGIC**

This parameter selects the logic to check the status of water level due by the digital input set by P4.21. Selections:

0 = the water level is ok when digital input set by P4.21 is high

1 = the water level is ok when digital input set by P4.21 is low

The drive trips with F63 fault (Low water level) when level is not ok. The fault is automatically reset with the Underload logic (see P10.4-7), when the level is restored.

Min level signal/fault refers to level in a well from which water is taken.

**P4.23          MAXIMUM WATER LEVEL**

Digital input for maximum water level.

**P4.24          MAXIMUM LEVEL LOGIC**

This parameter selects the logic to check the status of water level due by the digital input set by P4.23. Selections:

0 = the water level is ok when digital input set by P4.23 is high

1 = the water level is ok when digital input set by P4.23 is low

The drive trips with F64 fault (Max water level) when level is not ok. The fault is automatically reset with the Underload logic (see P10.4-7), when the level is restored.

Max level signal/fault refers to level in a possible tank where pumped water is stored.

#### 4.5 DIGITAL OUTPUTS

##### **P5.1 RELAY OUTPUT 1 CONTENT**

##### **P5.2 RELAY OUTPUT 2 CONTENT**

##### **P5.3 DIGITAL OUTPUT CONTENT**

Function for relays and digital output.

| Selection | Selection name              | Description   |
|-----------|-----------------------------|---|
| 0         | Not used                    |   |
| 1         | Ready                       | The frequency converter is ready to operate   |
| 2         | Run                         | The frequency converter operates (motor is running)   |
| 3         | General fault               | A fault trip has occurred   |
| 4         | General fault inverted      | A fault trip has <b>not</b> occurred  |
| 5         | General alarm               |   |
| 6         | Reversed                    | The reverse command has been selected   |
| 7         | At speed                    | The output frequency has reached the set reference  |
| 8         | Frequency supervision       | Output frequency is over/under the limit set with parameters P5.9 and P5.10                   |
| 9         | Current supervision         | Motor current is over the limit set with parameter P5.11                                      |
| 10        | Analogue inputs supervision | Analogue inputs selected with parameter P5.12 is over/under the limits set in P5.13 and P5.14 |
| 11        | Fieldbus bit 1              | Bit from fieldbus Aux Control word  |
| 12        | Fieldbus bit 2              | Bit from fieldbus Aux Control word  |
| 13        | Fault/Warning               |   |

Table 23. Functions for digital relays.

##### **P5.4 RELAY OUTPUT 1 ON DELAY**

##### **P5.5 RELAY OUTPUT 1 OFF DELAY**

Possible delays for ON/OFF transitions.

##### **P5.6 RELAY OUTPUT 1 INVERSION**

Inversion of relay state.

##### **P5.7 RELAY OUTPUT 2 ON DELAY**

##### **P5.8 RELAY OUTPUT 2 OFF DELAY**

Possible delays for ON/OFF transitions.

##### **P5.9 TO**

##### **P5.12 EXPANSION EO1, EO2, EO3, EO4 OUTPUT CONTENT**



These parameters are visible only when an expansion board with outputs is installed (to see table below). Relays are available on boards OPT-B2, B5, B9 and BF.

Digital outputs are available on board OPTB1, if no more than 3 terminals are used as inputs, and on OPTBF.

P5.12 is visible only when expansion board OPTBF is installed.

|       |     | OPTB1  | OPTB2                               | OPTB5                            | OPTB9                          | OPTBF                             |
|-------|-----|--|-------------------------------------|----------------------------------|--------------------------------|-----------------------------------|
| P5.9  | E01 | visible if P2.24 < 4<br>digital out terminal 5 | visible<br>relay terminals 21-22-23 | visible<br>relay terminals 22-23 | visible<br>relay terminals 7-8 | visible<br>relay terminals 22-23  |
| P5.10 | E02 | visible if P2.24 < 5<br>digital out terminal 6 | visible<br>relay terminals 25-26    | visible<br>relay terminals 25-26 | -                              | -                                 |
| P5.11 | E03 | visible if P2.24 < 6<br>digital out terminal 7 | -                                   | visible<br>relay terminals 28-29 | -                              | -                                 |
| P5.12 | E04 | -  | -                                   | -                                | -                              | visible<br>digital out terminal 3 |

*Table 24. Digital outputs available with OPTB-boards*

## 4.6 ANALOGUE OUTPUT

### **P6.1 ANALOGUE OUTPUT FUNCTION**

Signal coupled to analogue output.

| Selection | Selection name      | Value corresponding to maximum output |
|-----------|---------------------|---------------------------------------|
| 0         | Not used            | output always fixed at 100%           |
| 1         | Frequency reference | Max frequency(P1.2)                   |
| 2         | Output frequency    | Max frequency(P1.2)                   |
| 3         | Motor speed         | Motor nominal speed                   |
| 4         | Motor current       | Motor nominal current                 |
| 5         | Motor torque        | Motor nominal torque (absolute value) |
| 6         | Motor power         | Motor nominal power (absolute value)  |
| 7         | PID output          | 100%                                  |
| 8         | Fieldbus control    | 10000                                 |

*Table 25. Analogue output signals.*

### **P6.2 ANALOGUE OUTPUT MINIMUM**

0: 0V

1: 2V

### **P6.3 ANALOGUE OUTPUT SCALE**

Scaling factor.

### **P6.4 ANALOGUE OUTPUT FILTER TIME**

Time constant of low pass filter.

## 4.7 SUPERVISIONS

### **P7.1**            **FREQUENCY SUPERVISION 1**

0:No supervision

1:Low limit

2: High limit

### **P7.2**            **FREQUENCY SUPERVISION VALUE 1**

Threshold value for frequency supervision.

### **P7.3**            **CURRENT SUPERVISION VALUE**

Threshold value for current supervision.

### **P7.4**            **ANALOGIN SUPV SIGNAL**

0:A11

1:A12

### **P7.5**            **ANALOGIN SUPV ON LEVEL**

Output goes high when AI is higher than this value.

### **P7.6**            **ANALOGIN SUPV OFF LEVEL**

Output goes low when AI is lower than this value.

### **P7.10**          **PROCESS SOURCE SELECT**

Monitor V1.24 can show a process value, proportional to a variable measured by the drive. Source variables are:

0: PID actual value (max: 100%)

1: output frequency (max: Fmax)

2: motor speed (max: Speed at Fmax)

3: motor torque (max: Tnom)

4: motor power (max: Pnom)

5: motor current (max: Inom)

### **P7.11**          **PROCESS VAL DECIM DIGITS**

Number of decimals shown on monitor V1.24 and also on parameter P7.12.

### **P7.12**          **PROCESS MAX VALUE**

Value shown on V1.24 when source variable is at its maximum. Proportionality is kept if the source overtakes the maximum.

## 4.8 MOTOR CONTROL

### **P8.1** MOTOR CONTROL MODE

0: Frequency control

1: Speed control (sensorless control)

In speed control, the motor slip is compensated.

**Note:** motor identification automatically sets this parameter to 1.

### **P8.2** FIELD WEAKENING POINT

Output frequency corresponding to max voltage.

**Note:** if P1.7 Nominal Frequency is changed, P8.2 will be set at same value.

### **P8.3** VOLTAGE AT FIELD WEAKENING POINT

Motor voltage when frequency is above FWP, defined as% of nominal voltage.

**Note:** if P1.6 Nominal Voltage is changed, P8.3 will be set at 100%.

If the programmed maximum frequency is higher than motor nominal frequency, field weakening point is automatically set at maximum frequency and fwp voltage is set proportionally higher than 100%.

This could allow to exploit the higher voltage possibly coming from the panels.

In this situation the current limit has to be set properly, to prevent a motor overload.

If the drive is fed from mains, maximum output frequency will be limited by actual DC voltage, according to nominal U/f ratio.

**P8.4 U/F RATIO SELECTION**

0: linear

The voltage of the motor changes linearly as a function of output frequency from zero frequency voltage P8.7 to the field weakening point (FWP) voltage P8.3 at FWP frequency P8.2. This default setting should be used if there is no special need for another setting.

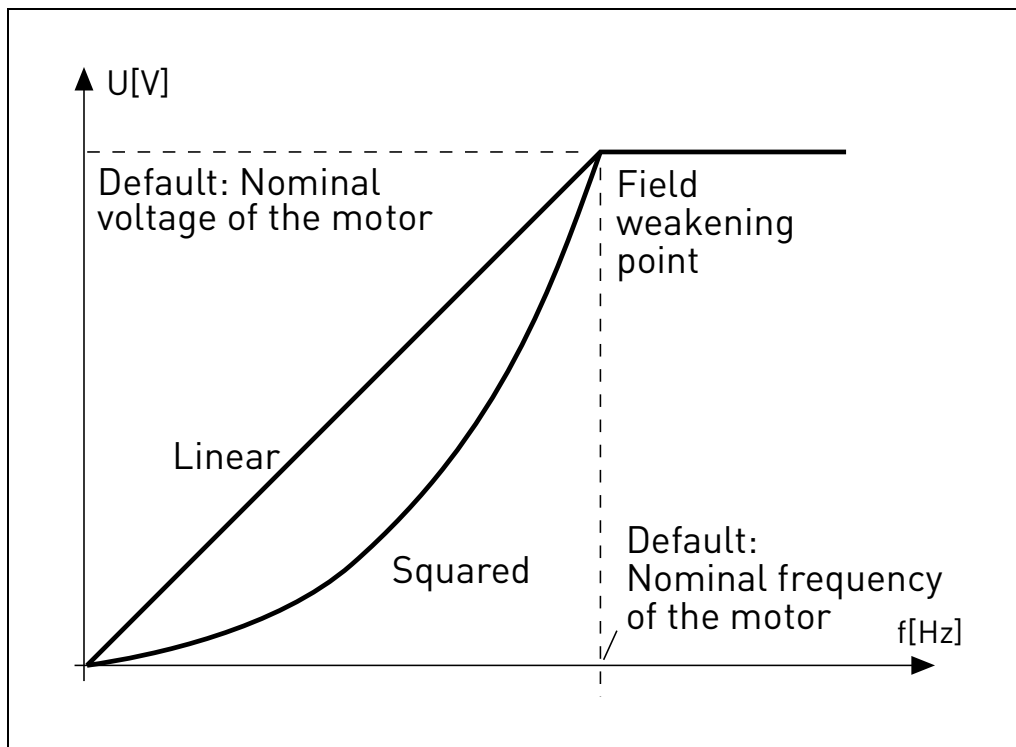


Figure 11. Linear and quadratic curve of the motor voltage.

1: quadratic

(from voltage P8.7 at 0Hz, to voltage P8.3 at P8.2 frequency)

The voltage of the motor changes from zero point voltage P8.7 following a squared curve form from zero to the field weakening point P8.3. The motor runs under-magnetized below the field weakening point and produces less torque. Squared U/f ratio can be used in applications where torque demand is proportional to the square of the speed, e.g. in centrifugal fans and pumps.

2: programmable

The U/f curve can be programmed with three different points: Zero frequency voltage P8.7 (P1), Midpoint voltage/frequency P8.6/P8.5 (P2) and Field weakening point P8.2/P8.3 (P3).

Programmable U/f curve can be used if more torque is needed at low frequencies. The optimal settings can automatically be achieved with Motor identification run.

**Note:** motor identification automatically sets this parameter to 2.

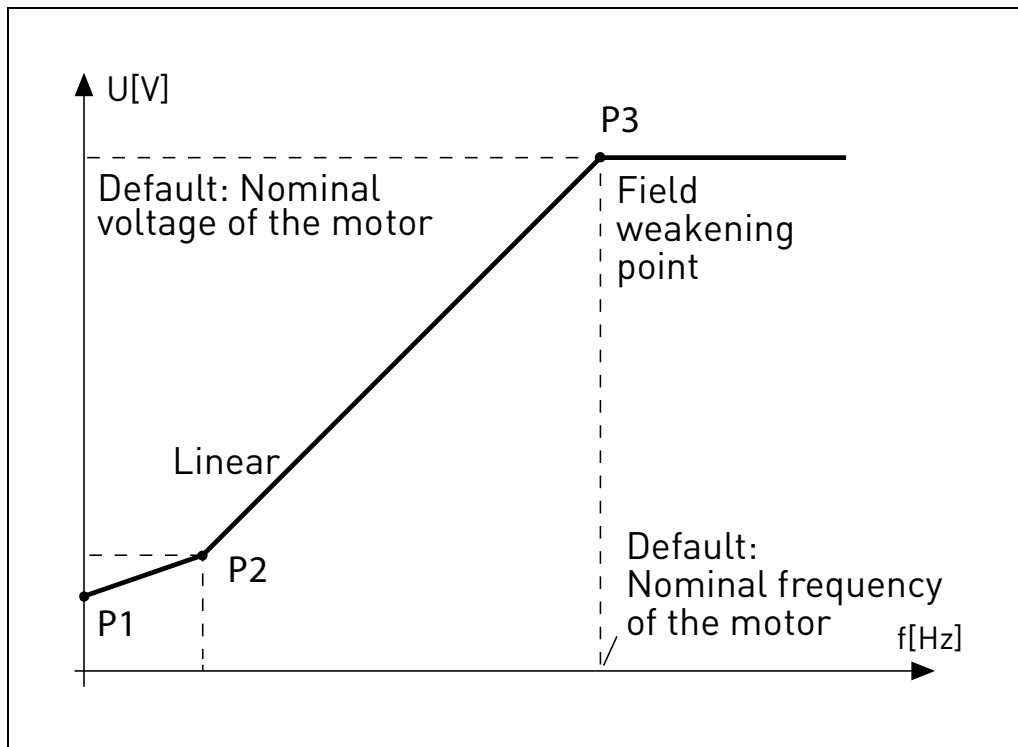


Figure 12. Programmable curve.

#### **P8.5** **U/F CURVE MIDPOINT FREQUENCY**

Enabled if P8.4= 2.

**Note:** motor identification automatically sets this parameter.

#### **P8.6** **U/F CURVE MIDPOINT VOLTAGE**

Enabled if P8.4= 2.

**Note:** motor identification automatically sets this parameter.

#### **P8.7** **OUTPUT VOLTAGE AT ZERO FREQUENCY**

Motor voltage at frequency zero.

**Note:** motor identification automatically sets this parameter.

#### **P8.8** **SWITCHING FREQUENCY**

PWM frequency. Values above default can cause thermal overload of the drive. Motor noise can be minimized using a high switching frequency. Increasing the switching frequency reduces the capacity of the drive. It is recommended to use a lower frequency when the motor cable is long in order to minimize capacitive currents in the cable.

#### **P8.11** **DC BRAKING CURRENT**

DC current injected at start or stop.

#### **P8.12** **DC BRAKING TIME AT STOP**

Time for DC current injection at stop.

### **P8.13**      **FREQUENCY TO START DC BRAKING IN RAMP STOP**

DC current injection starts below this frequency.

### **P8.14**      **DC BRAKING TIME AT START**

Time for DC current injection at start.

### **P8.15**      **MOTOR STATOR VOLTAGE DROP**

Voltage drop on stator windings, at motor nominal current, defined as % of nominal voltage. Value affects motor torque estimation, slip compensation and voltage boost.

Note: it is suggested not to program manually the value, but to perform motor identification procedure that automatically sets the value.

### **P8.16**      **MOTOR IDENTIFICATION**

This procedure measures motor stator resistance and automatically sets U/f characteristic, to obtain good torque also at low speed.

0 = not active

1 = standstill identification

Run command must be given and hold high within 20s after programming the value 1. The motor does not rotate and the drive will automatically exit run state at the end of the measurements.

**Note:** the drive exits run state only, if the measured current exceeds 55% of the motor nominal current. Procedure sets the following parameters: P8.4, P8.5, P8.6, P8.7, P8.15.

**Note:** optimized U/f settings will increase motor no load current to a value close to nominal in the low speed range. External cooling of the motor is needed if the motor works in this condition for significant time.

### **P8.18**      **DISABLE UNDERVOLTAGE REGULATOR**

Undervoltage regulator automatically decelerates the motor if the internal DC link voltage is too low.

0: enabled

1: disabled

### **P8.19**      **DISABLE SWITCHING FREQ. REGULATOR**

Switching frequency regulator automatically decreases the PWM frequency if the unit temperature is too high.

0: enabled

1: disabled

## 4.9 PROTECTIONS

### **P9.1**      **RESPONSE TO 4mA REFERENCE FAULT ( $AI < 4mA$ )**

- 0: No action
  - 1: Warning
  - 2: Fault
  - 3: Warning if Start active
  - 4: Fault if Start active
- Analogue reference below 4mA.

### **P9.2**      **4mA FAULT DETECTION TIME**

Delay as filter on fault generation

### **P9.3**      **EARTH FAULT PROTECTION**

- 0: No action
  - 1: Warning
  - 2: Fault
- Output currents sum not zero.

### **P9.4**      **MOTOR STALL PROTECTION**

- 0: No action
- 1: Warning
- 2: Fault

This is an overload protection. Stall is recognized by maximum motor current (=P1.5) and low output frequency.

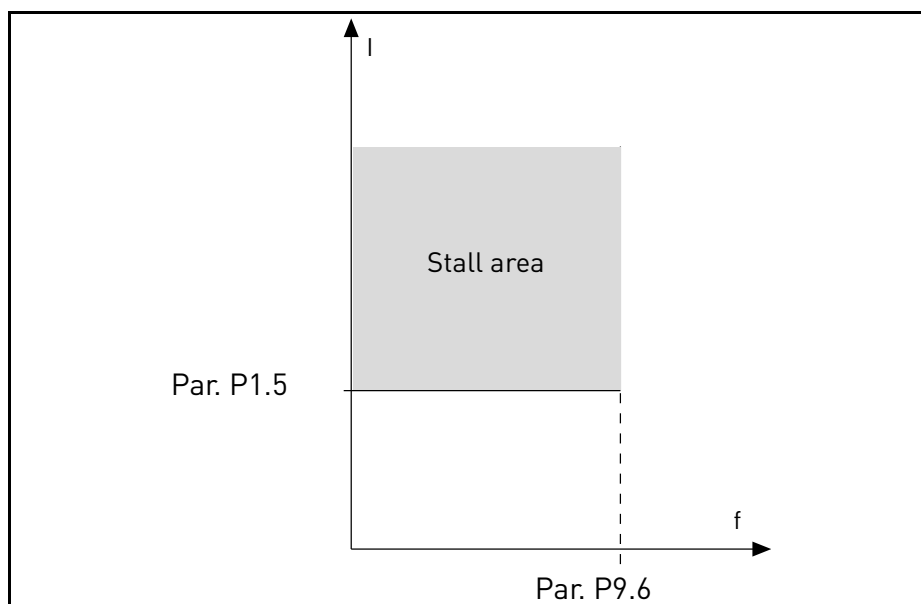


Figure 13. Stall characteristic settings.



### P9.5 MOTOR STALL DELAY

This time can be set between 0.0 and 300.0 s.

This is the maximum time allowed for all stage. the stall time is counted by an internal up/down counter. If the stall time counter value goes above this limit the protection will cause a trip.

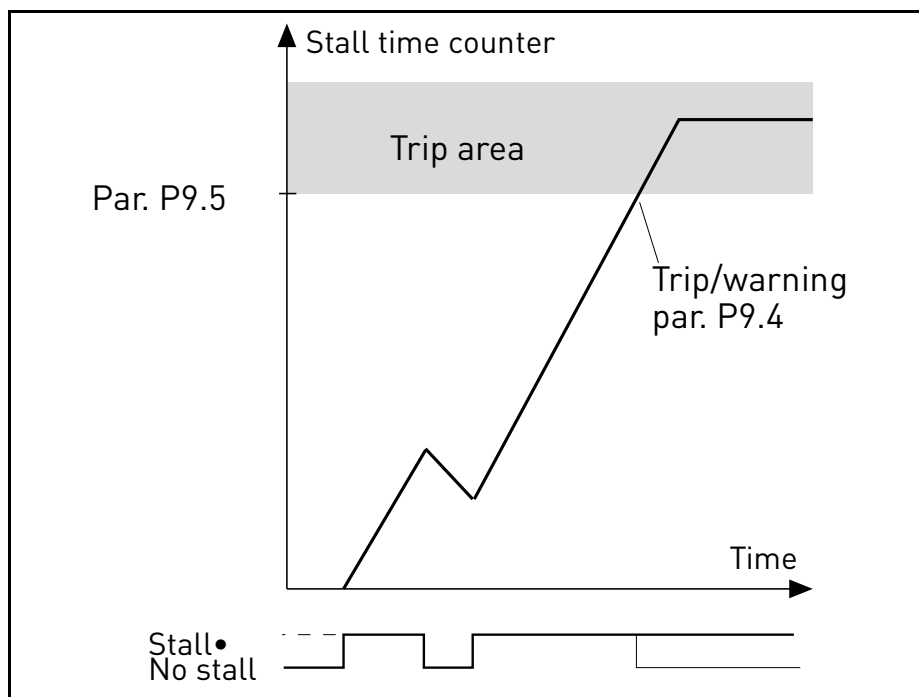


Figure 14. Stall time count.

### P9.6 MOTOR STALL MIN FREQ

Stall is recognized when the current limiter has reduced the output frequency below P9.6, for the time in P9.5.

### P9.7 UNDERLOAD PROTECTION

- 0: No action
- 1: Warning
- 2: Fault

Underload (Dry run) is recognized when torque is above the minimum curve defined by P9.8 and P9.9, for the programmed time P9.10.

The Underload mode is selected with P9.23. When P9.23 = 0, Underload is determined by parameters P9.8 - P9.10. When P9.23 = 1, the fault is related to P9.24.

### P9.8 UNDERLOAD LOAD CURVE AT NOMINAL FREQ

The torque limit can be set between 10.0-150.0% x  $T_{nMotor}$ .

This parameter gives the value for the minimum torque allowed when the output frequency is above the field weakening point.

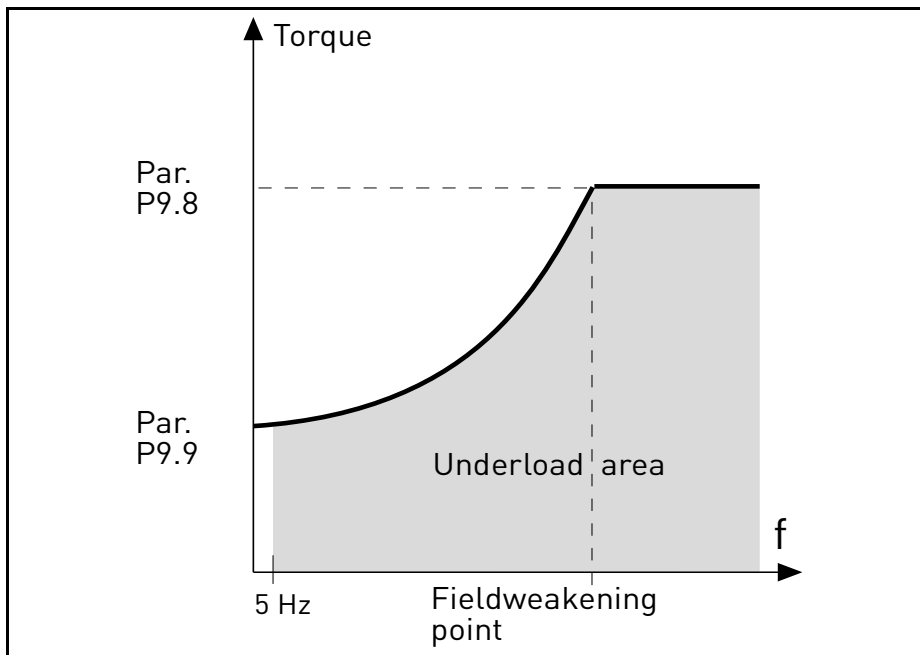


Figure 15. Underload (Dry run) characteristic settings.

**P9.9 UNDERLOAD LOAD CURVE AT MIN FREQ**

**P9.10 UNDERLOAD TIME**

Definition of minimum load at nominal and zero speed zero. Fault condition delay. This time can be set between 1.0 and 300.0 s.

This is the maximum time allowed for an underload state to exist. An internal up/down counter counts the accumulated underload time. If the underload counter value goes above this limit the protection will cause a trip according to parameter P9.7). If the drive is stopped the underload counter is reset to zero.

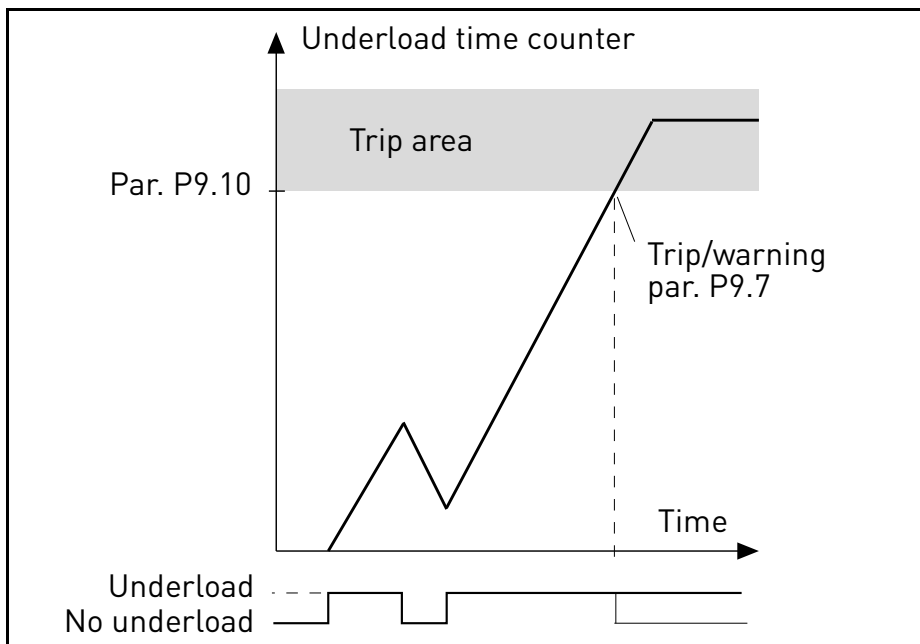


Figure 16. Underload time counter.

**P9.11 THERMAL PROTECTION OF THE MOTOR**

0: No action

1: Warning

2: Fault

This is a software protection, based on time integral of current.

**P9.12 MOTOR AMBIENT TEMPERATURE**

Change if environment is not standard.

**P9.13 MOTOR COOLING FACTOR AT ZERO SPEED**

Defines the cooling factor at zero speed in relation to the point where the motor is running at nominal speed without external cooling. See Figure 17.

The default value is set assuming that there is no external fan cooling the motor. If an external fan is used this parameter can be set to 90% (or even higher).

Setting this parameter does not affect the maximum output current of the drive which is determined by parameter P1.5 alone.

The corner frequency for the thermal protection is 70% of the motor nominal frequency (P1.7).

Set 100% if the motor has independent fan or cooling. Set 30-40% if the fan is on motor shaft.

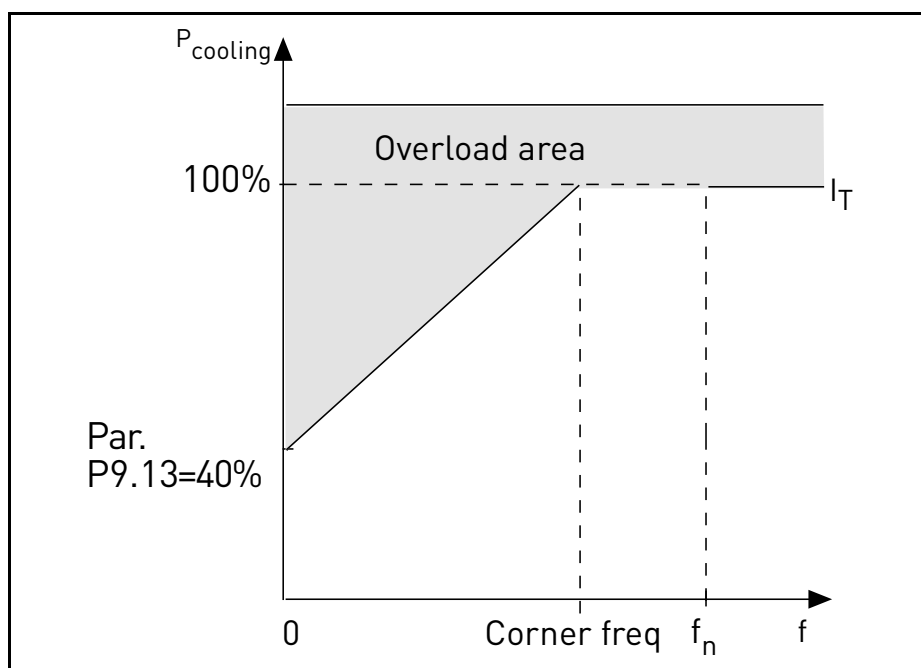


Figure 17. Motor thermal current  $I_T$  curve.

**P9.14 MOTOR THERMAL TIME CONSTANT**

Time at nominal current, to reach nominal temperature.

The time constant is the time within which the calculated thermal stage has reached 63% of its final value. The bigger the frame and/or slower the speed of the motor, the longer the time constant.

The motor thermal time is specific to the motor design and it varies between different motor manufacturers. The default value of the parameter varies from size to size.

If the motor's t6-time (t6 is the time in seconds the motor can safely operate at six times the rated current) is known (given by the motor manufacturer) the time constant parameter can be set basing on it. As a rule of thumb, the motor thermal time constant in minutes equals to 2\*t6. If the drive is in stop stage the time constant is internally increased to three times the set parameter value. The cooling in stop stage is based on convection and the time constant is increased.

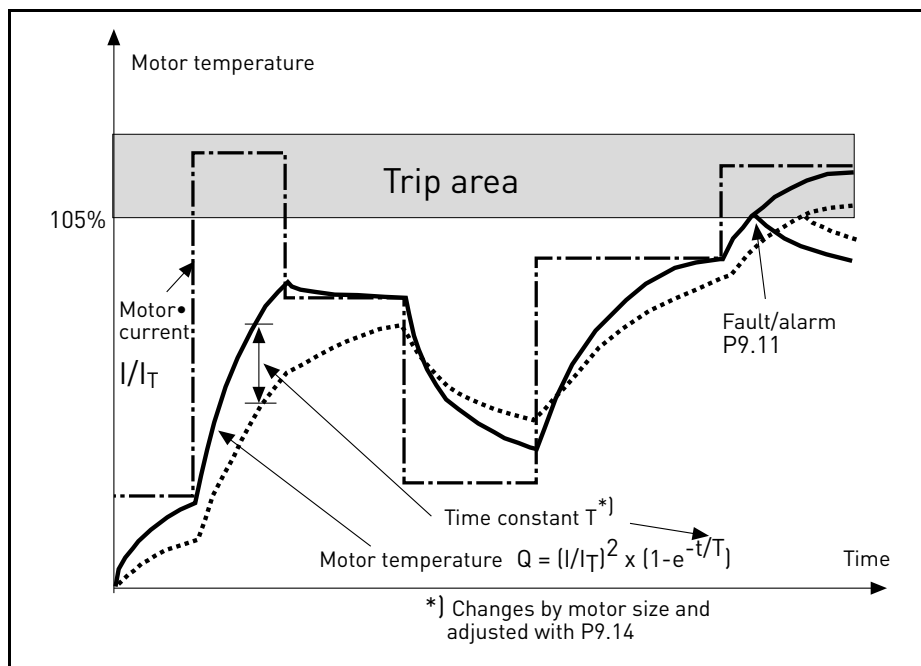


Figure 18. Motor temperature calculation.

**P9.15 RESPONSE TO FIELDBUS FAULT**

- 0: No action
  - 1: Warning
  - 2: Fault
- Communication lost.

**P9.17 PARAMETER LOCK**

- 0: Edit enabled
- 1: Edit disabled

**P9.18 RESPONSE TO STO DISABLE**

- 0: No action

1: Warning  
2: Fault, not stored in history  
3: Fault, stored in history  
Safe Torque Off disabled.

**P9.19          RESPONSE TO INPUT PHASE FAULT**

0: No action  
1: Warning  
2: Fault  
Input phase missing.

**P9.20          INPUT PHASE FAULT MAX RIPPLE**

Sensitivity for input phases detection:  
0: internal value (default)  
1-75: sensitivity from maximum(1) to minimum (75)

**P9.21          MOTOR TEMP INITIAL MODE**

Setting of estimated motor temperature at power on  
0: initialized at minimum value  
1: initialized at constant value from P9.22  
2: initialized at last previous value, with P9.22 used as factor

**P9.22          MOTOR TEMP INITIAL VALUE**

If P9.21= 1, motor temperature is initialized with this value.  
If P9.21= 2, motor temperature is initialized with last previous value, multiplied by this value as% factor.

**P9.23          UNDERLOADDETECTMODE**

This parameter selects the underload protection mode:  
0: Motor torque (standard sensorless mode based on motor torque measurement)  
1: Flow meter (based on flow metersensor)  
This parameter is related to parameter P9.7-P9.10.

**P9.24          MINIMUM FLOW**

This parameters is the threshold level to determine underload fault when P9.23 = Flow meter.

## 4.10 AUTORESET

### **P10.1**      **AUTOMATIC FAULT RESET**

0: Disabled

1: Enabled

The automatic reset function deletes fault state when the fault cause has been eliminated and the wait time P10.2 has elapsed. Parameter P10.4 determines the maximum number of automatic resets that can be effected during the trial time set by parameter P10.3. The time count starts from the first automatic reset. If the number of faults detected during the trial time exceeds the values of trials, the fault status becomes permanent and a reset command is needed.

### **P10.2**      **WAIT TIME**

Time after which the converter attempts to restart the motor automatically after the fault has been cleared.

### **P10.3**      **AUTOMATIC RESET TRIES**

Trials attempted during one hour.

### **P10.4**

### **P10.6**      **UNDERLOAD RESET TIME 1 -3**

Undervoltage fault is reset without limitations, also when P10.1 is not active. The drive will restart according the delay times defined by the parameters P14.1.1 to P14.1.4.

Underload (dry run) fault is reset when P10.1 is active, without limitations in number, but according to a specific time schedule.

At first fault, autoreset is done after time 1 (P10.4). If underload fault happens again, after the number of tries defined in P10.7, delay becomes time 2 (P10.5).

Similarly, delay will change to time 3 (P10.6) if further tries are unsuccessful.

Five minutes of correct working will reset the tries counter.

#### **Any other fault:**

Generic autoreset is enabled by P10.1. Faults will be reset after the wait time (P10.2), unless the number of faults in a hour overcomes the threshold in P10.3. Any fault event, apart undervoltage and underload, causes counter increasing.

**Note:** fault led (red) blinks during the autoreset wait time.

### **P10.7**      **UNDERLOAD TRIES T1, T2**

Trials attempted during Underload Reset time 1 and Underload Reset time 2.

#### 4.11 FIELDBUS

##### **P11.1** TO

##### **P11.8** *FB DATAOUT 1 - 8 SEL*

Parameter couples read only variables to output process data 1.

- 0: output frequency
- 1: motor speed
- 2: motor current
- 3: motor voltage
- 4: motor torque
- 5: motor power
- 6: DC link voltage
- 7: active fault code
- 8: analogue AI1
- 9: analogue AI2
- 10: digital inputs state
- 11: PID actual value
- 12: PID setpoint
- 13: Power kW
- 14: Energy
- 15: Flow
- 16: Volume 1
- 17: Volume 2

##### **P11.9** *FB AUX CW SELECTION*

Parameter defines the input process data coupled to Aux Control Word.

- 0: not used
- 1: PDI1
- 2: PDI2
- 3: PDI3
- 4: PDI4
- 5: PDI5

##### **P11.10** *FB PID SETPOINT SELECTION*

Parameter defines the input process data coupled to PID setpoint. Selections as P11.9.

##### **P11.11** *FB PID ACTUAL SELECTION*

Parameter defines the input process data coupled to PID actual value. Selections as P11.9.

##### **P11.12** *FB ANALOGUEOUT CNTRL SELECTION*

Parameter defines the input process data coupled to analogue output control. Selections as P11.9.

**4.11.1 FIELDBUS MAPPING**

**4.11.1.1 *Fieldbus Data IN: Master -> Slave***

| Modbus register | Name                 | Description   | Range   |
|-----------------|----------------------|---------------|---|
| 2001            | Control word(*)      | Drive control | Binary coded:<br>b0: Run<br>b1: Reverse<br>b2: Fault Reset (on edge)<br><br>b8: forces control place to fieldbus<br>b9: forces reference source to fieldbus |
| 2002            | General control word | Not used      |   |
| 2003            | Speed reference(*)   | Reference     | 0...10000 as 0,00...100,00% of Min freq. - Max freq. range  |
| 2004            | Fieldbus Data IN 1   | Programmable  | 0...10000   |
| 2005            | Fieldbus Data IN 2   | Programmable  | 0...10000   |
| 2006            | Fieldbus Data IN 3   | Programmable  | 0...10000   |
| 2007            | Fieldbus Data IN 4   | Programmable  | 0...10000   |
| 2008            | Fieldbus Data IN 5   | Programmable  | 0...10000   |
| 2009            | Fieldbus Data IN 6   | Not used      | -   |
| 2010            | Fieldbus Data IN 7   | Not used      | -   |
| 2011            | Fieldbus Data IN 8   | Not used      | -   |

*Table 26. (\*) Modbus Data inputs. They can vary depending on fieldbus used (See specific fieldbus option board installation manual).*

**Notes:**

- CW b0 Run is acquired on edge, only if the drive is in Ready state (see Status Word b0) and actual control place is Fieldbus.
- CW b2 Fault Reset is active even if control place is not the Fieldbus.
- Fieldbus different from Modbus have their own Control Word (see manual of the specific fieldbus board).



**Fieldbus data input mapping**

Fieldbus Data inputs from 1 to 5 can be configured, with parameters P11.9 - P11.12, as:

| Process Data IN   | Description  | Note  |
|-------------------|--|---|
| Aux Control Word  | b0: enable<br>b1: acc/dec ramp 2 selection<br>b2: freq reference 2 selection<br>b3: digital output 1 control<br>b4: digital output 2 control | <ul style="list-style-type: none"> <li>• b0 Enable is considered only when control place is the Fieldbus. It is computed in AND with a possible enable from digital input. Fall of enable will cause coasting stop.</li> <li>• b2 FreqRef2 Sel is considered only when control place is the Fieldbus.</li> <li>• functions related to bit1, b3 and b4 are available also when control place is not the Fieldbus. Aux CW must anyway be mapped onto a PDI, by means of parameter P11.9.</li> </ul> |
| PID Setpoint      | active if P12.1 = 3, range 0 - 10000 as 0 - 100,00% of regulation.   |   |
| PID Actual value  | active if P12.4 = 2, range 0 - 10000 as 0 - 100,00% of regulation.   |   |
| Analogue Out Ctrl | active if P5.1 = 8, range 0 - 10000 as 0 - 100,00% of output.  |   |

Table 27.

4.11.1.2 *Fieldbus Data OUT: Slave ->Master*

| Modbus register | Name                | Description  | Range   |
|-----------------|---------------------|--------------|---|
| 2101            | Status word(*)      | Drive state  | Binary coded:<br>b0: Ready<br>b1: Run<br>b2: Reverse<br>b3: Fault<br>b4: Warning<br>b5: Freq. reference reached<br>b6: Zero speed |
| 2102            | General Status word | Drive state  | As Status word and:<br>b7: Control place is fieldbus  |
| 2103            | Actual speed(*)     | Actual speed | 0...10000 as 0,00...100,00%<br>of Min freq. - Max freq.<br>range  |
| 2104            | Fieldbus Data OUT 1 | Programmable | See P11.1   |
| 2105            | Fieldbus Data OUT 2 | Programmable | See P11.2   |
| 2106            | Fieldbus Data OUT 3 | Programmable | See P11.3   |
| 2107            | Fieldbus Data OUT 4 | Programmable | See P11.4   |
| 2108            | Fieldbus Data OUT 5 | Programmable | See P11.5   |
| 2109            | Fieldbus Data OUT 6 | Programmable | See P11.6   |
| 2110            | Fieldbus Data OUT 7 | Programmable | See P11.7   |
| 2111            | Fieldbus Data OUT 8 | Programmable | See P11.8   |

Table 28. (\*) Modbus data outputs. They can vary depending on fieldbus used (See specific fieldbus option board installation manual).

**Notes:**

- Fieldbus different from Modbus have their own Status Word (see manual of the specific fieldbus board).

#### 4.12 PID CONTROL

Parameters of this group are hidden unless the regulator is used as frequency reference (P1.12= or P2.15=2)

##### **P12.1 SETPOINT SOURCE**

0: PID setpoint 1-2

1: analogue AI1

2: analogue AI2

3: fieldbus

##### **P12.2 PID SETPOINT 1**

##### **P12.3 PID SETPOINT 2**

Programmable setpoints. Setpoint 2 is activated with digital input defined in P4.16.

##### **P12.4 FEEDBACK SOURCE**

0: analogue AI2

1: analogue AI1

2: fieldbus

3: AI2-AI1 (differential)

4: temperature (only with board OPTBH, see P13.8-10)

##### **P12.5 FEEDBACK MINIMUM**

##### **P12.6 FEEDBACK MAXIMUM**

Minimum and maximum feedback values, corresponding to minimum and maximum of the signal.

##### **P12.7 PID CONTROLLER P GAIN**

Proportional gain. If set to 100%, a variation of 10% on error causes a variation of 10% on regulator output.

##### **P12.8 PID CONTROLLER I-TIME**

Integral time constant. If set to 1s, a variation of 10% on error will cause a variation of 10% on regulator output after 1s.

##### **P12.9 PID CONTROLLER D-TIME**

Derivative time. If set to 1s, a variation of 10% in 1s on error causes a variation of 10% on regulator output.

##### **P12.10 ERROR VALUE INVERSION**

0: direct control. Frequency increases if setpoint > feedback

1: inverted control. Frequency increases if setpoint < feedback

##### **P12.11 PID ERROR LIMIT**

If lower than 100%, determines a limit on max error. Useful to avoid excessive reaction at motor startup.

### **P12.12**      **SLEEP FREQUENCY**

This function will put the drive into sleep mode if the setpoint is reached and the output frequency stays below the sleep limit for a longer time than that set with the Sleep Delay (P12.13). This means that the start command remains on, but the run request is turned off. When the PID error value goes below, or above, the wake-up level depending on the set acting mode (P12.10) the drive will activate the run request again if the start command is still on.

### **P12.13**      **SLEEP TIME DELAY**

Time of working at minimum frequency, before entering sleep condition.

### **P12.14**      **WAKE UP LIMIT**

The drive exits from sleep if the error exceeds this value. Direction of regulation (P12.10) is internally considered.

### **P12.15**      **FEEDBACK SUPERV. RESPONSE**

Response to feedback supervision:

0 = No action

1 = Alarm

2 = Fault

### **P12.16**      **MIN FEEDBACK LEVEL**

### **P12.17**      **MIN FEEDBACK TIME**

### **P12.18**      **MAX FEEDBACK LEVEL**

### **P12.19**      **MAX FEEDBACK TIME**

These parameters manage the supervision of the PID actual value (feedback).

If the difference between setpoint and actual value stays then lower than P12.16 for the time in P12.17, the drive response is according to P12.15. If P12.15 is 2, this activates fault F58.

If the difference between setpoint and actual value stays then higher than P12.18 for the time in P12.19, the drive response is according to P12.15. If P12.15 is 2, this activates fault F59.

## 4.13 SOLAR

### 4.13.1 START SETTINGS

#### **P14.1**      **START DC VOLTAGE**

Start enable from solar condition needs that the DC voltage is above the threshold in P14.1.1 (at least for 5s).

#### **P14.2**      **SHORT RESTART DELAY**

The drive starts and tries to reach minimum frequency. If this doesn't happen within a defined time, the drive will stop and retry only after the short delay time P14.1.2 has elapsed.

#### **P14.3**      **SHORT RESTART DELAY TRIES**

#### **P14.4**      **LONG RESTART DELAY**

After a certain number of failed attempts (P14.1.3), the time between start attempts will change to long delay time P14.1.4.

If the drive can run continuously for the same long delay time, next start attempts will begin with short delay again. The same sequence is applied in case a running drive stops because of a temporary decrease in solar power.

**Note!** If the drive is supplied by mains, the drive is always enabled to start from external command.

### 4.13.2 MPPT

Generally, the MPP voltage of a panel is higher when the available power is high (good irradiation, low temperature).

The output power to the motor is considered an indicator of the panel state: if the drive can progressively increase motor speed and get a good amount of power, it means that the panel has basically "high" MPP voltage.

The DC voltage reference for the regulator is automatically changed by the MPP Tracker.

It results from four parallel algorithms:

- Feed-forward controller
- Correction controller
- Oscillation damping regulator
- Local Maxima logic

#### 4.13.2.1 MPPT feed-forward parameters

MPP feed-forward controller continuously changes the reference from  $V_{mp@10\%}$  to  $V_{mp@100\%}$ , according to actual motor power. The main purpose of this term is to follow variation of irradiation.

#### **P14.5 VMP AT 100% POWER**

#### **P14.6 VMP AT 10% POWER**

The  $V_{mp}$  parameters should be obtained from panel characteristics, considering standard temperature and irradiation at 10% and 100% level.

If the second value is not known, subtract 50-60V from the first value as a rough estimation.

The accuracy of these values is not really critical, because the correction logic can easily compensate error of some tens of volts. It is better to set values possibly higher than the real ones, and let the correction decrease the voltage reference, to get maximum power.

#### **P.14.7 PANEL/MOTOR RATIO**

In case the solar panels have less maximum power than the motor, a value lower than 100% should be set in P14.7.

#### 4.13.2.2 MPPT regulator

The drive tries to get the maximum power from solar panels by keeping the DC voltage at the optimum point (Max Power Point).

There is a PI regulator that changes the internal frequency reference, so that the power sent to the motor keeps the panels working on MPP.

The voltage reference can be monitored (V2.1) and compared to actual DC voltage (V1.9), to check the effect of gain tuning.

Continuous, low amplitude and high frequency oscillations mean gains too high.

Ramp times are meant to smooth the output frequency, but without introducing significant delay in response.

#### **P14.8 P GAIN**

Proportional gain [Hz/V]. If set to 1.000, a variation of 1V on DC bus voltage causes a variation of 1Hz on frequency reference

#### **P14.9 I GAIN**

Integral gain [Hz/Vxs]. If set to 1.000, a variation of 1V on DC bus voltage causes a variation of 1Hz per second on frequency reference.

#### **P14.10 ACCELERATION TIME**

Time from minimum to maximum frequency. Used only when solar power is active.

#### **P14.11 DECELERATION TIME**

Time from maximum to minimum frequency. Used only when solar power is active.

#### 4.13.2.3 MPPT correction parameters

This algorithm changes the DC voltage reference, to compensate temperature variations (usually slow) and to correct the error in feed-forward curve.

Correction can be up to +/- 150V.

The correction term is determined by “perturb-and-observe” logic (P&O).

#### **P14.12**      **P&O UPDATE TIME**

#### **P14.13**      **P&O VOLTAGE STEP**

DC voltage reference is periodically (at intervals defined by P14.12) increased or decreased by a small value (P14.13). If the variation brings a higher motor power, next variation will follow the same direction, otherwise it will be reversed.

A short perturb period (P14.12) makes the regulation faster, assuming that the PI gains are not too low (power variation has to complete within the period).

The correction term can be monitored (V2.2), to help the tuning of reference feed-forward. When the panels temperature is close to standard, 25°C, the correction term should result small (+/- 20 to 30V).

The correction decreases towards negative maximum as temperature increases.

The correction term increases towards positive maximum in case of low temperature.

If something different is observed, feed-forward values should be improved.

#### **P14.14**      **P&O POWER VARIATION**

P14.14 determines the variation in motor power, above which iteration of voltage reference change continues in the same direction.

Small value leads to a regulation very close to the maximum of the panel curve, with possible instability. Higher values lead to a more stable point, but with lower efficiency.

**4.13.2.4 P&O in local max points**

A panel with partial irradiation, or somehow defective, could cause a discontinuity on the power/voltage curve of the array. In this situation the basic P&O logic (perturb and observe) could lead to a local maximum point, that is not corresponding to maximum available power.

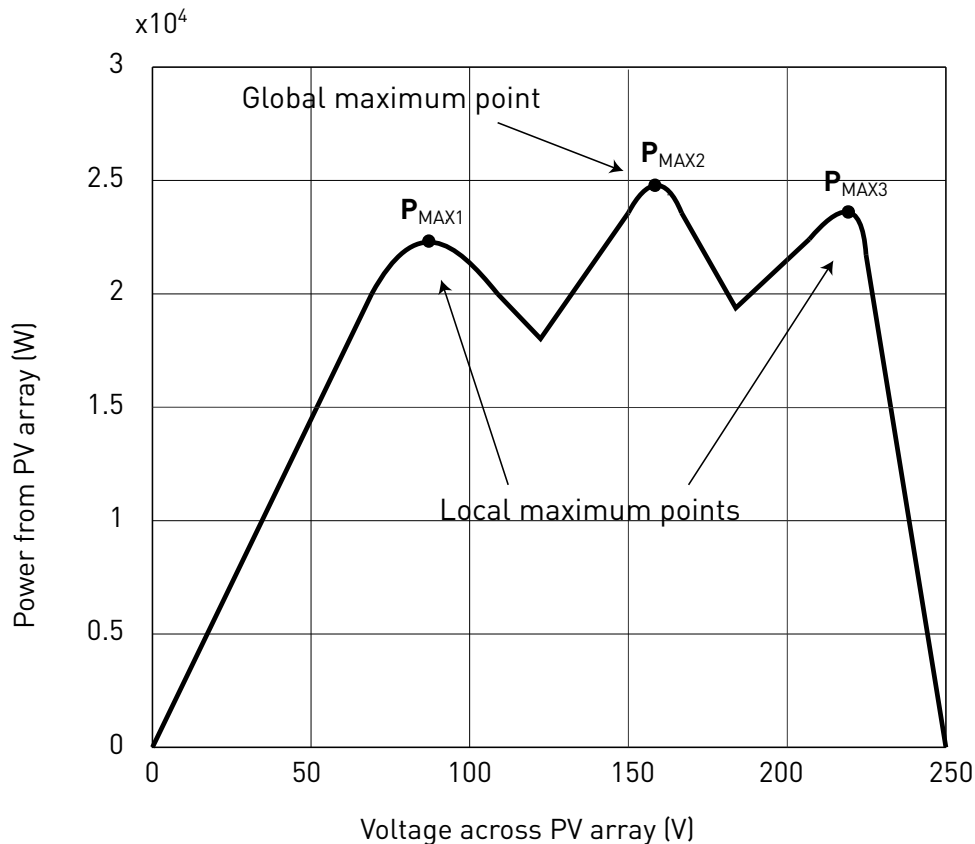


Figure 19.

**P14.15 P&O LOCAL MAX STEP**

To bypass discontinuity on power/voltage curve of array, after having reached a stable point, the P&O takes a bigger downward step (P14.15) in voltage. This step allows to overcome the local maximum and continue to search for the actual MPP.

If the point is the real MPP, the lower voltage reference will cause a drop in DC voltage and some oscillations, that are recognized and automatically damped by increasing the DC voltage reference.

The function can be disabled by programming P14.15= 0V.

**P14.16 P&O LOCAL MAX TIME**

Further attempts to reach a higher MPP after an unsuccessful attempt will follow only after the programmable masking time (P14.16).

**P14.17 P&O LOCAL MAX FREQ**

The downward step is done only when output frequency is above minimum frequency + P14.17.

**4.13.2.5 MPPT Oscillation Damping**



If the power regulation enters the “current source” branch of the panel current/voltage characteristic, the typical result is a oscillation in DC voltage and output frequency. The damping logic recognizes oscillation in DC voltage and quickly increases the voltage reference correction term. This brings the panels back in “voltage source” branch.

#### **P14.18      *DAMPING SENSITIVITY***

P14.18 parameter determines the amplitude of oscillation, to be recognized.

If the value is too low, normal variation in voltage level could be considered oscillation, and the DC voltage reference incorrectly increased.

#### **P14.19      *DAMPING TIME***

Oscillation is recognized when the logic sees three maximum and minimum point during the time defined by P14.19.

If the time is too short, the logic could fail with slow oscillations.

If the time is too long, spaced and unrelated min and max points could be confused with an oscillation.

#### **P14.20      *SLEEP IN SOLAR MODE***

This parameter enables or disables the sleep fuction:

0: Disabled

1: Managed with P12.12 and P12.13

When P14.20 =1, the drive will stop if the output frequency is below the value in P12.12, for the time in P12.13. It will restart as after a stop due to low power.

Sleep function allows to program a minimum frequency P1.1 that is below the efficient range of the pump. MPPT can reach this low value, leading to a minimum output power and avoiding to stop the drive in case of temporary reduced irradiation. If the condition persists, sleep logic will then stop the drive.

#### 4.14 FLOW METER

This group is to setup the flow meter sensor.

##### **P15.1 FLOW METER SIGNAL**

Flow meter selection:

- 0: Not used
- 1: Digital pulse
- 2: AI1
- 3: AI2

##### **P15.2 FLOW AT MAX ANLG SIGNAL**

Considered when flow meter signal is from analogue input. It is the flow value at maximum signal level of the analogue input.

##### **P15.3 PULSE OUTPUT VOLUME**

Considered when flow meter signal is from digital input. It is the total water volume for each pulse.

## 5. FAULT TRACING

| Fault code | Fault name   | Subcode | Possible cause   | Remedy  |
|------------|--------------|---------|--|---|
| 1          | Overcurrent  |         | AC drive has detected too high a current ( $>4 \cdot I_{\mu}$ ) in the motor cable: <ul style="list-style-type: none"> <li>• sudden heavy load increase</li> <li>• short circuit in motor cables</li> <li>• unsuitable motor</li> </ul>                          | Check loading.<br>Check motor.<br>Check cables and connections.<br>Make identification run.<br>Check ramp times.  |
| 2          | Overvoltage  |         | The DC-link voltage has exceeded the limits defined. <ul style="list-style-type: none"> <li>• too short a deceleration time</li> <li>• brake chopper is disabled</li> <li>• high overvoltage spikes in supply</li> <li>• Start/Stop sequence too fast</li> </ul> | Make deceleration time longer.<br>Use brake chopper or brake resistor (available as options).<br>Activate overvoltage controller.<br>Check input voltage.             |
| 3          | Earth fault  |         | Current measurement has detected that the sum of motor phase current is not zero. <ul style="list-style-type: none"> <li>• insulation failure in cables or motor</li> </ul>  | Check motor cables and motor.   |
| 8          | System Fault | 84      | MPI communication crc error  | Reset the fault and restart.<br>Should the fault re-occur, contact the distributor near to you.   |
|            |              | 89      | HMI receives buffer overflow   | Check PC-drive cable.<br>Try to reduce ambient noise  |
|            |              | 90      | Modbus receives buffer overflow  | Check Modbus specifications for time-out.<br>Check cable length.<br>Reduce ambient noise.<br>Check baudrate.  |
|            |              | 93      | Power identification error   | Try to reduce ambient noise.<br>Reset the fault and restart.<br>Should the fault re-occur, contact the distributor near to you.                                       |
|            |              | 97      | MPI off line error   | Reset the fault and restart.<br>Should the fault re-occur, contact the distributor near to you.   |
|            |              | 98      | MPI driver error   | Reset the fault and restart.<br>Should the fault re-occur, contact the distributor near to you.   |
|            |              | 99      | Option board driver error  | Check contact in option board slot<br>Try to reduce ambient noise;<br>Reset the fault and restart.<br>Should the fault re-occur, contact the distributor near to you. |

Table 29. Fault codes and descriptions.

| Fault code | Fault name                 | Subcode   | Possible cause                      | Remedy  |
|------------|----------------------------|---|-------------------------------------|---|
| 8          | System Fault               | 100   | Option board configuration error    | Check contact in option board slot<br>Try to reduce ambient noise;<br>Should the fault re-occur, contact the distributor near to you.   |
|            |                            | 101   | Modbus buffer overflow              | Check Modbus specifications for time-out.<br>Check cable length.<br>Reduce ambient noise.<br>Check baudrate.                            |
|            |                            | 104   | Option board channel full           | Check contacts in option board slot.<br>Try to reduce ambient noise.<br>Should the fault re-occur, contact the distributor near to you. |
|            |                            | 105   | Option board memory allocation fail | Check contacts in option board slot.<br>Try to reduce ambient noise.<br>Should the fault re-occur, contact the distributor near to you. |
|            |                            | 106   | Option board Object queue full      | Check contacts in option board slot.<br>Try to reduce ambient noise.<br>Should the fault re-occur, contact the distributor near to you. |
|            |                            | 107   | Option board HMI queue full         | Check contacts in option board slot.<br>Try to reduce ambient noise.<br>Should the fault re-occur, contact the distributor near to you. |
|            |                            | 108   | Option board SPI queue full         | Check contacts in option board slot.<br>Try to reduce ambient noise.<br>Should the fault re-occur, contact the distributor near to you. |
|            |                            | 111   | Parameter copy error                | Check if parameter set is compatible with drive.<br>Do not remove Keypad until copy is finished.  |
|            |                            | 113   | Frequency detective timer overflow  | Check keypad contacts.<br>Try to reduce ambient noise.<br>Should the fault re-occur, contact the distributor near to you.               |
|            |                            | 114   | PC control time out fault           | Do not close VACON® Live when PC control is active.<br>Check PC-Drive cable.<br>Try to reduce ambient noise.                            |
| 115        | DeviceProperty data format | Reset the fault and restart.<br>Should the fault re-occur, contact the distributor near to you. |                                     |   |

Table 29. Fault codes and descriptions.

| Fault code | Fault name                | Subcode | Possible cause  | Remedy   |
|------------|---------------------------|---------|---|--|
|            |                           | 120     | Task stack overflow   | Reset the fault and restart.<br>Should the fault re-occur, contact the distributor near to you.  |
| 9          | Undervoltage              |         | DC-link voltage is under the voltage limits defined. <ul style="list-style-type: none"> <li>• most probable cause: too low a supply voltage</li> <li>• AC drive internal fault</li> <li>• defect input fuse</li> <li>• external charge switch not closed</li> </ul> <b>NOTE!</b> This fault is activated only if the drive is in Run state. | In case of temporary supply voltage break reset the fault and restart the AC drive. Check the supply voltage. If it is adequate, an internal failure has occurred. Contact the distributor near to you.                          |
| 11         | Output phase              |         | Current measurement has detected that there is no current in one motor phase.   | Check motor cables and motor.  |
| 13         | AC drive undertemperature |         | Too low temperature measured in power unit's heatsink or board. Heatsink temperature is under - 10°C.   | Check the ambient temperature.   |
| 14         | AC drive overtemperature  |         | Too high temperature measured in power unit's heatsink or board. Heatsink temperature is over 100°C.  | Check the correct amount and flow of cooling air.<br>Check the heatsink for dust.<br>Check the ambient temperature.<br>Make sure that the switching frequency is not too high in relation to ambient temperature and motor load. |
| 15         | Motor stalled             |         | Motor is stalled.   | Check motor and load.<br>Insufficient motor power, check motor stall protection parametrization.   |
| 16         | Motor overtemperature     |         | Motor is overloaded.  | Decrease motor load.<br>If no motor overload exists, check the temperature model parameters.   |
| 17         | Motor underload           |         | Motor is under loaded   | Check load. Check underload protection parametrization.  |
| 19         | Power overload            |         | Supervision for drive power   | Drive power is to high: decrease load.   |
| 25         | Watchdog                  |         | Error in the microprocessor monitoring<br>Malfunction<br>Component fault  | Reset the fault and restart.<br>If the fault occurs again, please contact your closest VACON® representative.  |
| 27         | Back EMF                  |         | Protection of unit when starting with rotating motor  | Reset the fault and restart.<br>Should the fault re-occur, contact the distributor near to you.  |
| 30         | STO fault                 |         | Safe torque off signal does not allow drive to be set as ready  | Reset the fault and restart.<br>Should the fault re-occur, contact the distributor near to you.  |

Table 29. Fault codes and descriptions.

| Fault code | Fault name                   | Subcode | Possible cause   | Remedy   |
|------------|------------------------------|---------|--|--|
| 35         | Application error            | 0       | Firmware Interface version between Application and Control not matching  | Load a compatible application. Please contact your closest VACON® representative.  |
|            |                              | 1       | Application software flash error   | Reload Application   |
|            |                              | 2       | Application header error   | Load a compatible application. Please contact your closest VACON® representative.  |
| 41         | IGBT temp                    |         | IGBT temperature (UnitTemperature + I2T) too high  | Check loading.<br>Check motor size.<br>Make identification run.  |
| 50         | 4 mA fault (Analog input)    |         | Selected signal range: 4...20 mA (see Application Manual)<br>Current less than 4 mA<br>Signal line broken detached<br>The signal source is faulty  | Check the analog input's current source and circuit.   |
| 51         | External fault               |         | Error message on digital input. The digital input was programmed as an input for external error messages. The input is active.                     | Check the programming and check the device indicated by the error message.<br>Check the cabling for the respective device as well. |
| 52         | Keypad Communication fault   |         | The connection between the control keypad and the frequency converter is broken.   | Check keypad connection and keypad cable.  |
| 53         | Fieldbus communication fault |         | The data connection between the fieldbus master and fieldbus board is broken   | Check installation and fieldbus master.  |
| 54         | Fieldbus Interface error     |         | Defective option board or slot   | Check board and slot.  |
| 55         | Wrong run command            |         | Wrong run alarm and stop command   | Run forward and backward are activated at the same time  |
| 56         | Temperature                  |         | Temperature fault  | Board OPTBH is installed and measured temperature is above (or below) the limit  |
| 57         | Identification               |         | Identification alarm   | Motor identification has not been successfully completed   |
| 58         | Feedback Supervision Min     |         | The variation between setpoint and feedback is lower than min value P12.16 for the time P12.17   | Check settings and parameters of this protection.  |
| 59         | Feedback Supervision Max     |         | The variation between setpoint and feedback is higher than max value P12.18 for the time P12.19  | Check settings and parameters of this protection.  |
| 60         | Low DC Power                 |         | The drive has stopped due to insufficient power from solar panels. The drive cannot start because DC voltage is below the threshold level P14.1.1. | Check settings.  |
| 61         | Restart Delay                |         | The drive will start after the programmed delay.   |  |

Table 29. Fault codes and descriptions.

| Fault code | Fault name      | Subcode | Possible cause                          | Remedy   |
|------------|-----------------|---------|---|--|
| 63         | Low water level |         | The water level is not ok.              | Check settings and the minimum water level status. |
| 64         | Max water level |         | The water level is not ok.              | Check settings and the maximum water level status. |
| 71         | Unsupported     |         | Drive is not VACON® 20X or VACON® 100X. |  |
| 72         | Unsupported     |         | Drive has not solar property.           |  |

*Table 29. Fault codes and descriptions.*

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DPD01601F

Rev. F