• 15P00SDB100 •

SOLARDRIVE PLUS

AC DRIVE FOR SOLAR PUMPING APPLICATIONS

INSTALLATION AND PROGRAMMING GUIDE

Agg. 05/10/15
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SW Ver. 4.05x

English

- This manual is integrant and essential to the product. Carefully read the instructions contained herein as they provide important hints for use and maintenance safety.
- This product is to be used only for the purposes it has been designed to. Other uses should be considered improper and dangerous. The manufacturer is not responsible for possible damages caused by improper, erroneous and irrational uses.
- Elettronica Santerno is responsible for the product in its original setting.
- Any changes to the structure or operating cycle of the product must be performed or authorized by Elettronica Santerno.
- Elettronica Santerno assumes no responsibility for the consequences resulting by the use of non-original spare-parts.
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USER MANUALS MENTIONED IN THIS PROGRAMMING GUIDE

The following User Manual from Elettronica Santerno is mentioned throughout this Programming Guide:

- **15W0102B300** Safe Torque Off Function - Application Manual

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0.1. CHAPTERS

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1. GENERAL INFORMATION

1.1. General Information on the Product

Figure 1: Solardrive Plus Box

The **Solardrive Plus** line includes the following products:

1.1.1. Solardrive Plus

The **Solardrive Plus** drives are stand-alone drives designed to be utilized in pumping applications exploiting the energy produced by a PV field. They may be powered directly from a DC current PV field or the three-phase grid, or from an AC genset. The control an electric submersible pump (ESP).

For more information on the Solardrive Plus, stand-alone model, please contact ELETTRONICA SANTERNO.

1.1.2. Solardrive Plus Box

The **Solardrive Plus Box** models consist of a Solardrive Plus housed in a box. This is a complete solution for medium-low power ranges, comprising the drive and all the safety devices, the components required for the connection to the PV field and the components required for the connection to the pump.

The **Solardrive Plus Box product** line is suitable for motor mechanical power ratings ranging from 3 to 22 kW, with nominal currents up to 52 A, and output voltages up to 415 Vac 60 Hz.

Size	Nominal current		Applicable motor power			
	at 40°C	at 50°C	at 40°C		at 50°C	
	A	A	kW	HP	kW	HP
0018	17	13.6	5.5	7.5	4	5.5
0021	25	25	11	15	11	15
0024	40	40	15	20	15	20
0032	52	41.6	22	30	18.5	25

1.1.3. Solardrive Plus Cabinet

The **Solardrive Plus Cabinet** models consist of a Solardrive Plus housed in a cabinet. This is a complete solution for large power ranges, comprising the drive and all the safety devices, the components required for the connection to the PV field and the components required for the connection to the pump.

The **Solardrive Plus Cabinet** line is suitable for motor mechanical power ratings ranging from 26 to 315 kW, with nominal currents up to 640 A, and output voltages up to 415 Vac 60 Hz.

Taglia	Nominal current		Applicable motor power			
	at 40°C	at 50°C	at 40°C		at 50°C	
	A	A	kW	HP	kW	HP
0051	80.0	72.0	37	50	30	40
0069	105.0	84.0	51	70	37	50
0088	150.0	150.0	75	100	75	100
0164	230.0	184.0	110	150	92	125
0201	330.0	264.0	170	230	132	180
0259	400.0	320.0	190	260	170	230
0401	640.0	512.0	315	430	240	330

The Solardrive Plus and systems are designed and manufactured in Italy by Elettronica Santerno S.p.A.

1.2. Scope of this Manual

This manual covers:

- All products of the **Solardrive Plus** line.

1.3. For Whom this Manual is Intended

This manual must be read by:

- Installers
- Operators
- Plant manager

1.4. Symbols Used

KEY:

DANGER

Indicates an operating procedure which, if not carried out correctly, may lead to injuries or even death caused by electric shock.

WARNING

Indicates an operating procedure which, if not carried out correctly, may cause serious damage to equipment.

NOTE

Indicates important information concerning use of the equipment.

PROHIBITION

Strictly forbids the execution of operating procedures.

1.5. Definitions

Installer

Technician responsible for setting up, positioning and installing the equipment in compliance with the system diagram and in accordance with first-class, professional criteria.

Operator

Worker who has been suitably trained and informed on the risks and relative safety procedures to be adopted. The operator can carry out routine maintenance on the equipment.

Plant manager

Person who co-ordinates or manages system management activities and is responsible for ensuring health and safety standards are adhered to.

Technical room

Place used for housing the technological systems such as the wiring, plumbing, heating, air-conditioning, lifting and telecommunications systems.

It is equipped with suitable forced-air ventilation and/or air conditioning and is also fitted with appropriate safety devices governing access, maintenance and fire-prevention.

Person in charge of running the electrical system (System Manager)

Person with the highest level of responsibility concerning operation of the electrical system. If required some of his/her tasks may be delegated to others.

Person in charge of working activities (Works Supervisor)

Person with the highest level of responsibility concerning the execution of work. If required some of his/her tasks may be delegated to others.

The Works Supervisor must give all persons involved in the execution of work activities the relative instructions concerning reasonably foreseeable dangers which may not be immediately apparent.

Skilled electrician

Someone who has been trained and has enough technical knowledge or experience to enable him/her to avoid the dangers which may be generated by electricity.

Instructed person

Someone who has been adequately advised or supervised by a skilled person to enable him/her to avoid the dangers which may be generated by electricity.

1.6. Electrical and Mechanical Schematic

To facilitate understanding of the Electrical and Mechanical Schematic and help the user to identify the various parts illustrated therein, here is a description of how it has been drawn up.

The first page of the Electrical and Mechanical Schematic contains the technical features and configuration of the inverter, as illustrated below:

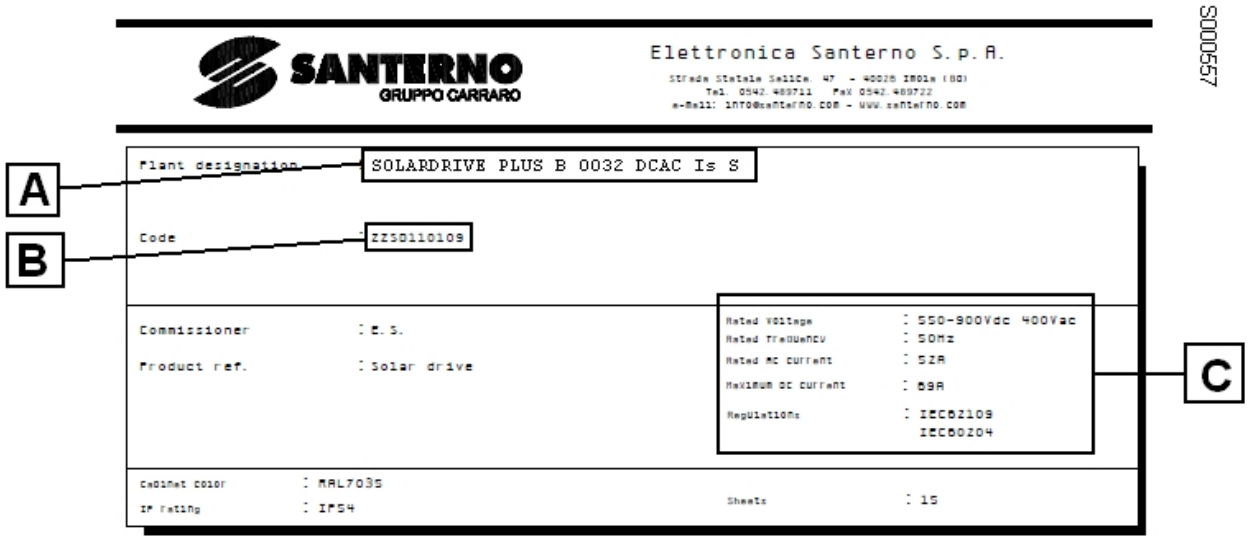


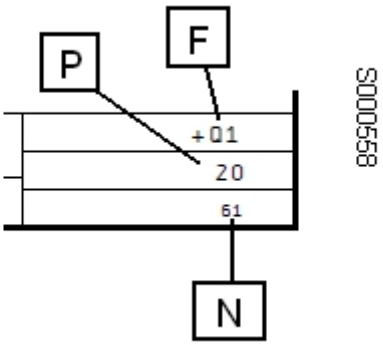
Figure 2: Cover page of the electrical schematic

A Type of product

B Part Number

C Technical Data

The pages of the electrical schematic are distinguished by three different numbers in the bottom right-hand corner:



F Location of the components: +Q1 = Inside the electrical cabinet
+Q1F = On the front of the electrical cabinet
+EXT = External device

P Progressive number of each sheet in the electrical schematic

N Number of the following sheet

The ID code for each component and conductor relates to the first page in which the component or conductor appears, usually based on the direction of energy flow, followed by a progressive number.

Cross-references are provided in the electrical schematic for conductors and components which appear on more than one page. The cross-reference format is: Sheet. Column.

1.7. References for the Electronic Board ID Codes

The table below indicates the electronic board ID codes used in the Electrical and Mechanical Schematic.

ID code	Description
ES942	EARTH LEAKAGE DETECTOR BOARD
ES853	POWER SUPPLY BOARD 24 V dc

2. CAUTION STATEMENTS

This section covers safety statements. The non-observance of the safety instructions below may cause serious injury or death and equipment failure. Carefully read the instructions below before installing, starting and operating the equipment.

Only competent personnel must carry out the equipment installation.

SAFETY RECOMMENDATIONS TO FOLLOW DURING USE AND INSTALLATION OF THE EQUIPMENT:

NOTE

Always read this instruction manual thoroughly before starting the equipment.

DANGER

ALWAYS EARTH THE EQUIPMENT.

OBSERVE THE PRESCRIPTIONS CONCERNING CONDUCTOR SECTION.

WARNING

Do not connect supply voltages which exceed the rated voltage. If voltage exceeding the rated value is applied, the internal circuits may be damaged.

In the event of an alarm, please consult section 6.7. Only restart the equipment once the problem has been rectified.

Do not carry out isolation tests between the power terminals or between the control terminals.

Make sure that the screws on the connection terminal board have been tightened correctly.

Observe the ambient conditions for installation.

The electronic boards contain components which are sensitive to electrostatic charges. Do not touch the boards unless absolutely necessary. Should this be the case, take all the necessary precautions to prevent damages caused by electrostatic charges.

2.1. Precautions for Use and Prohibitions

DANGER

RISK OF ELECTRIC SHOCK

NEVER carry out operations on the equipment when it is powered.

EXPLOSION AND FIRE RISKS

The risk of explosion or fire may exist if the equipment is installed in a room containing flammable vapours. Do not install the equipment where there is a risk of explosion or fire.

PROHIBITION

The product described in this manual has not been designed to operate in potentially explosive atmospheres. Consequently, installation in such an environment is strictly prohibited.

PROHIBITION

It is forbidden to make any technical or mechanical modifications to the cabinet even when out of warranty.

Elettronica Santerno is not responsible for any risks that may arise due to unauthorised alterations, modifications or tampering.

2.2. Intended Use

The Solardrive Plus products are digitally controlled drives which convert electrical energy from a DC power source produced by photovoltaic (PV) panels into AC current which is then utilized to power three-phase asynchronous motors.

The Solardrive Plus products may only be used as described in this manual. The DC power supply must come from the PV field only. The AC output must be parallel-connected to a three-phase asynchronous motor.

Any use other than that described in this manual is to be considered inappropriate and therefore improper.

2.3. Qualified Technical Personnel

All work on Solardrive Plus products must be carried out by skilled technical personnel only. By skilled personnel it is intended persons who have been suitably trained to carry out the work in question.

To commission and use the Solardrive Plus, personnel must know and understand the instructions for installation and use. In particular all safety warnings must be strictly observed

2.4. Specific Dangers Linked to Photovoltaic (PV) Systems

PV systems have certain characteristics which are the source of additional hazards and are described below:

- A live current source is connected. Depending on the operating conditions, there may be live voltage from the PV generator or from the electrical grid. This must be taken into consideration, particularly when disconnecting parts from the system.
- Very high DC voltages are involved (with no periodic zero crossings) hence failure or the incorrect use of fuses or plugs may cause electric arcs.
- The short-circuit current of the PV generator is only slightly higher than the maximum operating current and furthermore is linked to radiation. This means that fuses may not always blow in the event of a short-circuit.

- The PV generator grid is usually an IT type, i.e. it is only earthed in the event of a fault or energy leakage. For connection to PV fields with earthing pole, connection is of the TN type, but the earth connection is protected by a fuse which may trip in the event of a single fault.
- In the event of a fault (for example a short-circuit), cutting off a generator with a high number of branches may prove to be somewhat difficult. Take great care to ensure each sub-field disconnect switch has been opened before going near the devices installed in the technical room.
- If the PV lines coming from the PV generator cannot be cut off. Even if the disconnector located on the front part of the Solardrive Plus cabinet is open, some components remain live inside the cabinet upstream of the disconnect switch.

DANGER

Even if the disconnect switch located on the front part of the Solardrive Plus cabinet is open, some components are live inside the cabinet upstream of the disconnect switch.

2.5. Personal Protective Equipment

Maintenance technicians must be provided with the following personal protective equipment as envisaged by European Directives and relative implementation of the same on national territory.

SYMBOL		DESCRIPTION
	Safety glasses/face shield	Throughout operations.
	1000 V high-voltage insulated gloves	Throughout operations.
	Dielectric helmet	Throughout operations.
	Safety footwear/dielectric boots	Throughout operations.
	Insulated tools	Throughout operations.
	Operators must also be provided with a suitable means of communication for contacting the emergency services if necessary.	

NOTE

It is always advisable to work on the electrical cabinets with THE POWER SUPPLY SWITCHED OFF and the equipment in safety conditions (please refer to section 2.6).

2.6. Electric Connections: Safety Procedure

Before carrying out any kind of operation inside the inverter, always place the equipment in safety conditions. To do this follow the instructions provided below:

- Press the emergency pushbutton on the cabinet front part.
- Set the disconnector on the cabinet front part to “0”/OFF
- Wait at least 10 minutes before opening the cabinet doors.
- Open the disconnectors/circuit breakers (if any) upstream and downstream of the drive.
- Open the fuse-holders outgoing from the PV generator (marked as terminal boards X1 and X2).
- If the AC auxiliary power supply is applied, open the disconnectors/circuit breakers (if any) upstream of the drive.

DANGER

Dangerous voltages flow on the terminals in the fuse-holders incoming to the PV generator. Wear 1000 V dielectric gloves and safety goggles or visor.

DANGER

After turning off the inverter, wait at least 20 minutes before opening the cabinet doors to give the DC-link capacitors time to discharge.

DANGER

Opening the fuse-holders and the disconnector on the cabinet front part will remove voltage from the Solardrive Plus, but dangerous potentials persist on the terminals connecting the PV field (terminals X1 and X2) and, if present, on the terminals connecting the AC grid (terminals X5) (see Electrical Schematic).

3. GENERAL INFORMATION ON THE PRODUCT

3.1. Principle of Operation

The Solardrive Plus Box/Cabinet is a drive controlling AC motors (typically for water pumping), powered by DC power supplied from a PV field. If the solar radiation conditions range within the preset values, the motor starts running.

Thanks to a proprietary algorithm, the Solardrive Plus is capable of exploiting the maximum power made available from the PV field, in order to control the electropump under optimum performance conditions, even when solar radiation is weak.

A level switch stops the pump when the water tank is full. Based on the measured electric data, the Solardrive Plus is capable of detecting when the pump runs dry and stops it to avoid damaging the pump itself. The pump will be restarted based on custom pameterization in terms of start time and start mode.

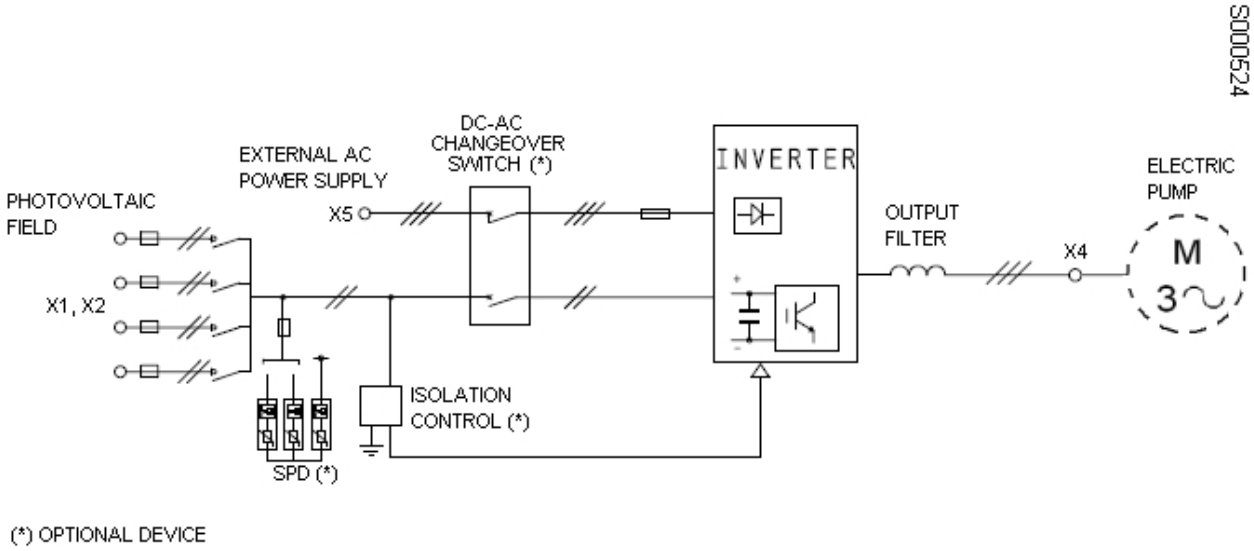


Figure 3: Single-line diagram of the Solardrive Plus Box

The Solardrive Plus Box is composed of the following functional blocks:

PV Field Interface Section
It includes:

- The inputs of each string in the PV field. Each input is provided with a fuse, both on the positive pole and on the negative pole.
- A Surge Protection Device for PV field-side overvoltage protection (optional).
- A device for PV isolation control, both isolated and with earthed pole, whose operating conditions are monitored and controlled by the drive (optional).

Interface Section with AC Auxiliary Power Supply (optional)
It includes:

- The input terminals for the auxiliary AC grid.
- A disconnector/DC/AC switch to switch from DC power supply (PV field) to auxiliary AC power supply.
- Input safety fuses.

Drive
It performs the following:

- Drives the electropump.
- Controls DC voltage by way of the Maximum Power Point Tracking (MPPT) algorithm.
- Monitors and controls the signals sent from the device for isolation control, from SPD etc.
- Controls the user interface display/keypad.

Electropump interface section
It includes:

- An output dU/dt filter.
- The terminals to be connected to the electropump cables.

3.2. Standard Supply and Standard Functions

The products of the Solardrive Plus Box come with the following components and functions:

3.2.1. Fuses for Direct Connection to PV Field

Fuses for direct connection to the PV field strings are provided for some Solardrive sizes.

Those fuses are marked as terminal blocks:

- X1 (positive pole)
- X2 (negative pole)

See section 5.3.4 for details.

Figure 4: Fuses for the connection to the PV field

3.2.2. Three-phase Output Filter

A three-phase inductor (dU/dt filter) between the drive AC output and terminal board X4 is installed on the Solardrive Plus Box and Cabinet line for the connection to the motor. That inductor is series-connected to the motor connection.

The output inductor protects the motor against high voltage gradients and limits overcurrent at the converter output, particularly in case of rather long motor connection cables.

See section 5.3.5 for details.

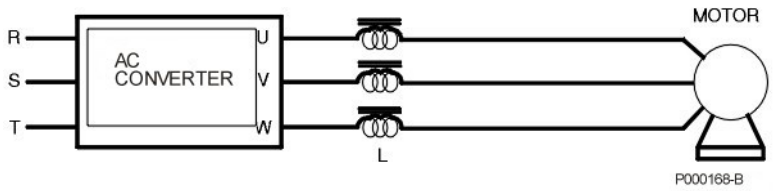


Figure 5: Output inductor connection

3.2.3. Digital Input for Level Control

The Solardrive is supplied with a digital input dedicated to the tank fill level control. When the tank is full, the electropump is stopped.

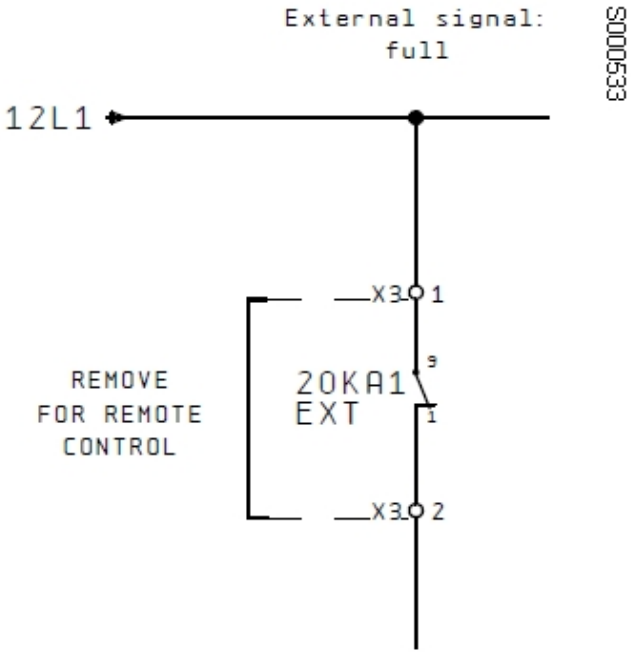


Figure 6: Level control input

Do the following to activate the level control input:

- Remove the bridge between terminals 1 and 2 in terminal block X3;
- Install a level sensor between terminals 1 and 2 in terminal block X3.

Use a sensor that makes a voltage-free contact available. The operation mode of the sensor is to be as follows:

- Open contact: motor stopped
- Closed contact: motor running

Figure 7: Terminal board X3 – Level control input

If the Solardrive does not feature the tank level control, do not remove the bridge between terminals 1 and 2 in terminal block X3, otherwise, the motor will not start running.

3.2.4. Serial Port

The Solardrive Plus Box/Cabinet is equipped with a serial comms port (COM0, serial link 0) for the connection to external devices, provided with 9-pin male D connector.

Use the 9-pin male D connector to establish a connection to serial link 0. The connector may be accessed by removing the cover on the top part of the drive for sizes S05..S15 (models 0018..0032 - Solardrive Plus Box), and on the bottom part of the drive next to the terminal block for sizes ≥ S20 (models 0051..0401 - Solardrive Plus Cabinet).

The serial port adopts RS485 electric standard and the MODBUS/RTU standard protocol.

See section 5.9 for details.

3.3. Optional Components and Functions

3.3.1. Input DC/AC Switch

The DC/AC switch selects the power supply source for the Solardrive Plus Box/Cabinet. Turn the switch handle located on the cabinet front part to the following positions:

- **I DC:** DC power supply from PV field.
- **Middle position:** No active power supply. The drive is off.
- **II AC:** AC power supply from auxiliary source.

The drive software controls the two power supply sources.

Figure 8: DC/AC Input switch

3.3.2. Earthed Option – PV Field Earthing

Some technologies adopted for the manufacture of PV modules require earthing a pole of the PV field. That earthing is called as follows:

- Positive Earthed, when the positive pole of the PV field is earthed.
- Negative Earthed, when the negative pole of the PV field is earthed.

Both the Positive Earthed option and the Negative Earthed option are available for the Solardrive Plus Box/Cabinet models. Both options are fully compatible with all PV modules available on the market.

All active parts of the Solardrive Plus Box/Cabinet are floating in respect to the earth potential. If a floating PV generator is connected to the drive, then, the overall system obtained upstream of the low frequency isolation transformer is IT type.

The Solardrive Plus Box/Cabinet drives featuring the Earthed option have the PV field positive pole connected to earth by means of a fuse. This system does NOT provide safety to people, but it only protects the negative pole against short-circuits to earth, thus avoiding overheating and fire risks.

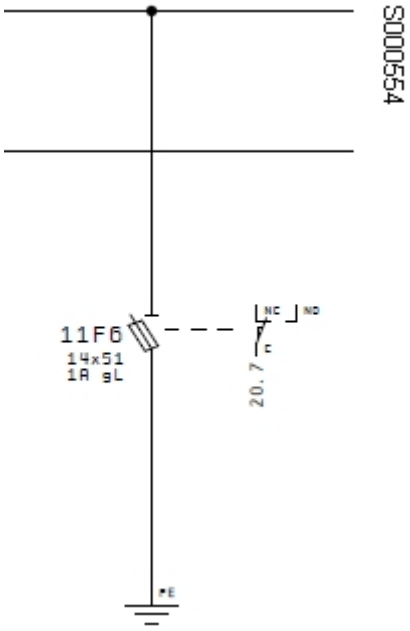


Figure 9: Positive Earthed Option – Connection of the positive pole to earth

Installing the Earthed option on the Solardrive Plus Box/Cabinet disables continuous isolation check.
If the safety fuse blows, alarm PV KO ISOLATION trips (due to pole earthing loss).

DANGER

The systems featuring an earthed pole are NON IT systems.

The earthed fuse is not a safety device against direct contacts.

If the earthed fuse blows, the field configuration may be floating. If the fault persists, the field configuration may be inverted in respect to the original configuration.

WARNING

The node underneath fuse 11F6 must be the only earth bonding connection point of the system.

Do not earth any other point of the PV field.

3.3.3. PV Field Isolation Control Option

The PV field isolation control option detects any PV field isolation losses. This option is applicable only if the PV field is isolated (Earthed option NOT fitted). Isolation control is implemented by ES942 isolation board.

The drive constantly checks isolation resistance between power supply and the earth and sends signals if isolation losses are detected.

The way how isolation loss is signalled when detected may be programmed as follows:

- Isolation loss detection triggers a WARNING that does not lock the equipment and the drive is kept running.
- Isolation loss detection triggers an ALARM that stops the drive.
- Isolation loss detection is disabled.

See section 6.6.9.

Figure 10: ES942 Isolation control board

The table below shows the position of Rotary Switch CE1 installed on ES942 isolation control board and the different values of the threshold isolation resistance triggering the alarm.

The rotary switch on ES942 board is factory set to 5 – 100 kΩ.

Rotary switch value	Resistive isolation value
0	30 KΩ
1	40 KΩ
2	50 KΩ
3	60 KΩ
4	80 KΩ
5	100 KΩ
6	130 KΩ
7	160 KΩ
8	POS EARTHED
9	NEG EARTHED

Table 1: Position of the rotary switch on ES942 control board

3.3.4. Surge Protection Device

The Solardrive Plus Box/Cabinet is protected against overvoltage at the PV field input by way of Class II Surge Protection Devices (SPD), suitable for protection against indirect discharges.

“Y” configuration is adopted, fully compatible with floating PV field installations.

The SPDs are referred to as 10AP1 in the electrical schematic.

Each SPD is protected by an integrated switch disconnector when the component is overloaded.

When the switch disconnector trips, alarm “SPD Tripped” is triggered.

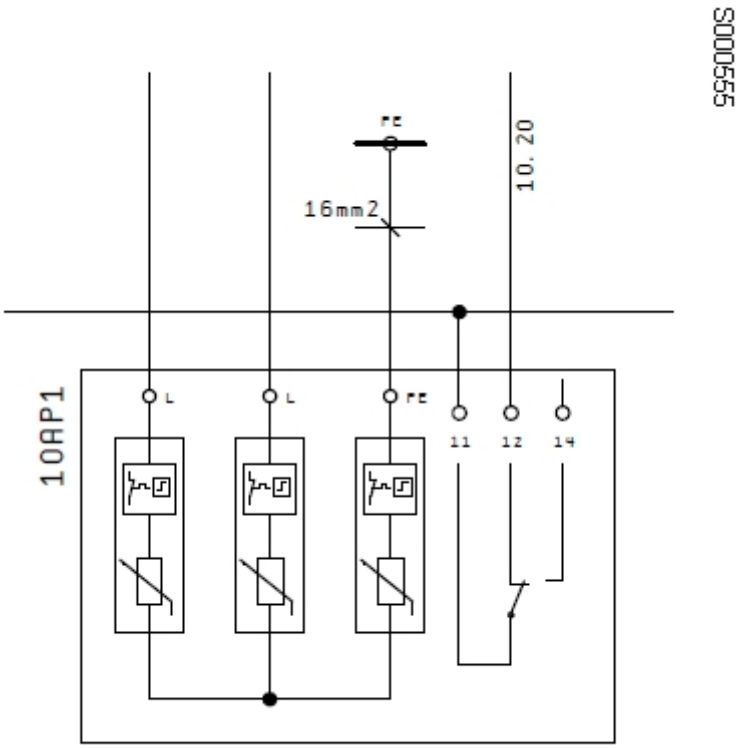


Figure 11: SPD (Surge Protection Device) as appearing on the electrical schematic

4. HANDLING AND ASSEMBLY

4.1. Product identification

4.1.1. Checking the Product on Delivery

On receiving delivery of the equipment make sure that the packaging shows no signs of damage. Check that it complies with your order by referring to the nameplates described below. In the event of any damage, please contact the relative insurance company or the supplier. If the delivery does not match your order, contact the supplier immediately.

If the equipment is to be stored before installation, make sure that the ambient conditions in the warehouse meet the necessary specifications (please refer to section 5.2). The warranty covers manufacturing defects. The manufacturer shall not be held liable for any damage which may have occurred during transport and unpacking. Under no circumstances shall the manufacturer be held liable for damage or faults caused by incorrect use, misuse, incorrect installation or inadequate temperature or humidity conditions or exposure to corrosives nor for faults caused by operation outside the rated values. Nor shall the manufacturer be held liable for consequential or accidental damage.

4.1.2. Product ID Code

The name identifying the product is given in the nameplate.

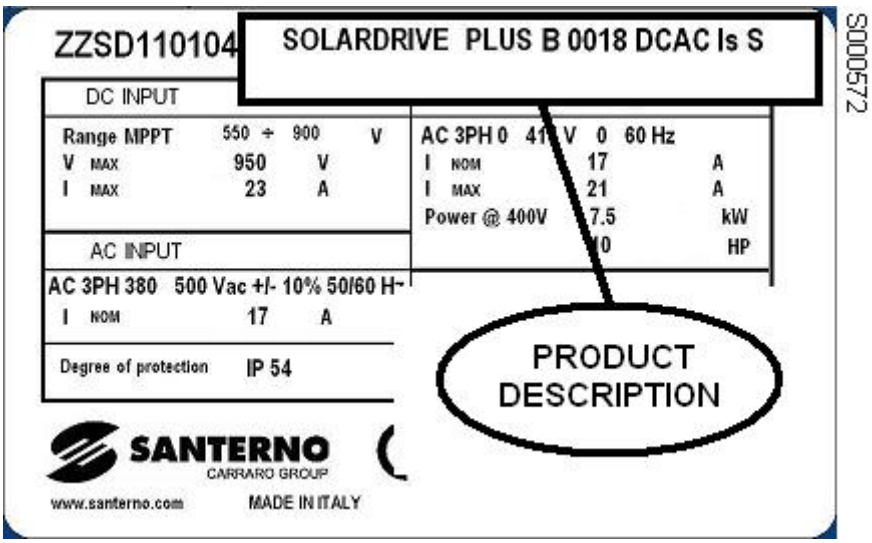


Figure 12: Product name in the nameplate

The product part number is made up of the following elements:

SOLARDRIVE PLUS X YYYY ZZZZ VvT SF

X	Type of cabinet	**B**: Box **C**: Cabinet
YYYY	Drive size	
ZZZZ	Type of power supply	**DC**: DC power supply (available only if a DC disconnetor is fitted) **DCAC**: DC and AC power supply (only if a DC/AC switch is fitted)

Vv	Isolation control	**Is**: Isolation control with isolated field (ES942) **Pp**: Earthed positive pole with fuse **Pn**: Earthed negative pole with fuse No field: no isolation control
T	Remote monitoring option	
S	Surge Protection Device (SPD) fitted	
F	Sinus Filter fitted	

Examples:

SOLARDRIVE PLUS B 0032 DCAC Is S

Solardrive Plus Box Size 0032 with DC/AC switch, isolation control implemented by ES942 board, Surge Protection Device (SPD) fitted

SOLARDRIVE PLUS C 0051 DC Pn SF

Solardrive Plus Cabinet Size 0051 with DC disconnect switch, earthed negative pole with fuse, Surge Protection Device (SPD), output sinus filter.

4.2. Commands on the Cabinet Front Part

Figure 13: Commands on the front wall of the Solardrive Plus Box

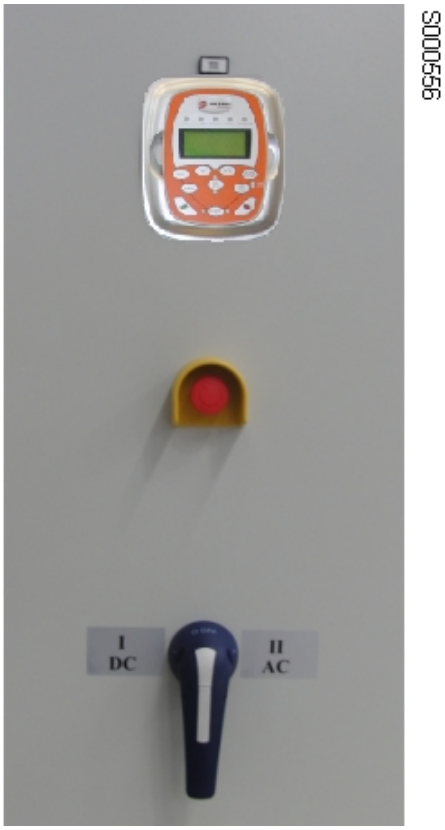


Figure 14: Commands on the front wall of the Solardrive Plus Cabinet

The following commands and devices are located on the cabinet front wall:

Display/keypad module

The display/keypad module allows doing the following (see section 6.2):

- Send the START, STOP and RESET commands (start, stop, alarm reset).
- Program the equipment parameters.
- Display measurements and signals of the operating conditions.

Emergency button (ref. +Q1F-20S1 on the electrical schematic)

The emergency button immediately stops the connected motor in safe mode (Safe Torque Off function). See Safe Torque Off Function - Application Manual.

DANGER

Pressing the emergency button stops the motor but does not guarantee that the motor is electrically disconnected. Dangerous voltages may flow in the motor even after pressing the emergency button.

DANGER

Pressing the emergency button does NOT cut off the cabinet power supply, both on DC side (PV field) and on AC side (if auxiliary power supply is available). The cabinet is live and all its components are kept running.

DC Disconnector (ref. 10F1 on the electrical schematic)

The DC disconnector connects the DC power supply (PV field) and the Solardrive Plus Box/Cabinet.

DANGER

Opening the DC disconnector on the cabinet front part cuts off power supply to the device, but dangerous potentials persist on the PV field connection terminals (terminals X1 and X2) and, if present, on the AC grid terminals (terminal board X5) (see Electrical schematic).

NOTE

The DC disconnector is installed alternatively to the Disconnector / DC/AC switch.

Disconnector / DC/AC switch

The Disconnector / DC/AC switch powers the Solardrive Plus Box/Cabinet from the DC power supply source (PV field) or the AC power supply source (auxiliary power supply) in a mutually exclusive way. An auxiliary contact conveys information on the switch position to the drive, which will manage the operating mode accordingly (PV mode/AC mode).

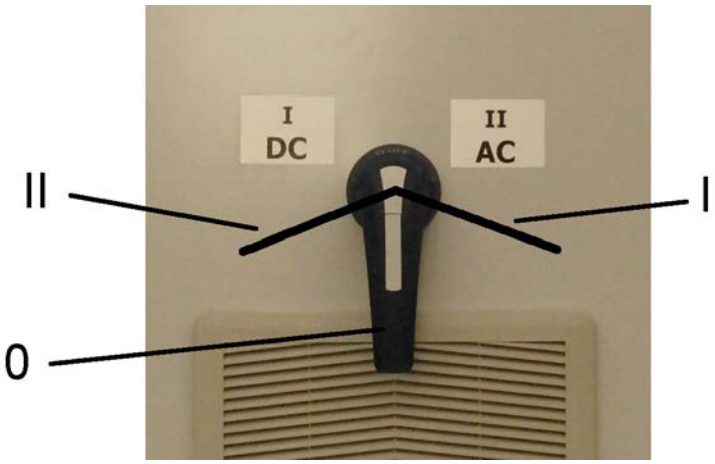


Figure 15: Disconnector / DC/AC switch

Positions of the Disconnector / DC/AC switch (Figure 15):

Pos.	Function	Description
0	Off	DC and AC power supply both OFF
I	DC mode	DC power supply from PV field ON (PV mode)
II	AC mode	AC power supply ON (AC mode)

DANGER

Opening the Disconnector / DC/AC switch on the cabinet front part cuts off power supply to the device, but dangerous potentials persist on the PV field connection terminals (terminals X1 and X2) and, if present, on the AC grid terminals (terminal board X5) (see Electrical schematic).

NOTE

This device is installed alternatively to the Disconnector / DC/AC switch.

4.3. Handling and Assembly

4.3.1. Conditions for Transport

Handling may be carried out using one of the following systems:

- Hoist
- Pallet jack
- Forklift

For further information, please consult section 5.6.

WARNING

For safety reasons and to ensure correct operation, it is strictly PROHIBITED to tilt Solardrive Plus Box/Cabinet forward or backwards.

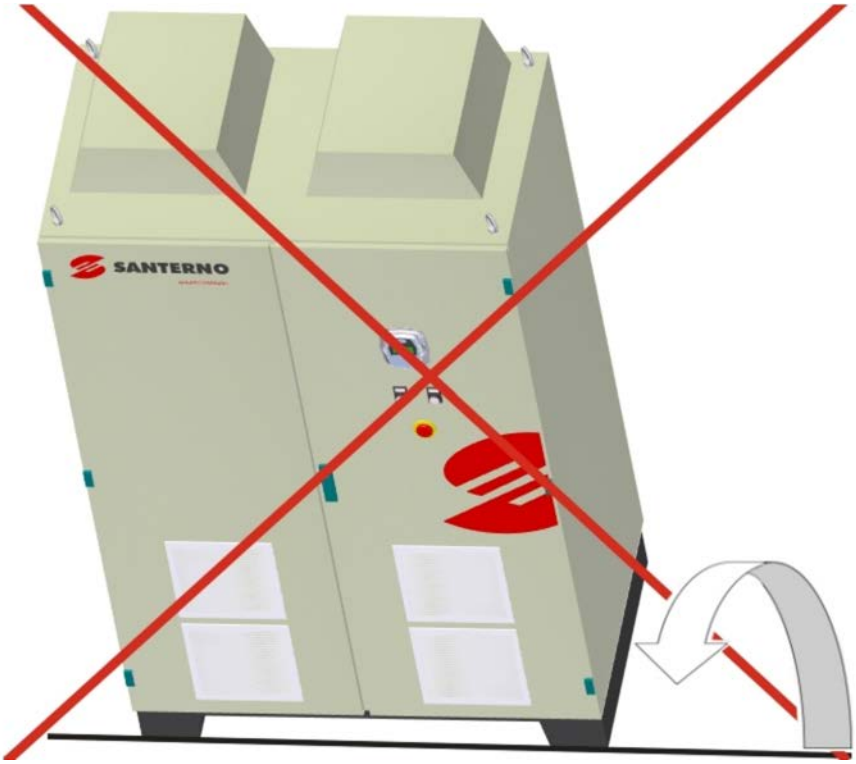


Figure 16: Cabinet tilting

4.3.1.1. Hoisting the Equipment

To hoist the equipment use the eyebolts and/or the perforated bars incorporated in the inverter frame. Make sure that the length of the hoisting ropes is such to form an angle which does not exceed 60°.

4.3.1.2. Crane Fork Hoisting

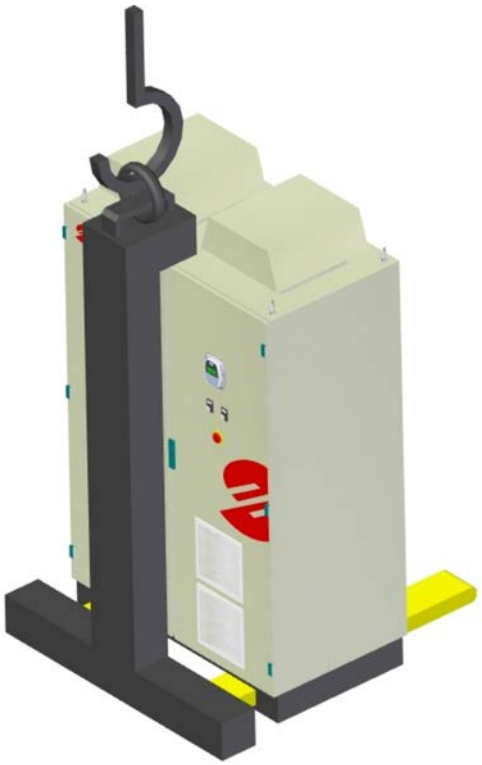


Figure 17: Hoisting the inverter with a crane fork

4.3.1.3. Handling Using a Pallet Jack or Forklift Truck

If the inverter is to be lifted from underneath, a forklift must be used. Position the fork tines in the spaces along the base which must be opened up beforehand by removing the central base panels.

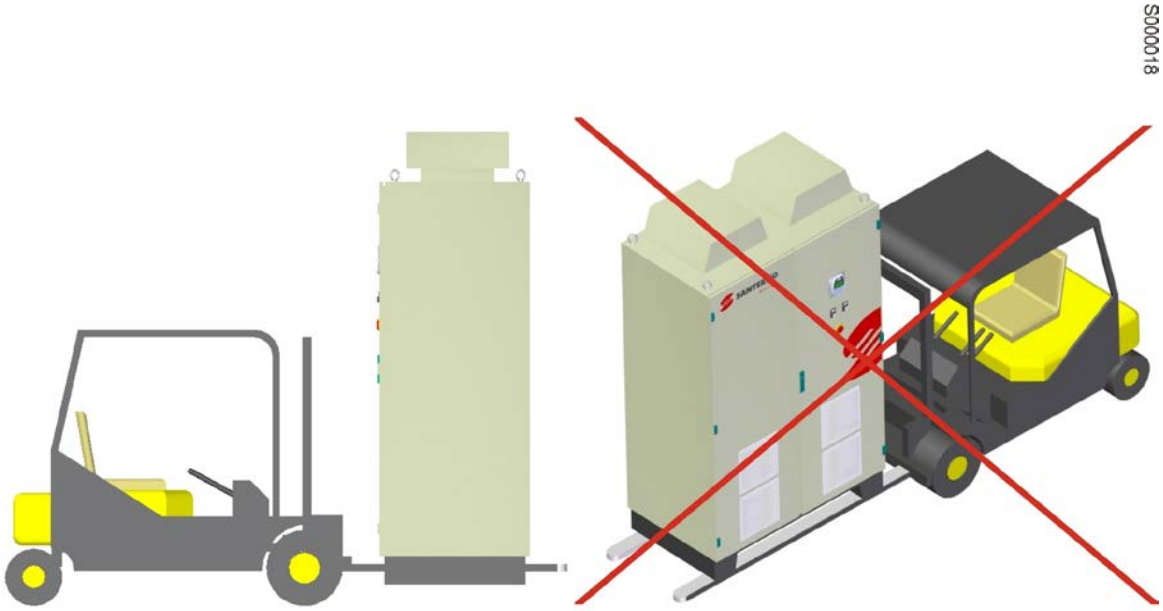


Figure 18: Lifting the equipment from underneath

4.3.1.4. Base

To lift the cabinet off the pallet and for final positioning, remove the front and back plates found on the base so that the forklift tines can be inserted under the cabinet.

After the cabinet has been positioned the openings can be closed off by replacing the plates.

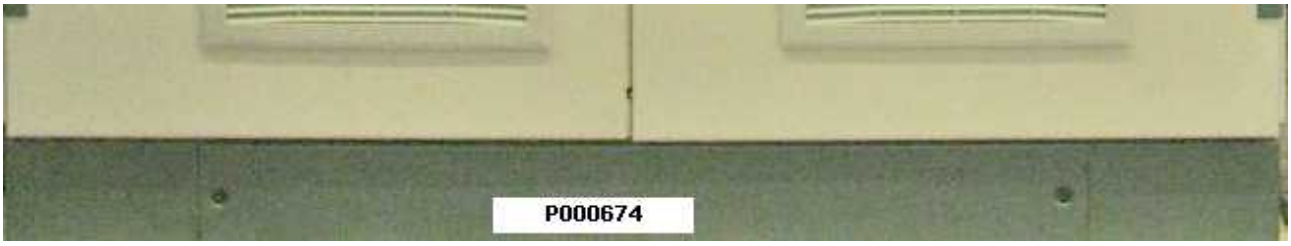


Figure 19: Base with removable plate

Figure 20: Base with the plate removed

4.3.2. Environmental Requirements for Storage and Transport

Required conditions	
Ambient temperature for storage and transport	-25 °C ÷ +60 °C
Ambient humidity for storage	From 5% – 95%, from 1 g/m^3 – 25 g/m^3, with no condensation or ice formation (category 3K3 in compliance with EN 50178).
Ambient humidity during transport	Maximum 95% up to 60 g/m^3. Slight condensation may occur when the equipment is not running (category 2k3 in compliance with EN 50178).
Atmospheric pressure for storage	86 – 106 kPa (categories 3k3 and 1k4 in compliance with EN 50178).
Atmospheric pressure during transport	70 – 106 kPa (category 2k3 in compliance with EN 50178).

Table 2: Environmental requirements for storage and transport

4.4. Installing the Product

The following parameters cover information on connecting power cables and signal cables.

4.4.1. Cable Connection Terminals

Terminal board	Type	Function
X1	Power	PV field positive pole
X2	Power	PV field negative pole
X3	Signals	Aux terminal board
X4	Power	Motor
X5	Power	AC power supply (optional)

Table 3: Cable connection terminals

4.4.2. Cable Input

4.4.2.1. BOX Cable Entry

In the Solardrive Plus Box, the cable entry is on the bottom part of the BOX. Cables go through the holes and are fastened with the cable-glands supplied.

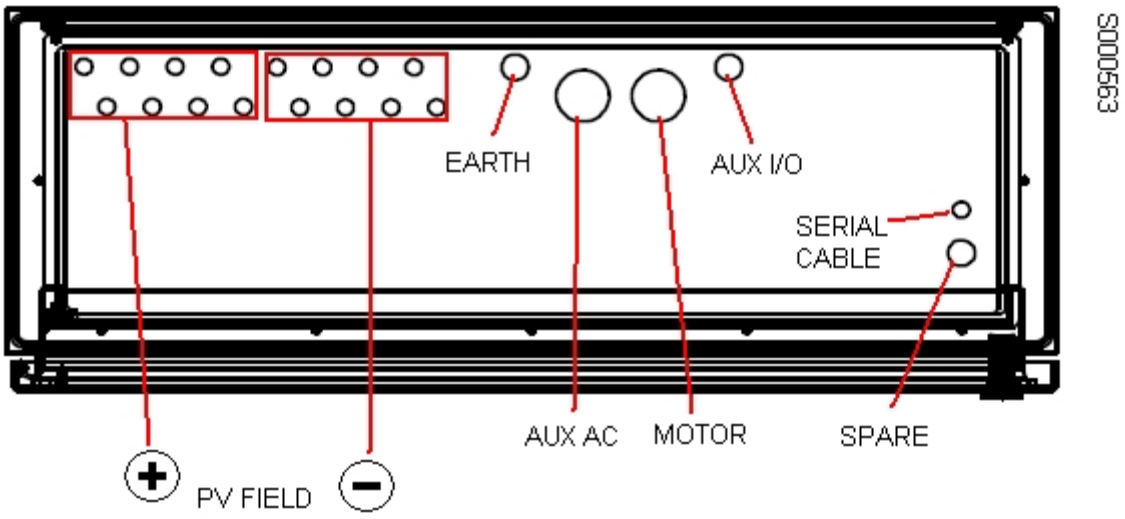


Figure 21: Holes on the bottom part of the Box

Cable entry is shown in the figure above. Terminal allocation is as follows:

PV FIELD +	X1
PV FIELD -	X2
EARTH	Earth bonding
AUX AC (if available)	X5
MOTOR	X4
AUX I/O	X3
SERIAL LINK CABLE	See section 5.9.

4.4.2.2. CABINET Cable Entry

Cable entry is from the bottom, through the holes pierced in the cabinet base. Remove the bottom panels to let cables in.

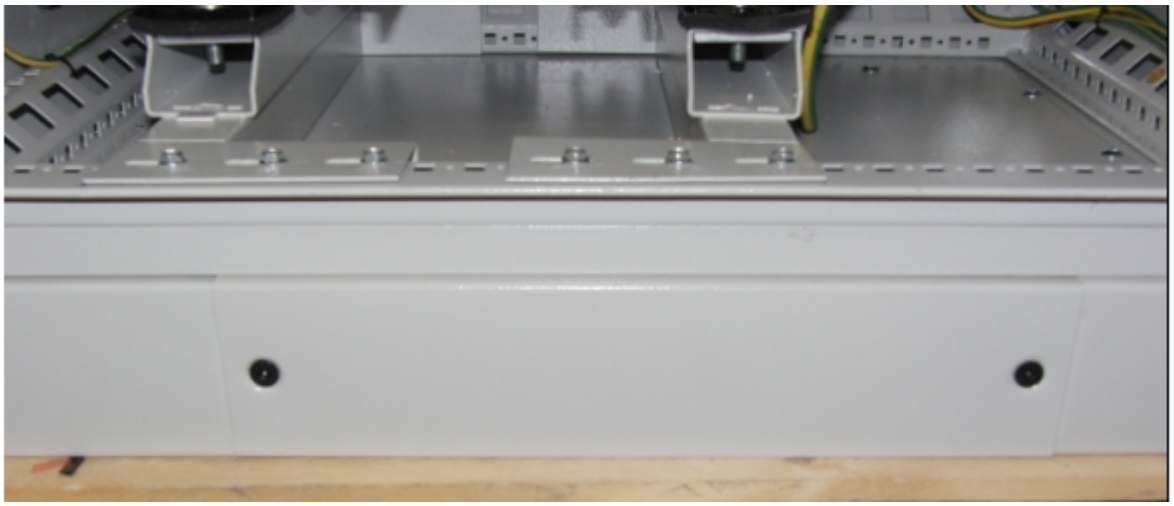


Figure 22: Panel closing the CABINET base

4.4.3. DC Cable Connection

For technical data related to the number of connectable cables, their maximum allowable cross-sections and the type of cable lugs, see section 5.7.1.

4.4.4. AC Cable Connection

For technical data related to the number of connectable cables, their maximum allowable cross-sections and the type of cable lugs, see section 5.7.2.

4.4.5. Earth Cable Connection

For technical data related to the number of connectable cables, their maximum allowable cross-sections and the type of cable lugs, see section 5.7.3.

4.4.6. Signal Cable Connection

For technical data related to the number of connectable cables, their maximum allowable cross-section and the type of cable lug, see section 5.7.4.

4.5. Commissioning

This section covers the basic commissioning procedures.

WARNING

Before interconnecting the PV field, check to see if all power connections, signal connections and auxiliary connections are properly tightened.

Before connecting the PV field cables to the Solardrive, check polarity of each individual string to the String Boxes (if fitted).

Check the following:

- Check if the disconnect switch (10Q1) on the cabinet front is set to OFF.
- Check if the emergency button is pressed.
- Gain access to terminal boards X1 and X2 and check polarity of the PV field input.
- Close the disconnect switch on the cabinet front part (or set the disconnector/switch to I-DC). Power supply will be applied to the drive and the Display/keypad will turn on.
- Enter the basic parameters as per the procedure in section 6.4 – Start Up Menu.
- Release the emergency push-button. If power and voltage available from the PV field are enough to start up the equipment, the equipment will start operating and the motor will start rotating.

4.6. Maintenance

Adequate maintenance ensures conversion performance and inverter reliability is maintained over time.

This heading describes all the activities required to keep machine parts which are subject to wear and deterioration and/or components which are essential for guaranteeing safety and optimum performance in good condition.

Access to products for the purpose of maintenance, modifications and management involves all persons responsible for production and maintenance. It must be carried out in observance of the health and safety regulations described in section 2.6.

The minimum maintenance interval is indicated in section 4.6.1.

Equipment installed in an environment where there is a high concentration of dust requires more frequent maintenance than generally indicated.

The operations above may stop the drive. Start the drive again when the procedures above are completed.

WARNING

Failure to observe the maintenance prescriptions may result in the product warranty conditions being nullified.

NOTE

In the event of any fault, please contact the Elettronica Santerno SpA CUSTOMER SERVICE for instructions on the necessary corrective action to be taken.

4.6.1. Maintenance Sheet

Maintenance Tasks	Minimum Frequency
Read the stored data and Fault List	Every month
Checking the external/internal conditions of the electrical cabinet	Every 6 months
Air filter maintenance	Every 6 months
Check the emergency stop button	Every 12 months
Checking the door microswitches	Every 12 months
Check gaskets	Every 12 months
Check locks and hinges	Every 12 months
Check the fans	Every 6 months
Check fuses and disconnect switches	Every 6 months
Check SPDs	Every 6 months
Check that cables and bars are securely tightened	Every 12 months
Check the condition of nameplate and warning signs	Every 24 months
The frequency of scheduled maintenance may need to be increased depending on the location in which the equipment is installed and the relative ambient conditions.	

Table 4: Maintenance Sheet

4.6.2. Reading the Fault List Archives

To guarantee correct operation of the system all its components must be correctly matched up. Incorrect operation leads to lower yields with a subsequent reduction in system profitability.

The inverter includes functions to warn the user of failures or faults affecting the system. Periodical checks of system operation are in any case still necessary for the detection of minor operating faults which are not associated with an alarm. The inverter's alarm memory and the data stored in the Data Logger (if installed) must be analysed at least once a month. To do this, proceed as described in section 6.5.6.

4.6.3. Checking the External/Internal Conditions of the Electrical Cabinet

Do the following:

OVERALL CONDITION OF THE CABINET:

- Check the external condition of the cabinet.
- Check the state of the insulating sheaths on the conductors.
- Check that there are no signs of overheating on the power conductors (especially near the connection points on the equipment).
- Check that there are no signs of cable gnawing caused by rodents.
- Check the state of all the signs/nameplates affixed to the equipment. Signs must always be in good condition and legible.

GENERAL CABINET CLEANING

- Check the interior of the cabinet for the build-up of dust, dirt, humidity and infiltration of water from the outside.
- Check that the ventilation ducts on the inductors are clear.

Should it be necessary to clean the Solardrive Plus, always adopt adequate measures. The electronic section in the Solardrive Plus series is well protected and hence does not require any maintenance.

Carry out a visual inspection only and clean the printed circuit board with a soft brush or a vacuum cleaner fitted with a soft cleaning tool. The cleaning accessories used must be antistatic tools in compliance with ESD specifications.

Do not use heavy brushes or brushes with coarse bristles.

NEVER use compressed air for cleaning operations.

DANGER

Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death!

NEVER work on the equipment unless it is switched off and disconnected from the power supply.

DANGER

Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death!

Do not touch any components other than those specifically indicated in the instructions.

4.6.4. Air Filter Maintenance

DANGER

Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death!

NEVER work on the equipment unless it is switched off and disconnected from the power supply.

The Solardrive Plus Box/Cabinet products are equipped with air intake grilles fitted with felt filters. Maintenance activities consist of replacing the felt filters.

The front air intake grille can be removed by inserting a screwdriver in the point indicated (Figure 23) and gently levering it out . The filter is held in a cavity in the air intake grille which is securely fastened to the cabinet door.

All air intake grille filters should be replaced at the same time, both passive filters and those installed on the fan units. The type of felt filters used must be suitable for the application.

For the relative technical specifications, please refer section 5.3.3. Replacement filters can be ordered from Elettronica Santerno.

NOTE

In the event of any fault, please contact the CUSTOMER SERVICE of Elettronica Santerno SpA for instructions on the necessary corrective action to be taken.

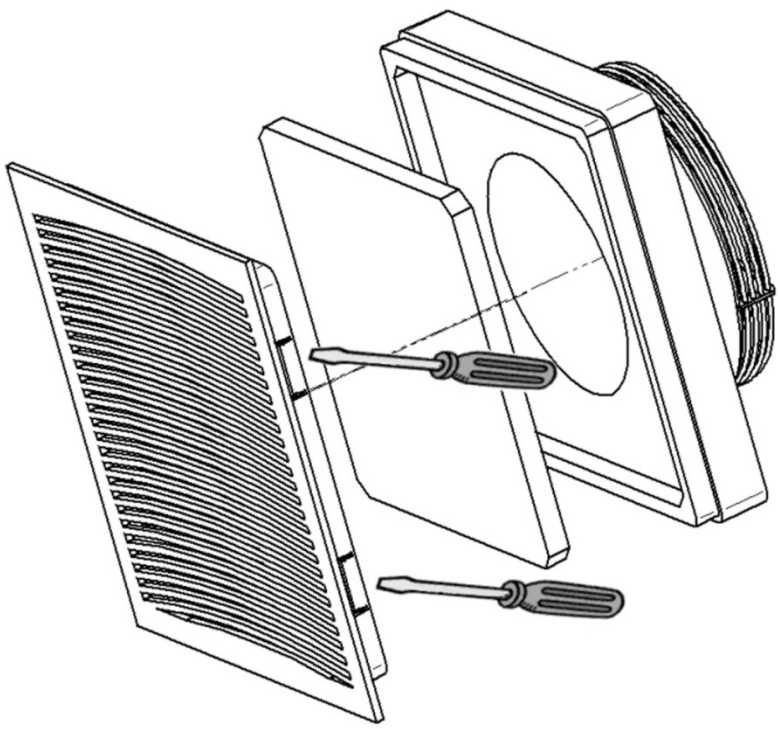


Figure 23: Filter replacement

4.6.5. Checking the Emergency Stop Button

DANGER

Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death!

Do not touch any components other than those specifically indicated in the instructions.

To check correct operation of the emergency stop switch, proceed as follows:

- RUN the drive.
- Press the emergency stop button.
- Make sure that the motor stops.
- Release the emergency stop circuit breaker.
- Make sure that the motor resumes operation.

4.6.6. Checking the Seals, Locks and Hinges

DANGER

Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death!

NEVER work on the equipment unless it is switched off and disconnected from the power supply.

To check the cabinet door seals, locks and hinges, proceed as follows:

- Visually inspect the cabinet seals for any signs of cracking or damage. Any seals showing signs of damage in the areas of door contact must be completely replaced.
- It is suggested to use talc to stop the seals from sticking to the sheet metal of the cabinet over time.
- Check correct operation of the inverter cabinet and compartment locks by locking and unlocking the doors.
- Check the door hinges operate smoothly.
- Spray all movable parts and parts subject to wear with a water-free lubricant.

4.6.7. Checking the Fans

DANGER

Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death!

Do not touch any components other than those specifically indicated in the instructions.

Check operation and noisiness of all the fans

4.6.8. Checking the Relays, Fuses and Disconnect switches

DANGER

Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death!

NEVER work on the equipment unless it is switched off and disconnected from the power supply.

This section refers to relays, fuses and fuse holders/disconnect switches located inside the cabinet.

- Visually inspect the installed fuses and the fixing springs on the fuse holders.
- If necessary, grease the contact points on the holders.
- Visually inspect the installed relays, checking that they fit well into their holders.

4.6.9. Checking the SPDs

DANGER

Electric shock and burns hazard: coming into contact with live PV field or grid components can lead to serious injury and even death!

NEVER work on the equipment unless it is switched off and disconnected from the power supply.

Inspect the state of the SPDs (Surge Protection Devices) by checking the status of the button/slot on the discharger.

The exact position of the SPDs can be seen on the Electrical and Mechanical Schematic.

Figure 24: Surge Protection Device

Button/slot Status	SPD Status
Button/slot with green indicator visible	SPD ready for use
Button/slot with red indicator visible	SPD faulty

See Table 16.

4.6.10. Checking the Tightening Torque

Solardrive Plus Box/Cabinet have special Belleville springs in all the internal tightening points for the copper bars and power cables. Usually no maintenance on these points is required.

However, for all tightening works carried out in the field, in order to guarantee correct tightness of the electrical contacts, periodical checking of the tightening torques is to be carried out over the equipment's life cycle.

- Check the tightness of all the terminal clamps for connecting the power wiring and tighten if necessary.
- Pay particular attention to any colour variations or anomalies concerning the insulation and the terminals.

Please refer to Table 12, Table 13, Table 14, Table 15, to section 5.7 and the inverter's Electrical and Mechanical Schematic.

5. TECHNICAL DATA

5.1. Nameplate

Each nameplate indicates the product's technical data and identification details.

- Name of the product.
- Part number assigned to the product by Elettronica Santerno.
- Technical data (rated input/output voltage and current, rated power, etc.)
- CE marking.
- Serial Number: identifies the product serial number

The nameplate measures 100 x 70 mm and is silver in colour.

Solardrive Plus Box/Cabinet nameplates are affixed to each individual device. They indicate all the data relative to the device.

Example of a nameplate on a Solardrive Plus Box:

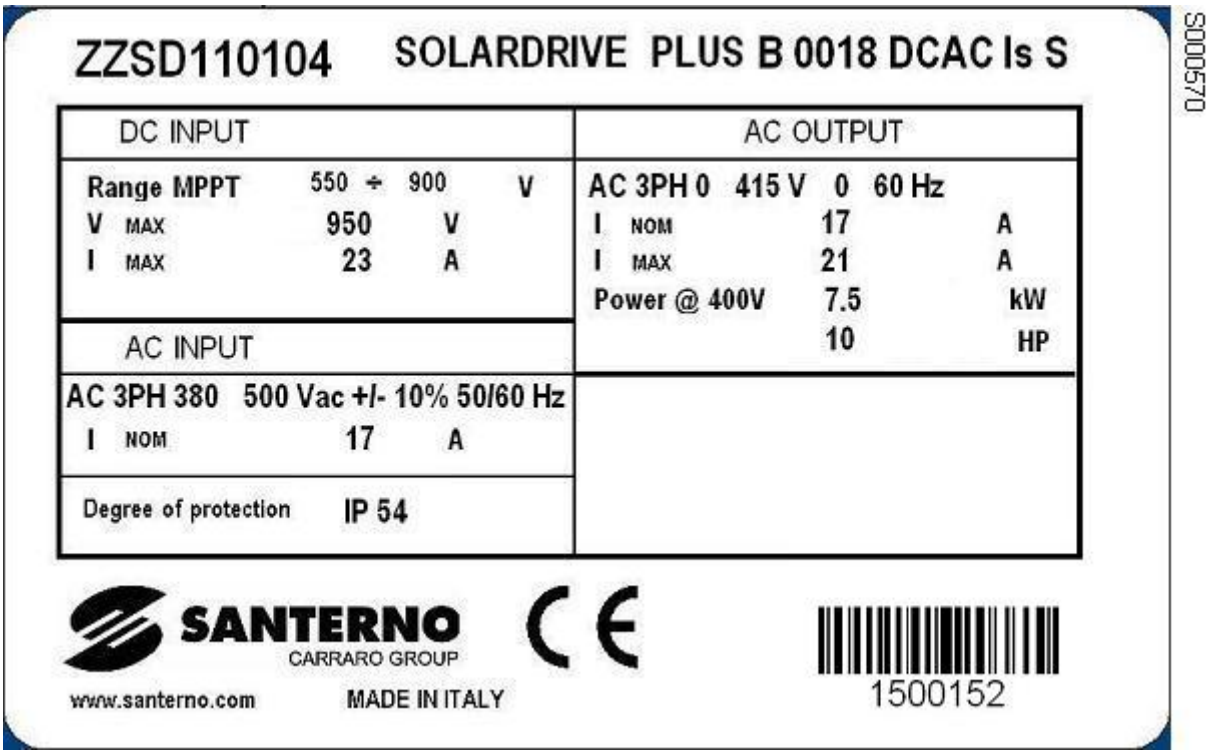


Figure 25: Solardrive Plus Box nameplate

Example of a nameplate on a Solardrive Plus Cabinet:

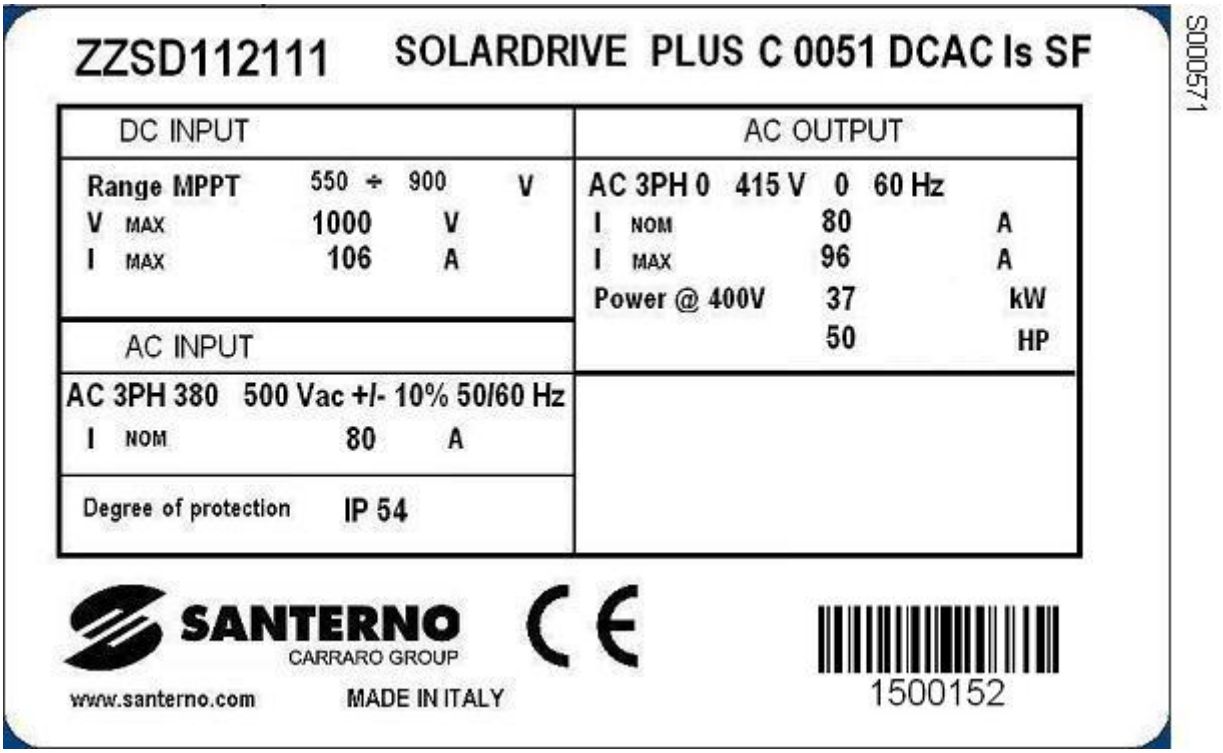


Figure 26: Solardrive Plus Cabinet nameplate

5.2. Installation Specifications

Installation specifications for the Solardrive Plus Box/Cabinet	
Operating ambient temperature	–10°C ÷ +55°C
Operating ambient humidity	From 5% – 95%, from 1 g/m^3 – 25 g/m^3, with no condensation or ice formation (category 3k3 in compliance with EN50178)
Altitude	Up to 2000 m a.s.l. For higher altitudes and up to 4000 m a.s.l., please contact Elettronica Santerno. Over 1000 m, derate the rated current by 1% every 100 m.
Installation site	Do not install the equipment where it is exposed to direct sunlight and atmospheric agents. Do not install where it is exposed to conductive dust, corrosive gases, vibrations, water spray or dripping or saline environments.
Degree of protection	IP54
Degree of pollution	Class 3S2 or better, according to IEC 60721-3-3.

Table 5: Installation specifications for Solardrive Plus Box/Cabinet

5.3. Electrical Specifications

5.3.1. Electrical Specifications for Solardrive Plus Box

SOLARDRIVE PLUS BOX (1)	0018	0021	0024	0032
DC INPUT				
Maximum input DC voltage	950 V	1000 V	1000 V	1000 V
Maximum input DC current(2)	23 A	33 A	53 A	69 A
PV field voltage range	550÷900 V	550÷900 V	550÷900 V	550÷900 V
Nr. input fuses for strings	4	8	8	8
AC INPUT (optional)				
Input AC voltage range	380÷500 V ± 10%			
Input AC frequency range	50÷60 Hz			
Rated input AC current	17 A	25 A	40 A	52 A
AC OUTPUT				
Output AC voltage range	0÷415 V			
Output AC frequency range	0÷60 Hz			
Rated output AC current (6)	17 A	25 A	40 A	52 A
Maximum output AC current (3) (6)	21 A	30 A	48 A	63 A
Rated output AC current @ 40°C (7)	17 A	25 A	40 A	52 A
Rated output AC current @ 50°C (7)	13.6 A	25 A	40 A	41.6 A
Applicable motor power @ 400 V, 40°C (7)	5.5 kW	11 kW	15 kW	22 kW
Applicable motor power @ 400 V, 50°C (7)	4 kW	11 kW	15 kW	18.5 kW
EFFICIENCY				
Maximum efficiency (4)	98.0%	98.5%	98.7%	98.8%
LOSSES				
Inverter power losses @ Inom	270 W	378 W	540 W	670 W
Power losses of standard output filter	48 W	70 W	96 W	150 W

SOLARDRIVE PLUS BOX (1)	0018	0021	0024	0032
Fans total power	24 W	24 W	24 W	24 W
Power losses of sinus filter (optional) (5)	95 W	121 W	105 W	361 W

Table 6: Solardrive Plus Box electrical specifications

(1) The values in the table may be changed to suit special applications.

(2) Maximum DC current that the inverter can accept as input current. However, a photovoltaic generator dimensioned for higher current ratings may be connected to the equipment with no risk to damage the inverter. If this is the case, the inverter will limit its power output so that the input current will not exceed the maximum DC current value given in the table above.

(3) Deliverable for 60 s every 10 min.

(4) Not including external fans; not including losses on output filter.

(5) Sinus filter, if present, replaces the standard output filter.

(6) Value related to the inverter when it is not in thermal derating mode.

(7) Ambient temperature external to the box.

5.3.2. Electrical specifications Solardrive Plus Cabinet

SOLARDRIVE PLUS CABINET (1)	0051	0069	0088	0164	0201	0259	0401
DC INPUT							
Maximum input DC voltage	1000 V	1000 V	1000 V	1000 V	1000 V	1000 V	1000 V
Maximum input DC current(2)	106 A	139 A	199 A	250 A	400 A	400 A	800 A
PV field voltage range	550÷900 V	550÷900 V	550÷900 V	550÷900 V	550÷900 V	550÷900 V	550÷900 V
Nr. input fuses for strings	12	-	-	-	-	-	-
AC INPUT (optional)							
Input AC voltage range	380÷500 V ± 10%						
Input AC frequency range	50÷60 Hz						
Rated input AC current	80 A	105 A	150 A	230 A	330 A	400 A	640 A
AC OUTPUT							
Output AC voltage range	0÷415 V						
Output AC frequency range	0÷60 Hz						
Rated output AC current	80 A	105 A	150 A	230 A	330 A	400 A	640 A
Maximum output AC current (3) (6)	96 A	135 A	200 A	300 A	420 A	560 A	850 A
Maximum output AC current @ 40°C (7)	80 A	105 A	150 A	230 A	330 A	400 A	640 A
Maximum output AC current @ 50°C (7)	72 A	84 A	150 A	184 A	264 A	320 A	512 A
Applicable motor power @ 400 V, 40°C (7)	37 kW	51 kW	75 kW	110 kW	165 kW	190 kW	315 kW
Applicable motor power @ 400 V, 50°C (7)	30 kW	37 kW	75 kW	92 kW	132 kW	165 kW	240 kW
EFFICIENCY							
Maximum efficiency (4)	98.9%	99.0%	99.0%	99.1%	99.0%	98.9%	99.0%
LOSSES							
Inverter power losses @ Inom	950 W	1200 W	1700 W	2500 W	3900 W	4950 W	7650 W
Power losses of standard output filter	183 W	272 W	342 W	342 W	752 W	752 W	752 W
Fans total power	53 W	53 W	86 W	86 W	98 W	98 W	181 W
Power losses of sinus filter (optional) (5)	361 W	354 W	526 W	526 W	740 W	740 W	740 W

Table 7: Solardrive Plus Cabinet electrical specifications

(1) The values in the table may be changed to suit special applications.

(2) Maximum DC current that the inverter can accept as input current. However, a photovoltaic generator dimensioned for higher current ratings may be connected to the equipment with no risk to damage the inverter. If this is the case, the inverter will limit its power output so that the input current will not exceed the maximum DC current value given in the table above.

(3) Deliverable for 60 s every 10 min.

(4) Not including external fans; not including losses on output filter.

(5) Sinus filter; if present, replaces the standard output filter.

(6) Value related to the inverter when it is not in thermal derating mode.

(7) Ambient temperature external to the box.

5.3.3. External Fan Felt Filters

	EN 779	EUROVENT
Type of felt filter	G3	EU 3

Table 8: Classification of the felt filter installed in the air intake grilles

5.3.4. Fuses for String Connection

Size	10x38 mm
Nominal voltage	1000 V DC
Nominal braking capacity	30 kA (L/R = 2 ms)
Class	gPV (I_f = 1.45 x I_n)

5.3.5. Output Inductors

The table below shows the ratings of the three-phase inductor series-connected to the motor connection.

	Size	Inductor value [mH]
BOX	**0018**	1.270
	0021	0.300
	0024	0.300
	0032	0.300
CABINET	**0051**	0.240
	0069	0.160
	0088	0.090
	0164	0.090
	0201	0.023
	0259	0.023
	0401	0.023

Table 9: Output inductor ratings

5.4. Nominal Current Derating

5.4.1. Altitude Derating

For installations over 1000 m a.s.l., consider a current derating of – 1% of the nominal current every 100 m.

5.5. Carrier Frequency

The table below indicates the minimum and maximum allowable frequency values per size. The carrier frequency is factory set to the minimum allowable value. Please contact Elettronica Santerno to change the carrier frequency value.

	Size	Minimum carrier frequency (kHz)	Maximum carrier frequency (kHz)
BOX	0018	3	5
	0021	3	5
	0024	3	5
	0032	3	5
CABINET	0051	3	5
	0069	3	5
	0088	3	4
	0164	3	4
	0201	3	4
	0259	3	4
	0401	3	4

5.6. Dimensions and Weights

5.6.1. Dimensions and Weights of the Solardrive Plus Box

SOLARDRIVE PLUS BOX (1)	0018	0021	0024	0032
Length	606 mm	806 mm	806 mm	806 mm
Depth	300 mm	300 mm	300 mm	300 mm
Height	806 mm	1006 mm	1006 mm	1006 mm
Weight	63 kg	95 kg	95 kg	95 kg

Table 10: Dimensions and weights of the Solardrive Plus Box

(1) Values related to standard output filter

5.6.2. Dimensions and Weights of the Solardrive Plus Cabinet

SOLARDRIVE PLUS CABINET (1)	0051	0069	0088	0164	0201	0259	0401
Length	600 mm	600 mm	800 mm	800 mm	800 mm	800 mm	1000 mm
Depth	500 mm	500 mm	600 mm	600 mm	600 mm	600 mm	600 mm
Height	1600 mm	1600 mm	1800 mm	1800 mm	2000 mm	2000 mm	2000 mm
Weight	176 kg	188 kg	289 kg	293 kg	420 kg	428 kg	514 kg

Table 11: Dimensions and weights of the Solardrive Plus Cabinet

(1) Values related to standard output filter

5.7. Connection of Power Cables and Signal Cables

5.7.1. DC Connection – Input Cables

Cables incoming from the PV field are connected to the following:

- Fuse-holder terminals, marked as X1 (positive) and X2 (negative), for the sizes where they are fitted;
- Terminals X1 (positive) and X2 (negative) for the remaining sizes.

	Size	Terminal		Maximum cable cross-section [mm^2]	Tightening torque [Nm]
		ID	Type		
BOX	**0018**	X1, X2	Fuse-holder	25	2÷2.5
	0021	X1, X2	Fuse-holder	25	2÷2.5
	0024	X1, X2	Fuse-holder	25	2÷2.5
	0032	X1, X2	Fuse-holder	25	2÷2.5
CABINET	**0051**	X1, X2	Fuse-holder	25	2÷2.5
	0069	X1, X2	Terminal	120	10÷15
	0088	X1, X2	Bar	150	85
	0164	X1, X2	Bar	150	85
	0201	X1, X2	Bar	150	85
	0259	X1, X2	Bar	150	85
	0401	X1, X2	Bar	150	85

Table 12: Specifications of DC input cables

5.7.2. AC Connection – Motor side and AC supply side (optional) cables

The output cables for the motor connection are connected to terminal board X4.

The auxiliary AC power supply cables (optional) are connected to terminal board X5.

	Size	Terminal	Maximum cable cross-section [mm^2]	Minimum cable cross-section [mm^2]	Tightening torque [Nm]
BOX	**0018**	X4, X5	16	4	1.2÷1.5
	0021	X4, X5	25	10	2.5÷4.5
	0024	X4, X5	25	10	2.5÷4.5
	0032	X4, X5	25	16	2.5÷4.5
CABINET	**0051**	X4, X5	50	35	2.5÷5
	0069	X4, X5	50	50	2.5÷5
	0088	X4, X5	95	70	15÷20
	0164	X4, X5	150	120	15÷20
	0201	X4, X5	Bus bar	240	30
	0259	X4, X5	Bus bar	2x120	30
	0401	X4, X5	Bus bar	2x240	50

Table 13: Specifications for AC output cables

5.7.3. Connection of Earth Cables

	Size	Minimum cable cross-section [mm^2]
BOX	**0018**	10
	0021	10
	0024	10
	0032	16
CABINET	**0051**	16
	0069	25
	0088	35
	0164	60
	0201	120
	0259	120
	0401	200

Table 14: Specifications for earth cable connection

5.7.4. Connection of Signal Cables

Signal cables are connected to terminal board X3. The allowable cable cross-section is given in the table below.

Size	Minimum cable cross-section [mm^2]	Maximum cable cross-section [mm^2]
All	0.5	2.5

Table 15: Specifications for signal cable connection

5.8. Surge Protection Device

Technical specifications for SPDs are provided in the table below.

Technical specifications	
Rated voltage of system	1000 V
Maximum voltage of system	1120 V
Back-up power supply	4 A
Rated discharge current	20 kA
Response time	25 ns
Residual current	< 1 mA
Configuration	Y connection of three SPDs to varistor
UP level of protection (L-L / L-PE)	3.8 kV
L tightening torque	2.8 Nm
Remote signal contact	
Type	1 NO/NC
Minimum range	12V DC – 10 mA
Maximum range	250 V AC - 1 A
Cable section	1.5 [mm^2]
Ambient conditions	
Operating temperature	-40...+80
Maximum altitude	2000
General specifications	
Removable cartridges	Yes
UL94 Fire resistance	V0

Table 16: SPD technical specifications

5.9. Serial Port

The technical specifications of the serial link 0 – male 9-pin D connector are given below.

5.9.1. Connection

Table 17: Serial port wiring connection

PIN	FUNCTION
1 – 3	(TX/RX A) Differential input/output A (bidirectional) according to standard RS485. Positive polarity in respect to pins 2 – 4 for one MARK. Signal D1 according to MODBUS-IDA association.
2 – 4	(TX/RX B) Differential input/output B (bidirectional) according to standard RS485. Negative polarity in respect to pins 1 – 3 for one MARK. Signal D0 according to MODBUS-IDA association.
5	(GND) control board zero volt. Common according to MODBUS-IDA association.
6	(VTEST) Auxiliary supply input (contact ELETTRONICA SANTERNO)
7 – 8	not connected
9	+ 5 V, max 100 mA for power supply of optional RS485/RS232 converter

5.9.2. Serial Comms Specifications

Baud rate:	configurable between 1200 and 38,400 bps (default value: 38,400 bps)
Data format:	8 bits
Start bit:	1
Parity: (1)	NO, EVEN, ODD
Stop bit:	2,1
Protocol:	MODBUS RTU
Supported functions:	03h (Read Holding Registers) 10h (Preset Multiple Registers)
Device address:	configurable between 1 and 247 (default value: 1)
Electric standard:	RS485
Inverter response delay:	configurable between 0 and 1000 ms (default value: 5 ms)
End of message timeout:	configurable between 0 and 10,000 ms (default value: 0 ms)
Communications Watch Dog: (2)	configurable between 0 and 65,000 s (default value: disabled)

(1) Ignored when receiving
(2) If set up, an alarm trips if no legal message is sent within the timeout period.

NOTE

For the parameters relating to the configuration of the serial communication, please contact ELETTRONICA SANTERNO.

6. PROGRAMMING

6.1. General specifications

6.1.1. Overview

This section provides any information required to setup and monitor the drives of the Solardrive Plus series manufactured by Elettronica Santerno SpA.

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

- Display/keypad unit;
- Serial link through RS485 standard port.

Any information sent to/from the drive via the display/keypad unit may be obtained also via serial link using the RemoteDrive software application offered by Elettronica Santerno

RemoteDrive allows the following functions: image acquisition, keypad simulation, oscilloscope functions and multifunction tester, data logger, table compiler including history data, parameter setup and data reception-transmission-storage from and to a calculator, scan function for the automatic detection of the connected drives (up to 247 drives may be connected).

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

6.1.2. Menus and Submenus

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

Programming parameters and Measure parameters are divided into:

Mxxx Measures (always Read Only):

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

Pxxx Parameters (always R/W):

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

Cxxx Parameters (Read Only when the drive is running and the motor is operating; R/W when the drive is in stand-by or in Run, but the motor is stopped).

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

Rxxx Parameters (Read Only when the drive is running and the motor is operating; R/W when the drive is in stand-by or in Run, but the motor is stopped).

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

NOTE

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

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

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

NOTE

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

NOTE

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

NOTE

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

6.1.3. Alarms and Warnings

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

Axxx	Description
Description	
Event	
Possible cause	
Solution	

6.2. Using the Display/Keypad unit

6.2.1. Overview

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

For any details on special settings of the Display/keypad module (contrast, backlight, etc…) and for details concerning custom navigation through the root page, the Keypad measurements and the Status page and the custom PID unit of measure, please contact Elettronica Santerno S.p.A.

The menu tree is detailed in section 6.2.2.

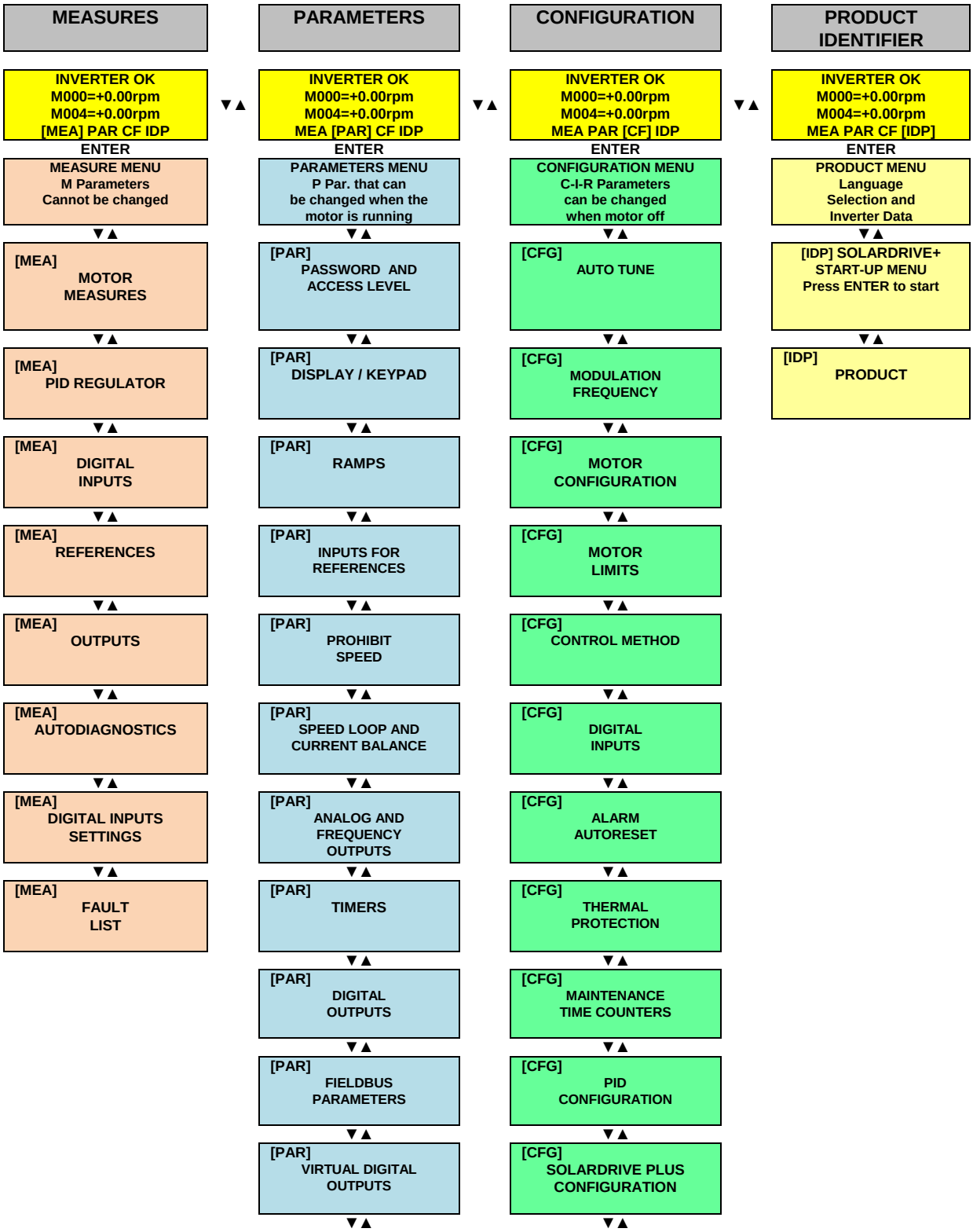
The complete tree structure is displayed, but the actual structure depends on the user level set in **P001** and on the implemented programming. When **P264** = Linear (linear navigation), the parameters displayed are no longer grouped into menus, and you can scroll through all parameters using the ▲ and ▼ keys.

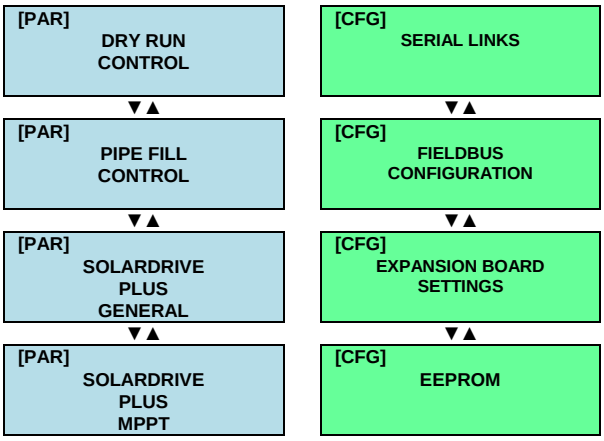
When **P264** = Modified Pars. Only, only the parameters having different values than the factory settings are displayed, and you can scroll through all parameters using the ▲ and ▼ keys.

The sections below show how to use function keys to navigate through the parameters and to change parameter values (**P264** = BY MENU).

The function keys and their functionality are described below.

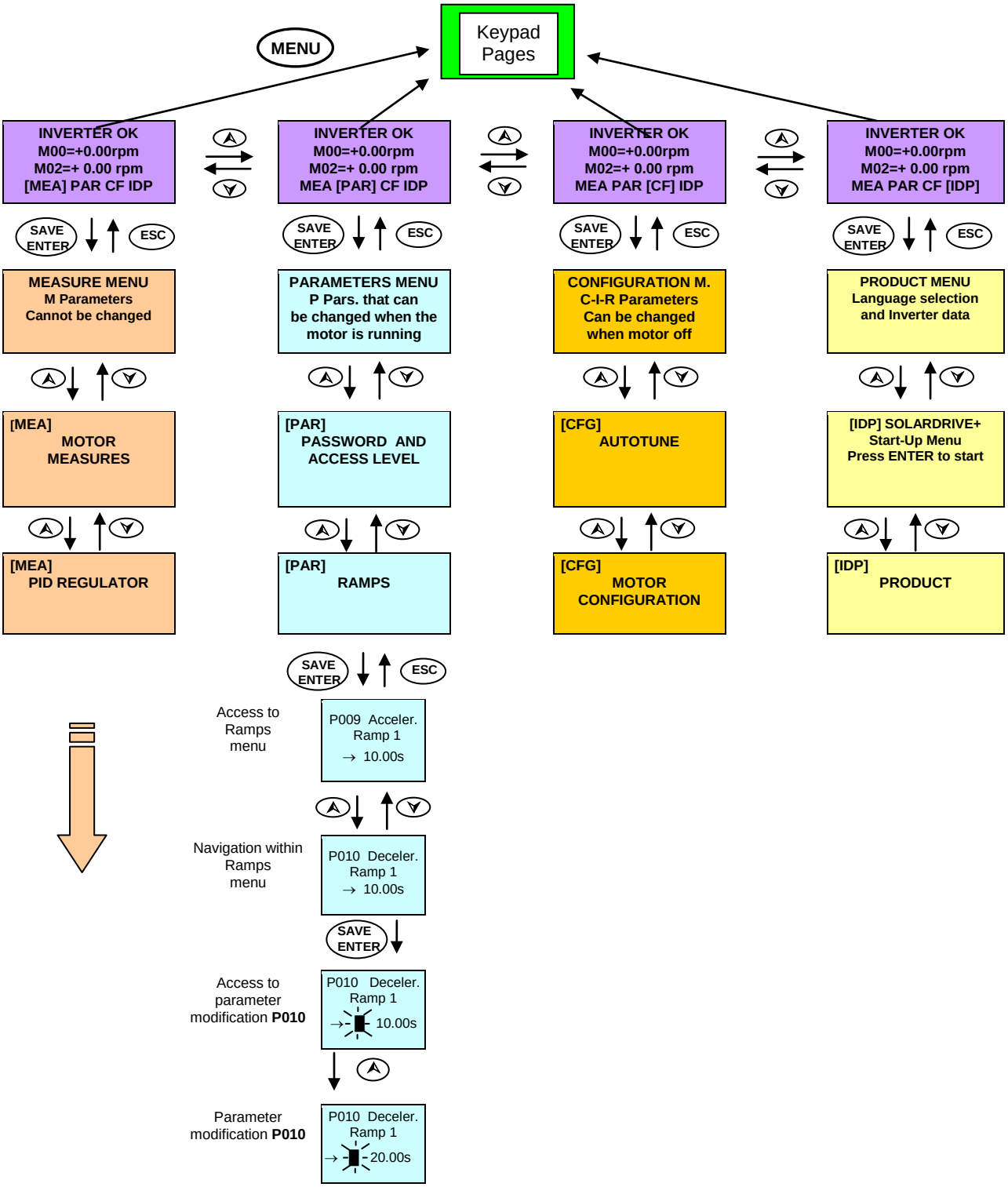
6.2.2. Menu Tree




[PAR]
DRY RUN
CONTROL
▼▲
[PAR]
PIPE FILL
CONTROL
▼▲
[PAR]
SOLARDRIVE
PLUS
GENERAL
▼▲
[PAR]
SOLARDRIVE
PLUS
MPPT
[CFG]
SERIAL LINKS
▼▲
[CFG]
FIELDBUS
CONFIGURATION
▼▲
[CFG]
EXPANSION BOARD
SETTINGS
▼▲
[CFG]
EEPROM

6.2.3. Navigation

Figure 27: Navigation example



If the **ESC** key is pressed to quit, the new parameter value will be acknowledged but not saved to non-volatile memory, and will therefore be lost at power off. Press **SAVE/ENTER** to confirm parameter alteration

6.2.4. Parameter Modification

Factory setting allows parameter modification. The parameters included in the Parameters Menu (**Pxxx** parameters) can be changed at any moment, whereas the parameters included in the Configuration Menu (**Cxxx**, **Rxxx**, **Ixxx** parameters) can be changed only when the motor is stopped.

For safer operating conditions, the configuration parameters must be changed only when the drive is disabled (the **ENABLE-A** and **ENABLE-B** commands are inactive): to do so, **P003** must be set to **0 (stand-by only)**.

To disable parameter changes, just change **P000** (write enable) and save its new setting. **P000** and **P002** (password) are both factory-set to 1. If **P000=0**, an inexpert user cannot change parameter values, but if **P000=1,** an advanced user will be able to change the parameter values.

For even safer operating conditions, you can change the password stored in **P002**; in that case, you must set **P000** accordingly.

NOTE

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

Press the **SAVE/ENTER** key for parameter modifications; when a flashing cursor appears, press ▲ and ▼ to change the parameter value. Do one of the following to quit the editing mode:

- Press **ESC** with **P269b** = 0: [No] → the parameter value used by the drive is changed and is maintained until the drive is shut down, then the value is lost when the drive is powered on again.
- Press **ESC** with **P269b** =1: [YES] → the previous value is restored.
- **Press SAVE/ENTER** → the parameter value is used by the inverter and stored to non-volatile memory and is not deleted when the drive is shut down.

Inputs (**Ixxx**) cannot be saved to non-volatile memory and are automatically set to their default values.

Rxxx parameters become active only when the drive control board has been reset by pressing the **RESET** key for a few seconds or by switching off the drive

6.2.5. Programming the Root Page

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

The first row shows the drive status (see Table 32).

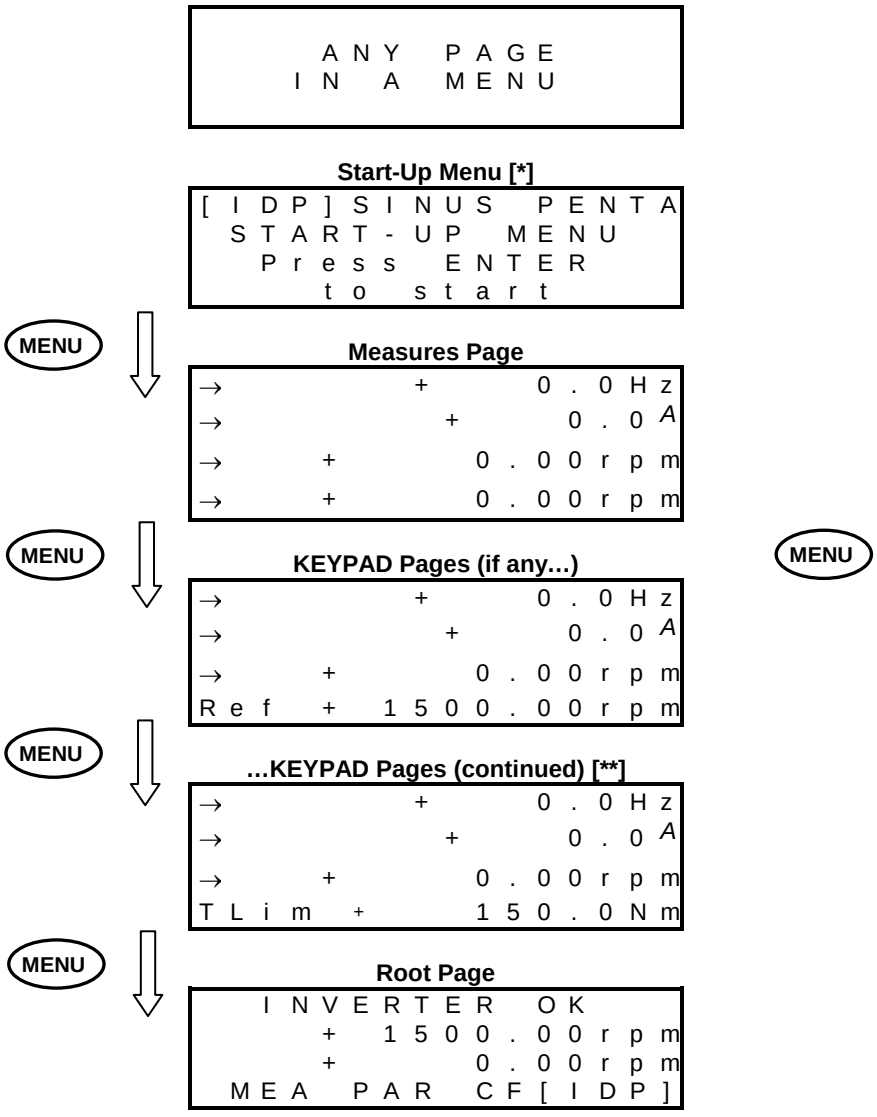
Root page

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

You can customise the root page using parameter **P265** (contact Elettronica Santerno).

6.2.6. Using the MENU Key

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



NOTE

*The Start-Up menu is available only if **P265**=3:Start.*

NOTE

The Keypad pages are available only if the relevant references / feedback / limits are activated.

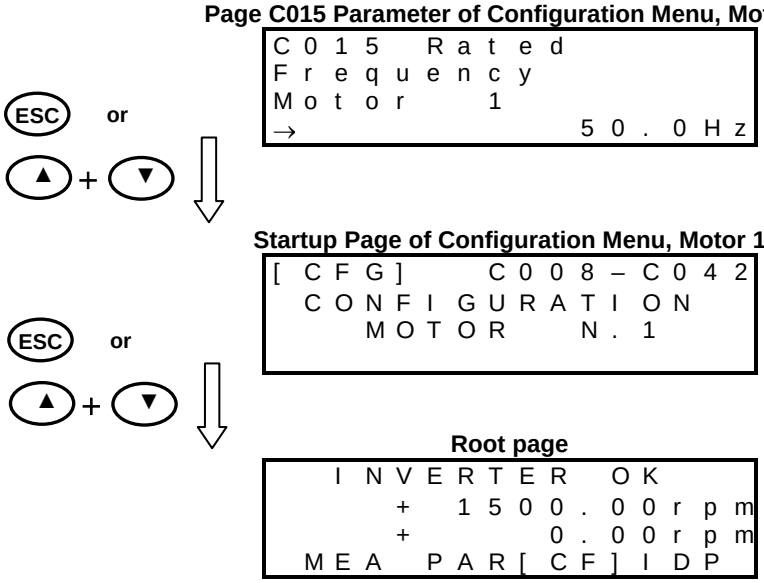
6.2.7. ESC Key

Press the **ESC** key and to do the following:

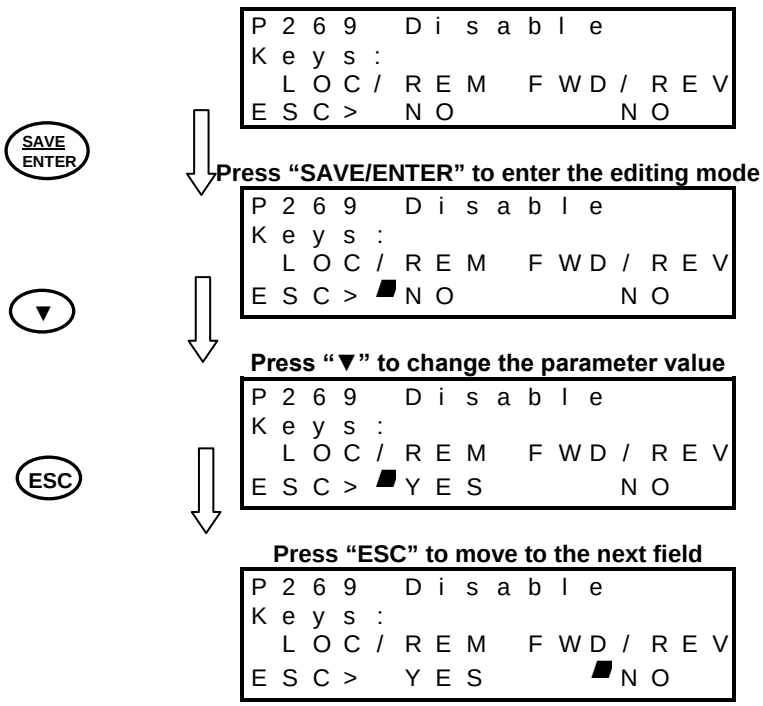
1. move up one level in the menu tree;
2. go to the next field when changing a parameter having multiple value fields;
3. quit the editing mode without storing the value to EEPROM, or go back to the previous value based on **P269b.**

1. In the example below, starting from parameter **C015** in the Motor Configuration Menu (section 6.6.4) inside the Configuration Menu, you can move up to the Root page by pressing the **ESC** key.

Page C015 Parameter of Configuration Menu, Motor 1



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



3. Press the following keys to quit the last page displayed:

- **ESC** without saving the value to EEPROM if **P269b** = **0:[No]** → press **ESC** to confirm the parameter, that will not be saved (the previous value will be restored at next power on);
- **ESC** without saving the value to EEPROM if **P269b** = **1:[No]** → press **ESC** to restore the previous value;
- **SAVE/ENTER** (new values are saved to Eeprom).

6.2.8. RESET Key (Alarm and Control Board Reset)

The **RESET** key is used to reset the drive after an alarm trips and the cause responsible for the alarm has been removed.

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

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

Use the keypad to perform the following functions:

1. UPLOAD (parameters stored in the drive are copied to the display/keypad);
2. DOWNLOAD (parameters stored in the keypad are copied to the drive).

Press the **TX/RX** key to go to the UPLOAD page; press the **TX/RX** key again to toggle between the UPLOAD and DOWNLOAD pages.

WARNING

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

NOTE

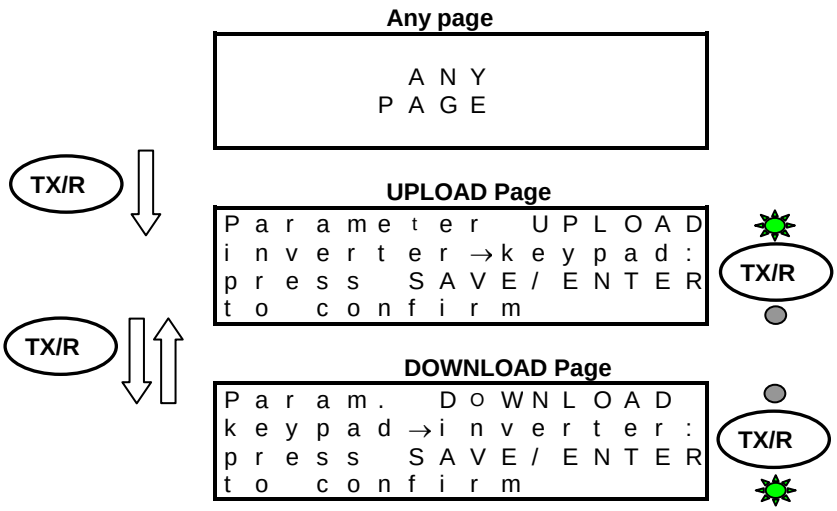
The DOWNLOAD function allows the parameters stored in the keypad to be copied to the drive. However, parameters are not stored to the non-volatile memory of the drive.

To store the downloaded parameters to the non-volatile memory of the drive, go to the EEPROM menu and execute a "Save Work" command once the download procedure is complete. Otherwise, when power is lost, the parameters downloaded to the drive are lost.

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

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

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



Press **SAVE/ENTER** from the UPLOAD (/DOWNLOAD) page to confirm UPLOADING (/DOWNLOADING). The relevant LED will come on (fixed light).

If the **SAVE/ENTER** key is not pressed for confirmation within 10 seconds from the selection of the UPLOAD (/DOWNLOAD) page, the starting page is automatically displayed.

While UPLOADING, **W08 UPLOADING (**flashing warning) appears.

If parameters are successfully uploaded, the following warning appears:

W11 UPLOAD OK

If not, the **W12 UPLOAD KO** warning appears. Retry parameter upload.

While DOWNLOADING, **W07 DOWNLOADING (**flashing warning) appears.

If parameters are successfully downloaded, the following warning appears:

W09 DOWNLOAD OK

If not, alarm **A073** trips, and download must be retried before restarting the drive.

6.2.10. LOC/REM Key

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

NOTE

*The **LOC/REM** key is enabled when no digital input is configured as **Loc/Rem**, or when a digital input is configured as a **Loc/Rem** button (see **C180a**).*
*The **LOC/REM** key is disabled when a digital input is configured as a **Loc/Rem** selector switch (see **C180a**). For further information, please contact Elettronica Santerno.*

C148 sets whether toggling between Remote mode and Local mode is activated only when the drive is disabled, or whether toggling from Remote to Local mode does not affect the drive running conditions (bumpless commands), but it does affect the reference. You can also choose to keep running conditions and reference unaffected (any command is bumpless). For more details, please refer to the description of parameter **C148** (Control Method Menu, section 6.6.6).

In LOCAL mode (the L-CMD and L-REF LEDs come on), when drive references and commands are sent via display/keypad, the Keypad page allows changing the given reference using the ▲ and ▼.

When not in LOCAL mode, press the **MENU** key to access the Keypad pages from the root page. Only the Keypad pages relating to the Keypad source will be displayed along with the Measure Keypad page.

Example: Parameter **C147** (Torque Limit Reference Selection) is set to Keypad. From the root page, press the **MENU** key once to display the Measure Keypad page, and press the **MENU** key twice to display the Keypad page relating to the torque limit and allowing changing the torque limit reference using the ▲ and ▼ keys.

The Keypad page allows entering custom measures (see parameters **P268b** to **P268e**, contact Elettronica Santerno).

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

6.2.11. SAVE/ENTER Key

The **SAVE/ENTER** key allows selecting a lower level when navigating within the programming menus. It also allows changing a parameter value (to change a parameter value, press the SAVE/ENTER key from the page of the parameter you want to change). An example is given in Figure 27.
From the Keypad pages, the **SAVE/ENTER** key allows accessing the Keypad Help page containing any details about the measures displayed in the Keypad page.

6.2.12. START-UP Key

The **START-UP** key goes to the Start Up Menu for the setup of the main parameters of the Solardrive Plus (see section 6.4).

6.2.13. Indicator LEDs on the Display/Keypad

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

RUN LED – GREEN	
●	Motor not powered
✳	Motor powered, but no torque (idle)
●	Motor powered and running
PV OK LED – GREEN	
●	DC voltage out of required working range
●	DC voltage within working range
ALARM LED – RED	
●	Inverter Ok
●	Alarm tripped
LIMIT LED – YELLOW	
●	No active limit
●	Voltage or current limit active
WARNING LED – YELLOW	
●	No active Warning
●	Warning showed on the display

TX and RX LED – GREEN		
TX	RX	
●	●	No parameter transfer in progress
✳	●	Download: waiting for confirmation
●	✳	Upload: waiting for confirmation
●	●	Parameter downloading from keypad to inverter
●	●	Parameter uploading from inverter to keypad

L-CMD LED – GREEN	
●	Commands sent from sources other than keypad
✳	Commands sent both from keypad and terminal board
●	Commands sent from keypad only
L-REF – GREEN	
●	Reference sent from sources other than keypad
✳	Reference sent both from keypad and terminal board
●	Reference sent from keypad only

Key	
●	LED off
✳	LED flashing
●	LED on (fixed)

S000565

Figure 28: Display/Keypad of the Solardrive Plus

6.2.14. Root Page

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

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

NOTE

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

Line 1 on this page displays the drive operating status (see the description of parameter M089 in section 6.5.5).

The specific states of the Solardrive Plus applications are the following:

State	Description
IFD WAIT MPPT	Timeout for solar radiation conditions allowing the motor to run. See section 6.6.11
INSOLATION KO	PV field conditions inadequate to run the motor (weak solar radiation)
INSOLATION OK	PV field conditions capable of running the motor, timeout set in **P801** (section 6.6.10). Press **RESET** to start the motor.
STARTING	Timeout set in **P802** (section 6.6.10) due to a reset alarm. Press **RESET** to start the motor.

Lines 2 and 3 display two measures which may be selected with parameters **P268**, **P268a**. These measures can be scaled through parameters **P268y** and **P268z**. For further details, contact Elettronica Santerno. As defaults, the following measures are displayed:

- Actual motor speed (measure **M004**)
- Actual output power (measure **M028**)

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

6.2.15. Keypad Page and Local Mode

keypad

```
→                    +   0 . 0 Hz
→                      +   0 . 0 A
→                          5 5 0 v
→          +           0 . 0 0 r p m
```

Keypad Help

```
→ M 0 0 6   M o t . F r e q .
→ M 0 2 6   I ( R M S )   O u t
→ M 0 2 9   V b u s - D C
→ M 0 0 4   M o t o r   S p d
```

To access the Keypad pages, press the **MENU key** from the Root Page or press the **LOC/REM key** after selecting the Local mode.

The measures displayed on the Keypad page can be set up through parameters **P268b** to **P268e**. From the Keypad page, press the **SAVE/ENTER** key to display the Keypad Help page, describing the measures displayed on the Keypad page. The Keypad Help page is displayed for a few seconds.

As default, there are displayed:

- Output frequency (measure **M006**)
- Output current (measure **M026**)
- DC bus voltage (measure **M029**)
- Motor speed (measure **M004**)

NOTE

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

The following Keypad Pages are available:

Measures only → four lines displaying measures only

Speed → line 4 shows the speed reference, that can be changed with the ▲ and ▼ keys.

If the Local Mode is NOT selected, pressing the MENU key allows viewing only the pages containing the references sent via keypad (See Control Method Menu, section 6.6.6).

LOCAL MODE

In **LOCAL** mode (the L-CMD and L-REF LEDs come on when the Local mode is active), only the commands and references sent via keypad are enabled, while any other control source or reference source is disabled (see Control Method Menu, section 6.6.6). The keypad page displayed when the **LOC/REM** key is pressed is as follows:

```
→                    +   0 . 0 Hz
→                      +   0 . 0 A
→                          5 5 0 v
R e f    + +         0 . 0 0 r p m
```

Use the▲ and ▼ keys to change the reference shown in line 4 on the Keypad Page.

6.3. Manual Mode (Local Mode)

Operation in manual mode allows doing the following:

- Manually set the speed of rotation of the connected motor (drive output frequency);
- Manually send the START and STOP commands to the motor.

Do the following to set manual mode:

1. Press the emergency pushbutton.
2. Press the LOC/REM key from the display/keypad. The L-CMD LED and the L-REF LED will come on and the display will show the following:

→					+				0	.	0	H	z	
→						+				0	.	0		A
→			+					0	.	0	0	r	p	m
R	e	f	+		1	5	0	0	.	0	0	r	p	m

3. Press ▲ and ▼; set the desired speed reference (Ref).
4. Release the emergency pushbutton.
5. Press START to start the motor. The motor will follow the acceleration ramp set in parameter **P009** (see section 6.6.1).
6. Press STOP to stop the motor. The motor will follow the deceleration ramp set in parameter **P009** (see section 6.6.1).

When in manual mode, the motor speed may be adjusted by pressing ▲ and ▼.

Do the following to return to operation in automatic mode:

7. Press the emergency button.
8. Press the LOC/REM key from the display/keypad. The L-CMD LED and the L-REF LED will turn off and the display will show the following:

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

9. Release the emergency button.

6.4. Start Up Menu

6.4.1. Overview

For easier startup of the Solardrive Plus, you can activate the Start-Up Menu. The Start-Up Menu is a wizard allowing programming the main parameters.

The Start-UP Menu is displayed by pressing the START-UP key from the keypad.

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

```
[ I D P ] S O L A R D R I V E
  S T A R T - U P   M E N U
    P r e s s   E N T E R
    t o   s t a r t
```

Press **ENTER** to enter the wizard.

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

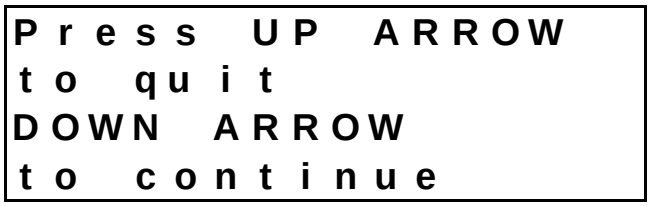
```
P 2 6 3   L a n g u a g e


→@@@@@@@@@@@@@@@@
```

Once the dialogue language has been selected, the Start-up menu appears. The available parameters are listed below:

Parameter	Description
C015	Rated mains voltage
C016	Rated motor rpm
C017	Rated motor power
C018	Rated motor current
C019	Rated motor voltage
C029	Max. motor speed
C800	Minimum Pump Speed
P009	Acceleration time to start 1
P010	Deceleration Time to stop 1
P018	Start Acceleration Time
P019	End Deceleration Time
P020	Speed Threshold for Initial and Final Ramps
C265	Motor thermal protection
C267	Motor thermal time constant

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



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

6.4.2. First Start Up

The Solardrive Plus accepts the IFD control mode only (**C010**).

1) Wiring: Follow the instructions stated in section 2 - CAUTION STATEMENTS and 4 - HANDLING AND ASSEMBLY.

2) Power on: Power on the drive with the emergency button pressed to prevent the motor from running. Check if the display/keypad turns on.

3) Parameter setting: The equipment startup is made easier by the Start Up Menu (section 6.4), which is a wizard for the set up of the main motor control parameters.

From the Start Up Menu, set the motor ratings:

- **C015** (fmot1) **Rated motor frequency**
- **C016** (rpmnom1) **Rated motor rpm**
- **C017** (Pmot1) **Rated power**
- **C018** (Imot1) **Rated current**
- **C019** (Vmot1) **Rated voltage**
- **C029** (Speedmax1) **Max. allowable speed.**

Enter the main parameter for pumping applications:

- **C800** (SpeedMinPump) **Minimum Pump Speed:**
  When the pump speed drops below the threshold in **C800**, the pump is stopped. See 6.6.9.

- **P009** (Tup1) **Acceleration Time at Start 1:**
  Acceleration ramp, expressed in seconds for the system to go from 0 rpm to the maximum allowable speed set in **C029**. See section 6.6.9.

- **P010** (Tdn1) **Deceleration Time at Stop 1:**
  Deceleration ramp, expressed in seconds for the system to go to the maximum allowable speed set in **C029** to 0 rpm. See section 6.6.1.

- **P018** (Tacc_in) **Acceleration Start Time:**
  Ramp applied during the initial stage of the ramp, from the motor startup to the instant when the frequency set in parameter **P020** is attained. See section 6.6.1.

- **P019** (Tdec_fin) **End Deceleration Time:**
  Ramp applied during the final stage of the ramp, starting from the speed value set in **C020**. See section 6.6.1.

- **P020** (Spd_IFramps) **Speed Threshold for Initial and Final Ramps:**
  Threshold used for ramps **P018** and **P019**. See section 6.6.1.

- **C265** (ThermProt M1) **Motor Thermal Protection Enable and Type of Derating for M1:**
  Motor thermal protection configuration. See section 6.6.8.

- **C267** (ThermConstM1) **Thermal Time Constant for motor M1**. See section 6.6.8.

The motor V/f pattern may be programmed in **C013**. For loads with quadratic torque in respect to the rpm (centrifugal pumps, fans, etc.), set **C034** (preboost1) to 0%.

4) Overload: Set parameters **C043**, **C044** and **C045** as the maximum desired overload current.

5) Startup: Press the **LOC/REM** key on the Display/keypad: the L-CMD LED and L-REF LED

come on and the drive will enter the local mode. Set the speed reference by pressing ▲ and ▼ (see section 6.3).
Activate the **ENABLE-A** input (terminal 15), **ENABLE-B** input (terminal S) by releasing the emergency button. Press the **START** button and the motor will start running. Make sure that the motor is rotating in the correct direction. If not, set parameter **C014** (Phase Rotation) to [1:Yes], or open the **ENABLE-A, ENABLE-B** and **START** inputs, remove voltage from the drive and, after waiting at least 20 minutes, swap two of the motor phases.
Press **STOP** to stop the motor. When the startup procedure is completed, set the drive in remote mode by pressing **LOC/REM**. The L-CMD LED and L-REF LED will turn off.

6) Possible failures:

If no failure occurred, go to step 7. Otherwise, check the drive connections paying particular attention to supply voltages, DC link and input reference. Also check if alarm messages are displayed. In the Measures Menu (section 6.5), check the reference speed (**M001**), the supply voltage to the control section (**M030**), the DC link voltage (**M029**), and the condition of control terminals (**M033**). Check to see if these readouts match with the measured values.

7) Additional parameter modifications:

When parameter **P003** = Standby Only (condition required for changing C parameters), you can change **Cxxx** parameters in the Configuration Menu only when the drive is DISABLED or STOPPED, whereas if **P003** = Standby + Fluxing, you can change **Cxxx** parameters when the motor is stopped but the drive is enabled.

8) Adjusting criteria:

Specific parameters might be adjusted for optimum operation of the Solardrive:

Parameter	Tuning criterion
C800 see 6.6.9	**Minimum pump speed** When the speed set in **C800** is attained and if the electrical power absorbed by the motor is too high, the pump might frequently start and stop when solar radiation is weak. Decrease **C800** accordingly to obtain smooth operation of the pump avoiding lubrication issues or overheating conditions. The expected behaviour is that when the speed value set in **C800** is attained, the pump flow rate is low but not zero.
P009, P010, P018, P019 see 6.6.1	**Ramps** If **P009** and **P018** are set too short, especially when the pump inertia is high, the pump might stop due to weak solar radiation at start, and impulsive power absorption. If this is the case, increase the ramp times to get slower start stages. The effects obtained by the time set in parameter **P009** is stronger when solar radiation is strong. The time set in **P009** is the minimum time required to attain the maximum power.
P020 see 6.6.1, 6.6.9	**Speed Threshold for Initial and Final Ramps** Set **P020** so that the speed threshold for the initial/final ramps is the same as **C800** if not required otherwise, for example for a 50Hz motor with 1 pole pair, if **C800**=1500rpm, **P020**=50%.
P800 see 6.6.10	**Minimum Solar Radiation Voltage** This is the DC voltage value required to start the motor. If “Insolation KO” is not displayed, decrease **P800** and/or check the dimensioning of the PV field. If the system restarts often at dawn, increase the values in **P800** and **P801**.
P801 see 6.6.10	**Minimum Solar Radiation Time** If the system restarts often at dawn, increase the value in **P801** to get a longer delay between two pump start stages and to allow solar radiation to reach values that make the pump start.
P810, P811 see 6.6.11	**MPPT Minimum Voltage** **MPPT Maximum Voltage** Set the minimum and maximum MPPT reference based on the PV field data considering all ambient conditions (e.g. temperature/solar radiation). If **P810** is set too low, the pump might frequently start/stop at dawn or when solar radiation is weak, because the available power is not sufficient to start the pump even if voltage is applied to the PV field. In case the pump frequently stops when solar radiation is high, increase **P810** to operate the system at higher field voltage values.
P813 see 6.6.11	**Load Curve Exponent** This parameter is the power load exponent vs. pump speed. For centrifugal pumps or quadratic torque loads, set **P813**=3. For volumetric pumps or other linear loads, set **P813**=2.
P814, P815 see 6.6.11	**Voltage Regulator Integral Gain** **Voltage Regulator Proportional Gain** The proportional gain and integral gain of the voltage regulator determine the promptness of the response from the field voltage

	regulator. If the drive stops due to sudden changes in solar radiation (clouds) or hydraulic load (flow rate variations when hydraulic valves are open), adjust the voltage regulator based on the criteria below: 1) Increase integral gain **P814** and proportional gain **P815**. The integral gain determines the response time of the voltage regulator: when it is increased, the pump speed is expected to change rapidly. The proportional gain acts promptly and timely on the pump speed reference. As a first attempt, change **P814** and **P815** without changing their ratio (e.g. double both **P814** and **P815**). 2) Monitor speed reference of pump **M001**. If too noisy or oscillatory, decrease gains **P814** and **P815.** The regulator is to be adjusted when the motor speed is adjusted to values lower than the maximum value set in **C029** with MPPT enabled **P818**=0. When speed is equal to **C029**, power made available from the PV field is greater than the power absorbed by the pump and the regulator is inactive. Otherwise, wait for ambient conditions to become correct (e.g. weaker solar radiation) or decrease power made available from the PV field (e.g. cut off some strings).
P822 see 6.6.11	**MPPT Initial Voltage Gain** The optimum value for **P822** is the ratio between MPPT voltage and open-circuit voltage of the PV field. The value obtained is the lower limit for **P822**. Example: from the datasheet of the PV panel: Open-circuit voltage: 38.58 V Voltage at maximum power: 30.90 V Minimum value for **P822** = 30.90/38.58*100 = 80.09%. If **P822** is set to higher values, the maximum power at start takes longer time to be attained. The closer the value to the theoretical value, the quicker the maximum power is attained. If **P822** is set too low, the motor might stop even when solar radiation is strong and the system might restart frequently at dawn. It is therefore recommended that a value approx. 5% higher than the theoretical value be set (as far as the example is concerned, **P822** = 85%).

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

6.5. Measures Menu

6.5.1. Overview

The Measures Menu contains the variables measured by the drive that can be used by the user.

In the display/keypad, measures are divided into subgroups.

This manual covers the measurements for the solar pumping application. For information on other available measurements, please contact Elettronica Santerno S.p.A.

The measure subgroups are the following:

Motor Measures Menu
This menu contains: the values of the speed reference at constant rpm, the values of the reference being used and the speed values of the connected motor expressed in rpm; the drive rated frequency and the electrical variables measured by the drive mains side, the DC-bus and output.

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

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

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

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

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

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

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

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

6.5.2. Motor Measures Menu

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

M001	Speed Reference at Constant RPM	
Range	± 32000 (integer part) ± 99 (decimal part)	± 32000.99 rpm Note: The actual range depends on the value set in the parameters for the motor max. speed and min. speed. **C028**–**C029** Motor 1
Active	Active only when a speed reference is used for the selected motor.	
Address	1650 (integer part) 1651 (decimal part)	
Function	Value of the speed reference obtained when the motor rotates at constant speed, once the preset ramp time is over.	

M002	Speed Ramp Output	
Range	± 32000 (integer part) ± 99 (decimal part)	± 32000.99 rpm Note: The actual range depends on the value set in the parameters for the motor max. speed and min. speed. **C028**–**C029** Motor 1
Active	Active only when a speed reference is used for the selected motor.	
Address	1652 (integer part) 1653 (decimal part)	
Function	This is the measure of the speed value processed with respect to the ramp time.	

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

M006	Drive Output Frequency	
Range	± 10000	± 1000.0 Hz (see Table 28)
Active	Always active.	
Address	1656	
Function	This is the measure of the voltage frequency output of the drive.	

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

M026a	Motor Thermal Capacity	
Range	0 ÷ 1000	0.0 ÷ 100.0%
Active	Always active.	
Address	1728	
Function	Heating of the connected motor. This parameter indicates the current level of the motor heating following I2t pattern set in the Motor Thermal Protection Menu (section 6.6.8). This value is expressed as a percentage of the allowable asymptotic value.	

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

M027a	Power Factor	
Range	0 ÷ 1000	0 ÷ 1.000
Active	Always active.	
Address	1742	
Function	Estimation of power factor (or cos phi), i. e. the ratio between active power and apparent power at the drive output.	

M028	Output Power	
Range	–32768 ÷ +32767	–3276.8 ÷ +3276.7 kW Note: The actual range depends on the drive voltage class.
Active	Always active.	
Address	1678	
Function	Measure of the active power produced by the drive. A negative value indicates input power (the motor is regenerating energy).	

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

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

M029a	DC-Bus Voltage Reference	
Range	0 ÷ 1400	0 ÷ 1400 V
Active	Always active.	
Address	1725	
Function	This is the setpoint value of the DC voltage computed by the algorithm for the Maximum Power Point Tracking (MPPT). This is the voltage value that the drive forces to the PV field.	

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

6.5.3. Digital Inputs Menu

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

M031	Delayed Digital Inputs	
Range	Bit-controlled measure	See Table 18
Active	Always active.	
Address	1681	
Function	Status of the control terminal board used by the drive. This is the terminal board resulting from the combination of the preset command sources (local terminal board, serial link and fieldbus), where: - Inputs **MDI1** to **MDI8** are the result of the OR between the different control sources. - The **ENABLE (E)** status is the result of the AND of inputs **MDI2&S** of the physical terminals and of **MDI2** inputs of all the other programmed control sources. - The **ENABLE SW (ESW)** is the result of the AND of the inputs programmed as **ENABLE SW** (**C152**) of all the programmed command sources. See also the Control Method Menu, section 6.6.6. Refer to Figure 29 for the **ENABLE** and **ENABLE SW** status. For further information, contact Elettronica Santerno.	

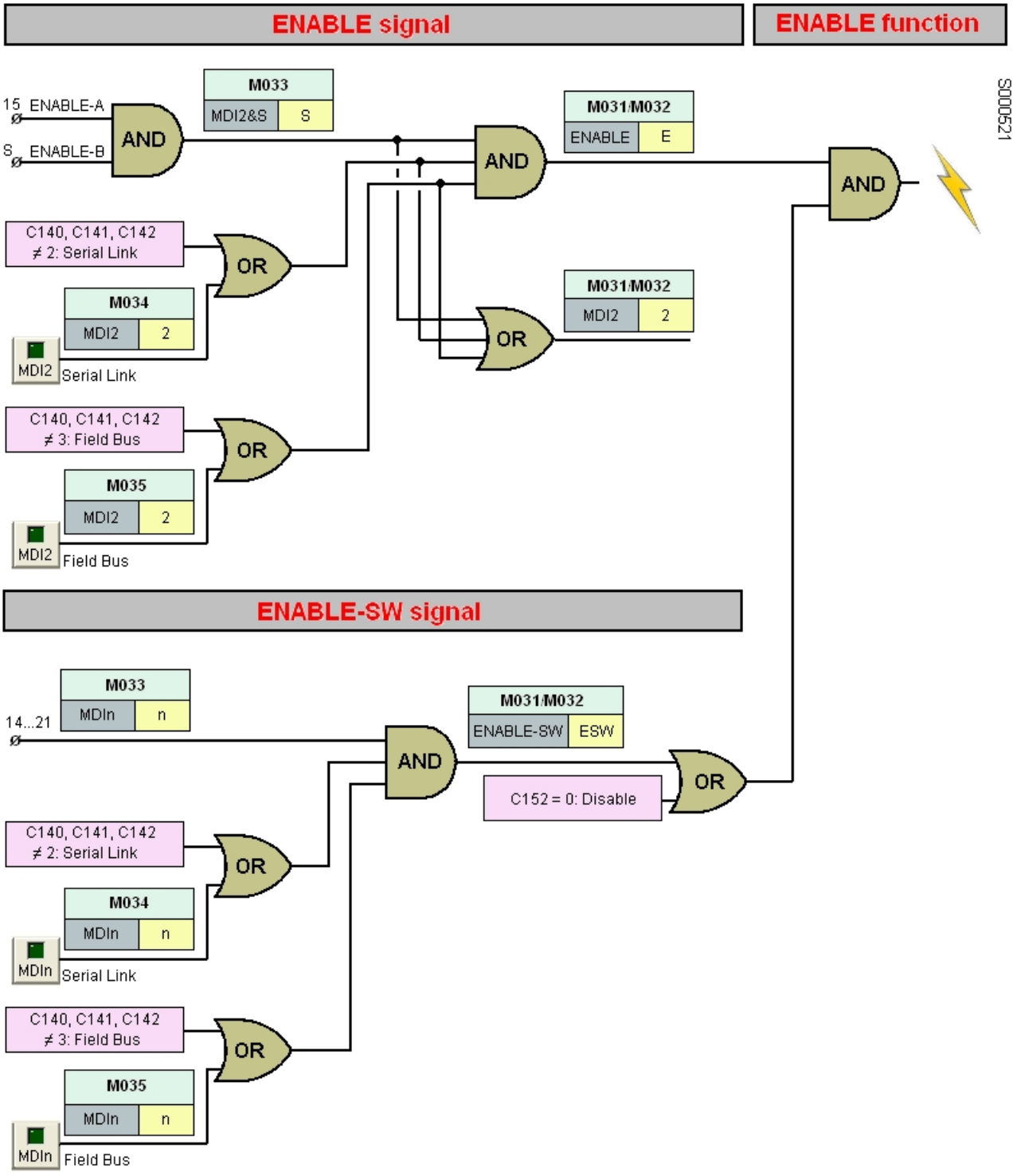


Figure 29: The ENABLE Function

M032	Instant Digital Inputs	
Range	Bit-controlled measure	See Table 18.
Active	Always active.	
Address	1682	
Function	Status of the virtual control terminal board before applying the timers to the digital inputs (if no timer is applied, it matches with **M031**). See Control Method Menu – section 6.6.6.	

Table 18: Coding of Measures M031, M032

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

M033	Local Control Terminal Board	
Range	Bit-controlled measure	See Table 19.
Active	Always active.	
Address	1683	
Function	Status of the digital inputs in the drive physical terminal board. The status of **MDI2&S (S)** input is the result of a logic AND between **ENABLE-A** and **ENABLE-B** physical signals.	

Table 19: Coding of Measures M033

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

6.5.4. Outputs Menu

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

M056	Digital Outputs	
Range	Bit-controlled measure	See Table 20
Active	Always active.	
Address	1706	
Function	Status of digital outputs MDO1÷4 and status of the precharge contactor.	

Table 20: Coding of Measure M056

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

6.5.5. Autodiagnostics Menu

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

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

Functioning Times:

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

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

M064	IGBT Temperature Measure	
Range	± 32000	± 320.0 °C
Active	Always active.	
Address	1714	
Function	Measure of the IGBT temperature. If the temperature readout is <–30.0 °C or >150.0 °C, warning **W50 NTC Fault** appears.	

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

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

M089	Drive Status
Range	See Table 32
Active	Always active.
Address	1739
Function	Describes the current condition of the drive.

M090	Active Alarm
Range	See Table 30
Active	Always active.
Address	1740
Function	Alarm tripped at the moment.

6.5.6. Fault List Menu

Scroll the **Fault List Menu** to display the codes of the last eight alarms tripped.
Press the **SAVE/ENTER** key to access the alarm submenu and navigate to each value measured by the drive when the alarm tripped.
The diagram below shows a navigation example for the **Fault List Menu** (relating to alarm n.1 in particular). Note that n.1 is the last alarm tripped and n.8 is the first alarm tripped.
The measures marked with **Mxxx** are the same measures covered in this section.
If the Data Logger ES851 is installed (even the ES851 RTC version only) and parameter **R021** Data Logger is set to 2: ENABLE, the date and time when the alarm has tripped are displayed instead of the Supply Time (ST) and the Operation Time (OT) respectively.

Navigation Example - Fault List Menu

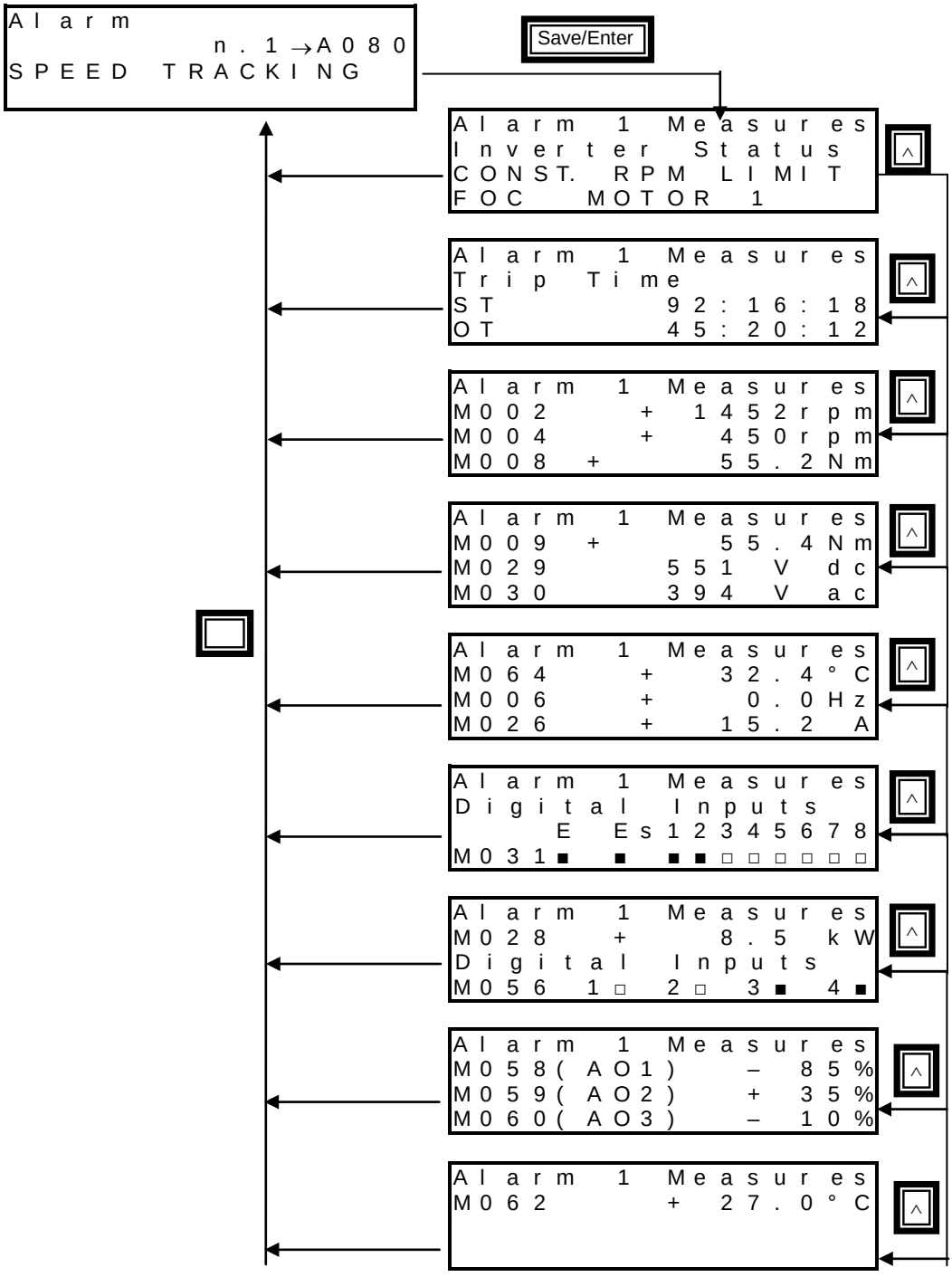


Table 21: Modbus base addresses in the Fault Lists

Fault List	Modbus Base Address
FL1	7712
FL2	7744
FL3	7776
FL4	7808
FL5	7840
FL6	7872
FL7	7904
FL8	7936

Table 22: List of the measures in the Fault Lists

Measure	Function	Range	Value	Modbus Offset Address
M090	Active Alarm	See Table 30	-	0
M052	Supply Time	See measurement description	-	1: LSW 2: MSW
M054	Operation Time	See measurement description	-	3: LSW 4: MSW
M089	Inverter Status	See Table 32	-	5
M026	Output Current	0 ÷ 65535	0 ÷ 6553.5 A	6
M004	Motor Speed	±32000	±32000 rpm	7
M002	Speed Reference after Ramps	±32000	±32000 rpm	8
M008	Torque Demand	±32000	±32000 Nm	9
M009	Torque Generated by the Motor	±32000	±32000 Nm	10
M029	DC-bus Voltage	0 ÷ 1400	0 ÷ 1400 V	11
M030	Grid Voltage	0 ÷ 1000	0 ÷ 1000 V	12
M064	IGBT Temperature	±32000	± 320.0 °C	13
M006	Inverter Output Frequency	±10000	±1000.0 Hz	14
M031	Delayed Digital Inputs	See measurement description	-	16
-	Selected Motor (high byte)	0 ÷ 2	0: Mot1 1: Mot2 2: Mot3	17
	Selected Control (low byte)	0 ÷ 2	0: IFD 1: VTC 2: FOC	
M028	Output Power	0 ÷ 65535	0 ÷ 6553.5 kW	19
M056	Digital Outputs	See measurement description		20
M058	Analog output AO1	±100	±100 %	21
M059	Analog output AO2	±100	±100 %	22
M060	Analog output AO3	±100	±100 %	23
M062	Ambient Temperature	±32000	± 320.0 °C	24

To get the Modbus address of a given measure in a Fault List, sum up the base address to the measurement's offset.

Example:

The address of measure **M058** in Fault List **FL6** is as follows:

7872 + 21 = 7893

6.5.7. Power Off List Menu

This menu contains the measures of some characteristic variables detected at the drive power off, in conjunction with the alarm (if any) tripped at that moment.
Press the **SAVE/ENTER** key to access the submenu and navigate to the measures detected by the drive when the alarm tripped. Measures and codes are the same as the ones shown in the Fault List Menu (section 6.5.6).
If the Data Logger ES851 is installed (even the ES851 RTC version only) and parameter **R021** Data Logger is set to 2: ENABLE, the date and time when the alarm has tripped are displayed instead of the Supply Time (ST) and the Operation Time (OT) respectively.
The diagram below shows a navigation example for the **Power Off List**.

Navigation Example – PowerOff List Menu

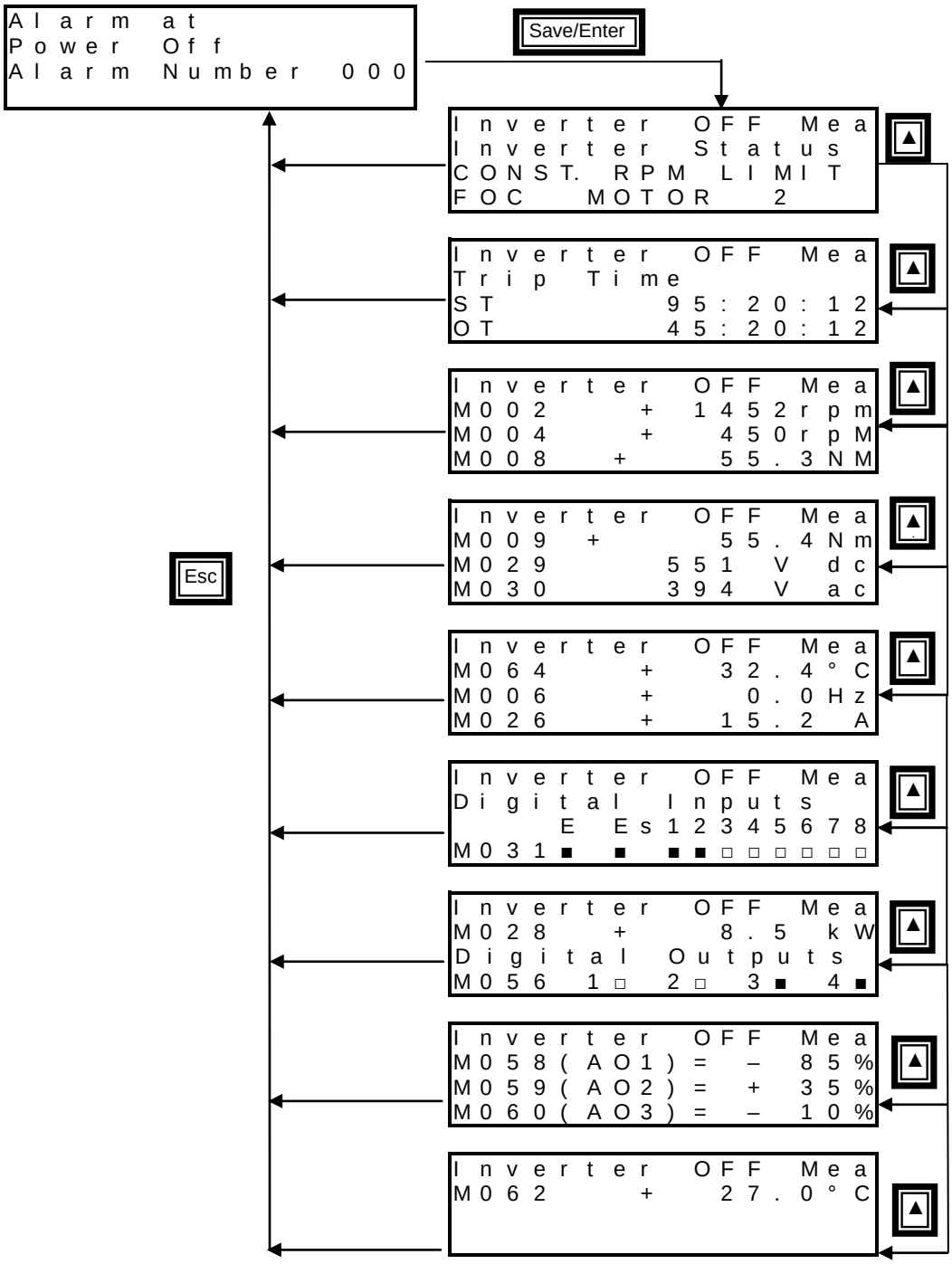


Table 23: List of the measures in the Power Off List

Measure	Function	Range	Value	Modbus Address
M090	Active Alarm	See Table 30	-	5044
M052	Supply Time	See measurement description	-	5045: LSW 5046: MSW
M054	Operation Time	See measurement description	-	5047: LSW 5048: MSW
M089	Inverter Status	See Table 32	-	5049
M026	Output Current	0 ÷ 65535	0 ÷ 6553.5 A	5050
M004	Motor Speed	±32000	±32000 rpm	5051
M002	Speed Reference after Ramps	±32000	±32000 rpm	5052
M008	Torque Demand	±32000	±32000 Nm	5053
M009	Torque Generated by the Motor	±32000	±32000 Nm	5054
M029	DC-bus Voltage	0 ÷ 1400	0 ÷ 1400 V	5055
M030	Grid Voltage	0 ÷ 1000	0 ÷ 1000 V	5056
M064	IGBT Temperature	±32000	± 320.0 °C	5057
M006	Inverter Output Frequency	±10000	±1000.0 Hz	5058
M031	Delayed Digital Inputs	See measurement description	-	5060
-	Selected Motor (high byte)	0 ÷ 2	0: Mot1 1: Mot2 2: Mot3	5061
	Selected Control (low byte)	0 ÷ 2	0: IFD 1: VTC 2: FOC	
M028	Output Power	0 ÷ 65535	0 ÷ 6553.5 kW	5063
M056	Digital Outputs	See measurement description		5064
M058	Analog output AO1	±100	±100 %	5065
M059	Analog output AO2	±100	±100 %	5066
M060	Analog output AO3	±100	±100 %	5067
M062	Ambient Temperature	±32000	± 320.0 °C	5068

6.6. Parameters Menu

This manual covers only the menus and parameters for the solar pumping application. For more details on other available parameters, please contact Elettronica Santerno S.p.A.

6.6.1. Ramps Menu

6.6.1.1. Overview

An acceleration/deceleration ramp is a function allowing linear variations of the motor speed.

The ramp time is the time the motor takes to reach its max. speed when it starts from zero speed (or the time the motor takes to reach 0 speed when decelerating).

Two sets of two values to be programmed for the motor start and stop are available. Each set of values identifies the acceleration time and the deceleration time, and each value set is allocated to the unit of measure of the basic time. The default value is the first set of two values. When the motor runs at constant speed, and follows the speed reference generated by the MPPT regulator, a set of two values for acceleration/deceleration defined by other parameters (acceleration and deceleration after start stage) is applied.

Two values are allocated to the specific function for the start/end ramp.

The Fire Mode operation features two parameters with acceleration ramp times and deceleration ramp times.

The Ramps menu allows setting the acceleration times and the deceleration times of the available speed ramps.

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

The time unit of measure may have the following values:

0 → 0.01 s

1 → 0.1 s

2 → 1 s

3 → 10 s

The programmable range may be 0s – 327000s.

Example of a speed ramp:

Table 24: Example of a Speed Ramp

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

6.6.1.2. List of Parameters P009 to P033

Parameter	Function	User Level	Default Value	MODBUS Address
P009	Acceleration Time at Start 1	BASIC	Depending on size	609
P010	Deceleration Time at Stop 1	BASIC	Depending on size	610
P012	Acceleration Time at Start 2	ADVANCED	Depending on size	612
P013	Deceleration Time at Stop 2	ADVANCED	Depending on size	613
P014	Unit of Measure for Ramps 1 and 2	ADVANCED	Depending on size	614
P015	Acceleration Time after Start	ADVANCED	Depending on size	615
P016	Deceleration Time after Start	ADVANCED	Depending on size	616
P018	Start Acceleration Time	ADVANCED	Depending on size	618
P019	End Deceleration Time	ADVANCED	Depending on size	619
P020	Speed Threshold for Initial and Final Ramps	ADVANCED	50.0%	757
P032	Acceleration Ramp in Fire Mode	ENGINEERING	Depending on size	632
P033	Deceleration Ramp in Fire Mode	ENGINEERING	Depending on size	633

P009	Acceleration Time at Start 1	
Range	0 ÷ 32700	0 ÷ 327.00 s se **P014**=0 → 0.01 s 0 ÷ 3270.0 s se **P014**=1 → 0.1 s 0 ÷ 32700 s se **P014**=2 → 1 s 0 ÷ 327000 s se **P014**=3 → 10 s
Default	Depending on size	
Level	BASIC	
Address	609	
Function	Ramp for motor start. Determines the time the reference takes to go from 0 rpm to the max. preset speed (considering the max. value between absolute values for max. speed and min. speed of the motor).	

P010	Deceleration Time at Stop 1	
Range	0 ÷ 32700	0 ÷ 327.00 s se **P014**=0 → 0.01 s 0 ÷ 3270.0 s se **P014**=1 → 0.1 s 0 ÷ 32700 s se **P014**=2 → 1 s 0 ÷ 327000 s se **P014**=3 → 10 s
Default	Depending on size	
Level	BASIC	
Address	610	
Function	Ramp for motor stop. Determines the time the reference takes to go from the max. preset speed (considering the max. value between absolute values for max. speed and min. speed set for the motor) to zero rpm.	

P012	Acceleration Time at Start 2	
Range	0 ÷ 32700	0 ÷ 327.00 s se **P014**=0 → 0.01 s 0 ÷ 3270.0 s se **P014**=1 → 0.1 s 0 ÷ 32700 s se **P014**=2 → 1 s 0 ÷ 327000 s se **P014**=3 → 10 s
Default	Depending on size	
Level	ADVANCED	
Address	612	
Function	Same as ramp 1 (see **P009**).	

NOTE

Values for ramp 2 can be applied to the reference provided that multiramp digital inputs are set up and that ramp 2 is selected (for more details, contact Elettronica Santerno).

P013	Deceleration Time at Stop 2	
Range	0 ÷ 32700	0 ÷ 327.00 s if **P014**=0 → 0.01 s 0 ÷ 3270.0 s if **P014**=1 → 0.1 s 0 ÷ 32700 s if **P014**=2 → 1 s 0 ÷ 327000 s if **P014**=3 → 10 s
Default	Depending on size	
Level	ADVANCED	
Address	613	
Function	Same as ramp 1 (see **P010**).	

NOTE

Values for ramp 2 can be applied to the reference provided that multiramp digital inputs are set up and that ramp 2 is selected (for more details, contact Elettronica Santerno).

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

P015	Acceleration Time after Start	
Range	0 ÷ 32700	0 ÷ 327.00 s if **P020**=0 → 0.01 s
Default	Depending on size	
Level	ADVANCED	
Address	615	
Function	Ramp applied when the motor runs at constant speed and applied to the reference generated by the algorithm for the Maximum Power Point Tracking (MPPT). See also parameter **P009** (ramp for motor stop).	

P016	Deceleration Time after Start	
Range	0 ÷ 32700	0 ÷ 327.00 s if **P020**=0 → 0.01 s
Default	Depending on size	
Level	ADVANCED	
Address	616	
Function	Ramp applied when the motor runs at constant speed and applied to the reference generated by the algorithm for the Maximum Power Point Tracking (MPPT). See also parameter **P010** (deceleration ramp time).	

P018	Start Acceleration Time	
Range	0 ÷ 32700	0 ÷ 327.00 s if **P020**=0 → 0.01 s
Default	Depending on size	
Level	ADVANCED	
Address	615	
Function	Ramp applied during the initial stage of the ramp, from the motor start to the instant when the frequency set in parameter **P020** is attained. See also parameter **P009** (ramp for motor stop).	

P019	End Deceleration Time	
Range	0 ÷ 32700	0 ÷ 327.00 s if **P020**=0 → 0.01 s
Default	Depending on size	
Level	ADVANCED	
Address	619	
Function	Ramp applied during the final stage of the ramp, from the instant when the frequency set in parameter **P020** is attained until the motor stops. See also parameter **P010** (deceleration ramp time).	

P020	Speed Threshold for Initial and Final Ramps	
Range	0 ÷ 1500	0 ÷ 150.0% The maximum value depends on **C800** (see section 6.6.9) and **C029** (see 6.6.4).
Default	500	50.0%
Level	ADVANCED	
Address	757	
Function	This is the output frequency, considered as a percentage in respect to the nominal motor frequency (parameter **C015**), below which the following ramps are applied: - ramp **P018** while accelerating, - ramp **P019** while decelerating. The maximum value for this parameter is: **C800 / C015 * p *** 100 where *p* is the number of pole pairs of the motor. In that way, the speed threshold will not drop below the value set in **C800**.	

6.6.2. Dry-run Control Menu

6.6.2.1. Overview

Thanks to the Dry-run detection function, the drive is capable of detecting when the pump is working under Dry-run conditions or when cavitation is about to occur.

The Dry-run Control algorithm is based on electrical measurements of the motor and does not require pressure measurements, as these are not always available and, moreover, are dependent on the application. This allows the Dry-run Control to be kept activated even in speed control only.

The reference variables for the Dry-run Control conditions may be selected via parameter **P710:**

- Electric power
- Power factor (*cosphi*)

The latter guarantees greater sensitivity and accuracy.

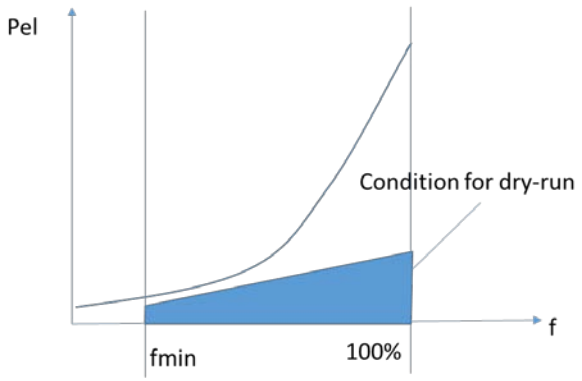
The user may choose the most suitable measurement based on the type of application.

These values are computed and displayed runtime and are part of the custom measurements to be displayed on the keypad for easier calibration.

6.6.2.2. Calibration

The Dry-run zone is to be defined based on the plant and the characteristic curves of the connected pump.

As shown in the figure below, the zone is limited by 2 points at two different operating frequency values.



The two Dry-run points are set in parameters **P710a-P710b** and **P710c-P710d.**

Parameter **P711** inhibits the Dry-run detection below a preset operating frequency.

The calibration guidelines for two different applications are given below:

- Stop water flow from the plant (valve closure).
- Reach maximum speed and set **P710c**.
- Set **P710d** to a value lower than the selected Dry-run measurement (electric power or power factor).
- Repeat the steps above by adopting a low speed reference.

6.6.2.3. Dry-run Activation

The Dry-run function activates if both the following conditions are true:

- Operation in Dry-run zone
- Speed reference greater than the minimum value between **P711** and **C029** (with suitable adjustment of the units of measures controlled internally to the drive)

If the Dry-run condition persists for a time longer than **P712**, the action defined in **P716** is carried out.

To facilitate testing or expand activation logics, parameter **P715** is available, allowing allocating an MDI to the deactivation of the Dry-run function.

If the Dry-run function is active, resetting its activation is possible either manually (by pressing the reset button on the keypad) or automatically if the system quits the Dry-run detection mode for a time longer than **P713**.

When **P716** is set as Alarm or Warning, the countdown of the automatic reset is displayed.

The automatic reset allows for the service re-activation without manual activation after a transient condition has occurred, such as a transient lower level of water in a well.

6.6.2.4. List of Parameters P710 to P716

Parameter	Function	User Level	Default Value	MODBUS Address
P710	Quantity for Dry-Run Detection	ADVANCED	1: Power factor	888
P710a	Low Frequency for Dry-Run Threshold	ADVANCED	0.00%	889
P710b	Dry-Run Threshold at Low Frequency	ADVANCED	0	890
P710c	High Frequency for Dry-Run Threshold	ADVANCED	100.00%	891
P710d	Dry-Run Threshold at High Frequency	ADVANCED	0	892
P711	Minimum Frequency for Dry-Run Enable	ADVANCED	0.00%	893
P712	Dry-Run Trip Time	ADVANCED	20.0 s	894
P713	Dry-Run Autoreset Time	ADVANCED	30 s	895
P714	Filter Time Constant for Detection Quantity	ADVANCED	300 ms	896
P715	MDI for Dry-Run Disable	ADVANCED	0: Disable	897
P716	Dry-Run Action Selector	ADVANCED	0: Disable	898

P710	Quantity for Dry-Run Detection	
Range	0 ÷ 1	0: Electrical Power 1: Power Factor
Default	1	1: Power Factor
Level	ADVANCED	
Address	888	
Function	Defines the measurement for the Dry-run detection.	

P710a	Low Frequency for Dry-Run Threshold	
Range	0 ÷ 10000	0 ÷ 100.00 %
Default	0	0.00 %
Level	ADVANCED	
Address	889	
Function	Speed for the first point defining the Dry-run function. Expressed as a percentage of **C015**: nominal motor frequency.	

P710b	Dry-Run Threshold at Low Frequency	
Range	0 ÷ 10000	0 ÷ 100.00
Default	0	0.00
Level	ADVANCED	
Address	890	
Function	Value of the Dry-run detection measurement, selected in **P710**, at first point speed **P710a**.	

P710c	High Frequency for Dry-Run Threshold	
Range	0 ÷ 10000	0 ÷ 100.00 %
Default	10000	100.00 %
Level	ADVANCED	
Address	891	
Function	Speed for the second point defining the Dry-run function. Expressed as a percentage of **C015**: nominal motor frequency.	

P710d	Dry-Run Threshold at High Frequency	
Range	0 ÷ 10000	0 ÷ 100.00
Default	0	0.00
Level	ADVANCED	
Address	892	
Function	Value of the Dry-run detection measurement, selected in **P710**, at second point speed **P710c**.	

P711	Minimum Frequency for Dry-Run Enable	
Range	0 ÷ 10000	0 ÷ 100.00
Default	0	0.00
Level	ADVANCED	
Address	892	
Function	Frequency below which the Dry-run condition detection is kept disabled. Expressed as a percentage of **C015**: nominal motor frequency.	

P712	Dry-Run Trip Time	
Range	0 ÷ 32000	0 ÷ 3200.0 s
Default	200	20.0 s
Level	ADVANCED	
Address	894	
Function	Minimum time for the Dry-run condition to be true before triggering the function activation as per **P716**.	

P713	Dry-Run Autoreset Time	
Range	0 ÷ 3200	0 ÷ 3200 s
Default	30	30 s
Level	ADVANCED	
Address	895	
Function	Timeout for condition reset from the latest Dry-run detection event. If **P716** is set as Alarm or Warning, this value is the start point of the reset countdown.	

P714	Filter Time Constant for Detection Quantity	
Range	0 ÷ 32000	0 ÷ 32000 ms
Default	300	300 ms
Level	ADVANCED	
Address	896	
Function	First order filter time constant applied to the reference variable chosen in **P710.** Useful in case of electric noise affecting the variable.	

P715	MDI for Dry-Run Disable	
Range	0 ÷ 24	0 ÷ 24:XMDI8
Default	0	0: Disable
Level	ADVANCED	
Address	897	
Function	If a digital input is set, when the signal is high, the Dry-run detection is disabled.	

P716	Dry-Run Action Selector	
Range	0 ÷ 3	0: Disable 1: Alarm 2: Warning 3: Only MDO
Default	0	0: Disable
Level	ADVANCED	
Address	898	
Function	When a Dry-run condition is detected for a time equal to at least the time set in **P712**, the selected action is executed. The default setting is “No action”. The possible options are the triggering of an alarm (inverter stop) or a warning signal (displayed on the keypad, but the inverter is kept running). If an MDO for Dry-run detection is allocated to this function from the **Digital Outputs Menu**, its status will be changed in cases 1, 2 and 3. Option 3 is required to have only the **MDO** command without any additional signal.	

6.6.3. Pipe Fill Control Menu

6.6.3.1. Overview

The hydraulic systems are affected by the “water hammer” phenomenon, occurring in case of sudden changes in pressure and that may damage piping, thus adversely affecting the lifetime of the system.

The water hammer phenomenon may occur if pipes are filled in an abrupt way.

The Pipe Fill function has been developed to smoothly control pipe fill and avoid water hammer phenomena damaging hydraulic outlets (such as irrigation nozzles) by limiting the system filling rate.

The Pipe Fill logic is a general-purpose one to better meet the customer’s application requirements, i.e. vertical or horizontal systems:

- In vertical systems, the more pipes are full, the greater the pressure. In that case, the acceleration ramp must be slower and maintain constant flow rate for the time required for pressure stabilization.
- In horizontal systems, pressure does not increase during pipe fill, so the pipe fill rate may be attained quickly and can be kept constant for the time required to fill the whole pipe length.

The figures below show the pipe fill rate trend over time in case of vertical and horizontal plant.

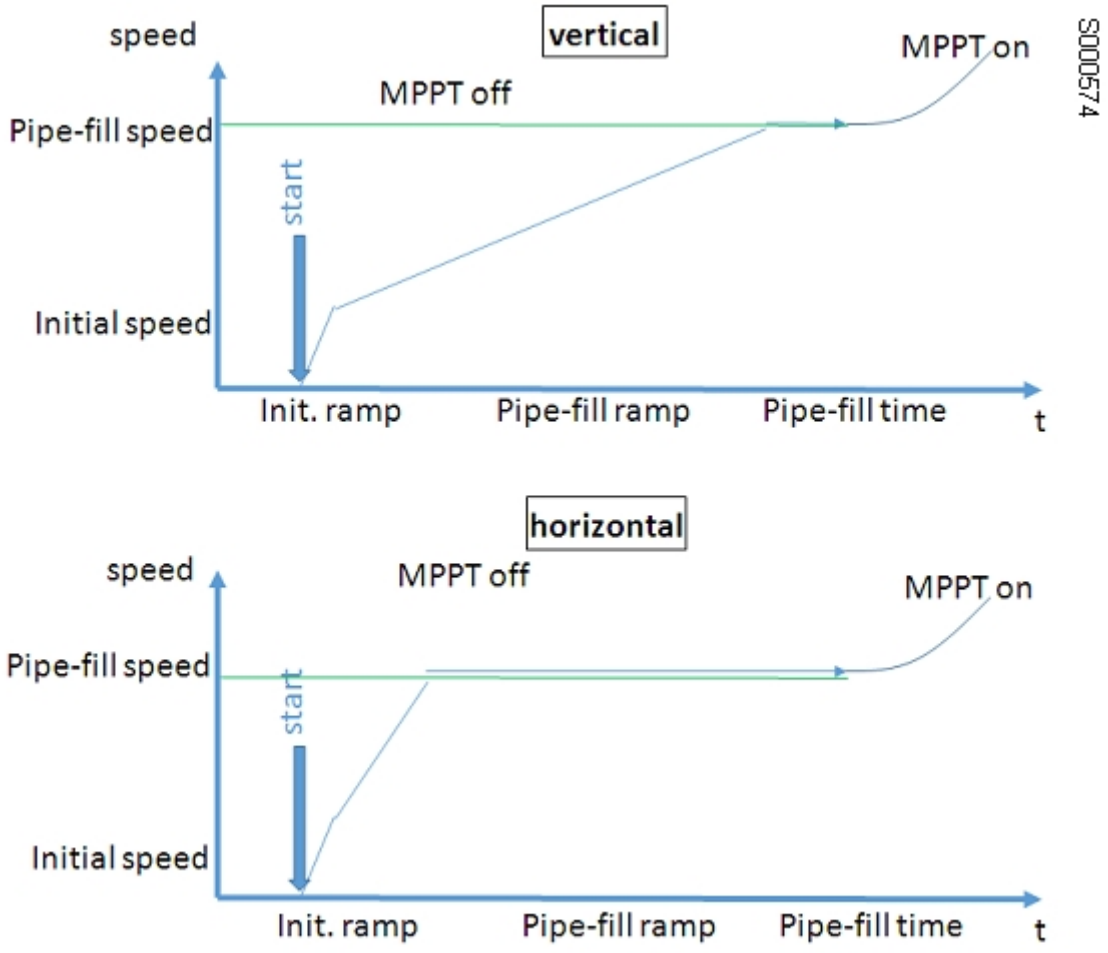


Figure 30: Pipe Fill function

If the PID regulator is adopted, parameter **P734** allows choosing whether to stop pipe fill when the preset fill time is over, or even when the PID reference is attained.

When the PID is disabled, the Pipe Fill function will stop when the preset fill time is achieved and will be resumed to reach the reference fill rate via the active ramps.

6.6.3.2. List of Parameters P730 to P734

Parameter	Function	User Level	Default Value	MODBUS Address
P730	Pipe Fill Ramp	ADVANCED	10.0 s	932
P731	Pipe Fill Rate	ADVANCED	30.00%	933
P732	Pipe Fill Time	ADVANCED	5s	934
P734	Pipe Fill Enable Mode	ADVANCED	0: Disable	936

P730	**Pipe Fill Ramp**	
Range	0 ÷ 32000	0 ÷ 3200.0 s
Default	100	10.0 s
Level	ADVANCED	
Address	932	
Function	Determines the time taken to go from zero rpm to the value set in **P731**.	

P731	**Pipe Fill Rate**	
Range	0 ÷ 32000	0 ÷ 320.00 %
Default	3000	30.00 %
Level	ADVANCED	
Address	933	
Function	Determines the pipe fill rate for the reference during the Pipe Fill stage.	

P732	**Pipe Fill Time**	
Range	0 ÷ 32000	0 ÷ 32000 s
Default	5	5 s
Level	ADVANCED	
Address	934	
Function	Indicates the time when the pipe fill rate is kept at the value set in **P731**.	

P734	**Pipe Fill Enable Mode**	
Range	0 ÷ 1	0: Disabled 1: Enabled
Default	0	0: Disabled
Level	ADVANCED	
Address	936	
Function	0: Disabled The Pipe Fill function is inactive and the active ramps are implemented. 1: Enabled The function is active; exiting the Pipe Fill mode is conditioned only when the preset times are over 2: Enabled + PID feedback The function is active; exiting the Pipe Fill mode is conditioned when the preset times are over or when the PID reference is attained.	

6.6.4. Motor Configuration Menu

6.6.4.1. Overview

The Solardrive Plus software controls the motor according to the IFD (Voltage/Frequency Control) algorithm, where the output voltage is computed based on frequency and special parameterization.

6.6.4.2. Motor Ratings

Table 25: Motor Ratings

Motor Ratings	Parameter
Rated frequency	**C015**
Rated rpm	**C016**
Rated power	**C017**
Rated current	**C018**
Rated voltage	**C019**
No-load power	**C020**
No-load current	**C021**

6.6.4.3. Parameters for IFD control

This group of parameters defines the V/f pattern trend of the drive when it is used as an IFD control algorithm. When setting the type of V/f pattern (**C013**), the following curves can be used:

- Constant torque
- Quadratic
- Free setting

The diagram below illustrates three types of programmable curves compared to the theoretical V/f curve.

If **C013 = Constant Torque,** Preboost parameter **C034** allows changing the starting voltage value if compared to the theoretical V/f curve (this allows torque compensation for losses caused by the stator impedance and a greater torque at lower revs).

If **C013 = Quadratic,** the drive will follow a V/f pattern with a parabolic trend. You can set the starting voltage value (**C034**), the desired voltage drop if compared to the relevant constant torque (use **C032**) and the frequency allowing implementing this torque reduction (use **C033**).

If **C013 = Free Setting,** you can program the starting voltage (**C034 Preboost**), the increase in voltage to 1/20 of the rated frequency (**C035 Boost0**), and the increase in voltage (**C036 Boost1**) at programmable frequency (**C037 Frequency for Boost1**).

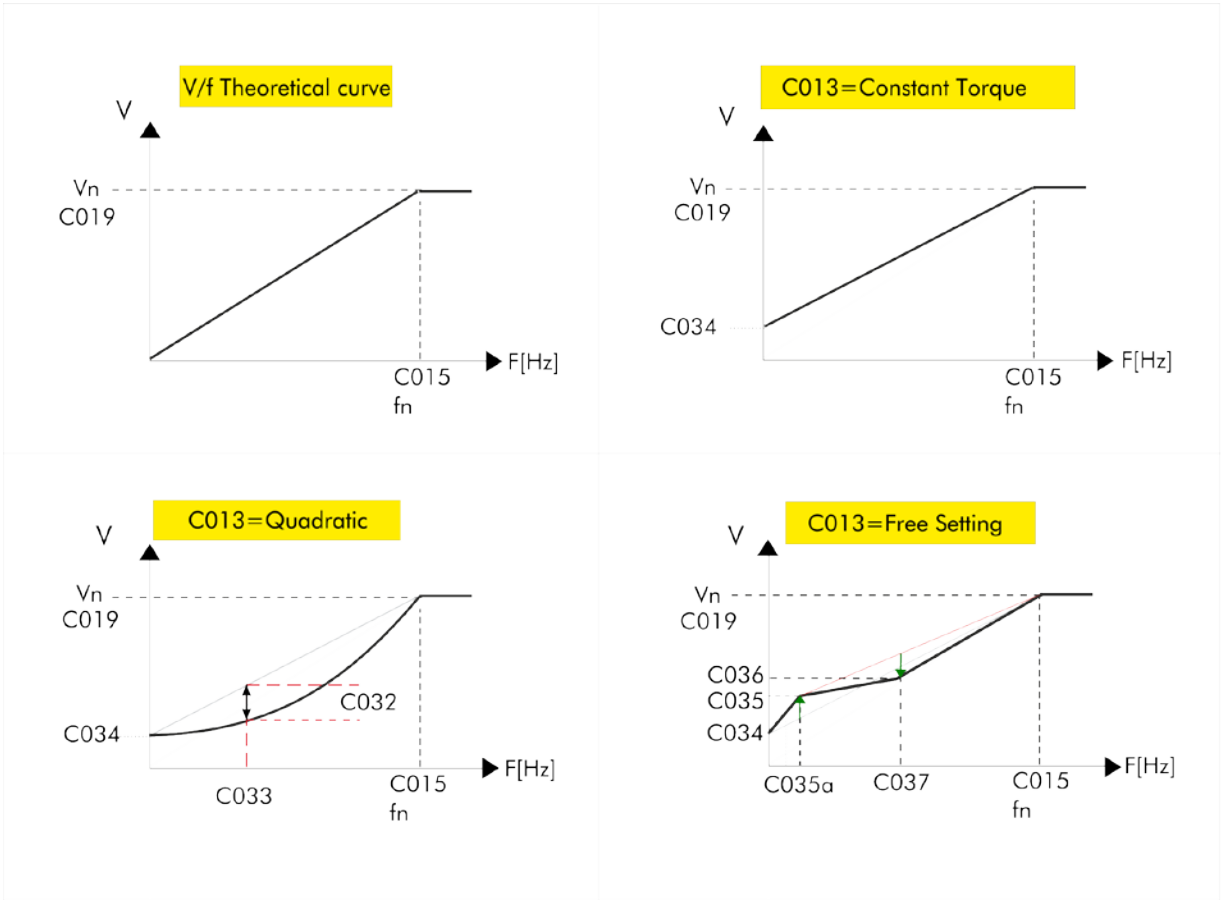


Figure 31: Types of programmable V/f curves

The voltage produced by the drive may be changed also by setting the **Automatic Increase in Torque Curve** parameter (**C038**).
For the description of the parameters used in the figure above, see Table 26.

Table 26: IFD control parameters for the connected motors

Description	Parameter
Rated frequency: Rated frequency of the connected motor (current rating).	**C015**
Rated voltage: rated voltage of the connected motor (voltage rating).	**C019**
V/f curve type: Type of V/f curve applied.	**C013**
Torque reduction with quadratic curve: Torque reduction using V/f quadratic curve.	**C032**
Rated speed referring to torque reduction with quadratic curve: Speed actuating the torque reduction using a quadratic curve.	**C033**
Voltage preboost: Determines the voltage produced by the drive at min. output frequency fomin.	**C034**
Voltage Boost 0: Determines the voltage variations in respect to the nominal voltage at the frequency set up by the relevant parameter.	**C035**
Boost 0 application frequency: Determines the Boost 0 application frequency.	**C035a**
Voltage Boost 1: Determines the frequency for the application of the boost at preset frequency.	**C036**
Boost 1 application frequency: Determines the Boost 1 application frequency at preset frequency.	**C037**
Autoboost: Variable torque compensation expressed as a percentage of the rated motor voltage. The preset value expresses the voltage increase when the motor is running at rated torque.	**C038**

6.6.4.4. List of parameters C008 to C042

Parameter	Function	User Level	Default Value	MODBUS Address
C008	Rated Mains Voltage	BASIC	2:[380÷480V]	1008
C010	Type ff Control Algorithm	NOT ADJUSTABLE	0: IFD	1010
C011	Type ff Reference	NOT ADJUSTABLE	0: Speed (MASTER mode)	1011
C012	Speed Feedback from Encoder	NOT ADJUSTABLE	0: Speed (MASTER mode)	1012
C013	Type of V/F Curve	BASIC	Depending on size	1013
C014	Phase Rotation	ENGINEERING	0: No	1014
C015	Rated Motor Frequency	BASIC	50.0 Hz	1015
C016	Rated Motor Rpm	BASIC	1420 rpm	1016
C017	Rated Motor Power	BASIC	Depending on size	1017
C018	Rated Motor Current	BASIC	Depending on size	1018
C019	Rated Motor Voltage	BASIC	400.0 V	1019
C020	Motor No-Load Power	ADVANCED	0.0%	1020
C021	Motor No-Load Current	ADVANCED	0%	1021
C022	Motor Stator Resistance	ENGINEERING	Depending on size	1022
C023	Leakage Inductance	ENGINEERING	Depending on size	1023
C024	Mutual Inductance	ADVANCED	250.00mH	1024
C026	Time Constant Of Bus Voltage Low-Pass Filter	ENGINEERING	0 ms	1026
C028	Min. Motor Speed	BASIC	0 rpm	1028
C029	Max. Motor Speed	BASIC	1500 rpm	1029
C031	Max. Speed Alarm	ADVANCED	0: Disabled	1031
C032	Reduction in Quadratic Torque Curve	ADVANCED	30%	1032
C033	Rated Revs Referring to Reduction in Quadratic Torque Curve	ADVANCED	20%	1033
C034	Voltage Preboost for IFD	BASIC	Depending on size	1034
C035	Voltage Boost 0 at Programmable Frequency	ADVANCED	Depending on size	1035
C035a	Frequency for Boost 0 Application	ADVANCED	5%	1052
C036	Voltage Boost 1 at Programmable Frequency	ADVANCED	Depending on size	1036
C037	Frequency for Application of Voltage Boost 1	ADVANCED	Depending on size	1037
C038	Autoboost	ADVANCED	Depending on size	1038
C039	Slip Compensation	ADVANCED	0: Disabled	1039
C040	Voltage Drop at Rated Current	ADVANCED	0: Disabled	1040
C042	Vout Saturation Percentage	ENGINEERING	100%	1042

C008	Rated Mains Voltage	
Range	0 ÷ 8	0: [200 ÷ 240] V 1: 2T Regen. 2: [380 ÷ 480] V 3: [481 ÷ 500] V 4: 4T Regen. 5: [500 ÷ 600] V 6: 5T Regen. 7: [600 ÷ 690] V 8: 6T Regen.
Default	2	2: [380 ÷ 480] V
Level	BASIC	
Address	1008	
Function	This parameter defines the rated voltage of the mains powering the drive, thus allowing obtaining voltage ranges to be used for the drive operation. The value set in this parameter depends on the **Drive voltage class.** To supply the drive via a non-stabilized DC source, the corresponding AC voltage range must be used (see Table 27). DO NOT USE xT Regen settings in this case.	

Table 27: Equivalence between AC mains range and DC range

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

C013	Type of V/F Pattern	
Range	0 ÷ 2	0: Constant Torque 1: Quadratic 2: Free Setting
Default	Depending on the size	
Level	BASIC	
Address	1013	
Function	Allows selecting different types of V/f pattern. If **C013 = Constant torque**, voltage at zero frequency can be selected (Preboost **C034**). If **C013 = Quadratic**, you can select voltage at zero frequency (preboost, **C034**), max. voltage drop with respect to the theoretical V/f pattern, **C032**, and the frequency allowing implementing max. voltage drop, **C033**. If **C013 = Free Setting**, you can set voltage at zero frequency (preboost, **C034**); voltage increase to 20% of the rated frequency (Boost0, **C035**); and voltage increase to a programmed frequency (Boost1, **C036**; frequency for Boost1, **C037**).	

C014	Phase Rotation	
Range	0÷1	0: [No]; 1: [Yes]
Default	0	0: [No]
Level	ENGINEERING	
Address	1014	
Function	Allows reversing the mechanical rotation of the connected motor.	

WARNING

When activating C014, the mechanical rotation of the connected motor and its load is reversed accordingly.

C015	Rated Motor Frequency	
Range	10 ÷ 10000	1.0 Hz ÷ 1000.0 Hz (See upper limits in Table 28)
Default	500	
Level	BASIC	
Address	1015	
Function	This parameter defines the rated motor frequency (nameplate rating).	

Table 28: Maximum value of the output frequency depending on the drive size

Size	Max. output frequency (Hz) (*)
	2T/4T
Smaller than 0015	1000
0015 to 0129 (**)	625
0150 to 0162	500
Greater than 0162	400

(**) From 0023 to 0030 (437.5Hz), 0040 (1000Hz) and 0049 (800Hz)

Size	Max. output frequency (*)
	5T/6T
Smaller than 0076	500
0076 to 0524	400
Greater than 0524	200

(*) NOTE

*The maximum output frequency is limited to the speed level programmed in parameters **C028, C029 [–32000 ÷ 32000]rpm.** This results in **Fout$_{max}$= (RPM$_{max}$*NPole)/120.***

C016	Rated Motor RPM	
Range	1 ÷ 32000	1 ÷ 32000 rpm
Default	1420	
Level	BASIC	
Address	1016	
Function	This parameter defines the rated motor rpm (nameplate rating).	

C017	Rated Motor Power	
Range	1 ÷ 32000	0.1 ÷ 3200.0 kW (Upper limited to twice the default value)
Default	Depending on the size	
Level	BASIC	
Address	1017	
Function	This parameter defines the rated motor power (nameplate rating).	

C018	Rated Motor Current	
Range	1 ÷ 32000	0.1 ÷ 3200.0 A (Depending on the size)
Default	Depending on the size	
Level	BASIC	
Address	1018	
Function	This parameter defines the rated motor current (nameplate rating).	

C019	Rated Motor Voltage	
Range	50 ÷ 12000	5.0 ÷ 1200.0 V
Default	4000	400.0 V
Level	BASIC	
Address	1019	
Function	This parameter defines the rated motor voltage (nameplate rating).	

C020	Motor No-load Power	
Range	0 ÷ 1000	0.0 ÷ 100.0%
Default	0	0.0%
Level	ADVANCED	
Address	1020	
Function	This parameter defines the power absorbed by the motor at rated voltage and rated rpm when no load is connected to the motor.	

C021	Motor no-load current	
Range	1 ÷ 100	1 ÷ 100%
Default	0	0%
Level	ADVANCED	
Address	1021	
Function	This parameter defines the current absorbed by the motor at rated voltage and rated rpm when no load is connected to the motor. It is expressed as a percentage of the motor rated current **C018**.	

C022	Motor Stator Resistance	
Range	0 ÷ 32000	0.000 ÷ 32.000Ω
Default	Depending on the size	
Level	ENGINEERING	
Address	1022	
Function	This parameter defines stator resistance Rs. If a star connection is used, it matches with the value of the resistance of one phase (half the resistance measured between two terminals); if a delta connection is used, it matches with 1/3 of the resistance of one phase.	

C023	Leakage Inductance	
Range	0 ÷ 32000	0.00 ÷ 320.00mH
Default	Depending on the size	
Level	ENGINEERING	
Address	1023	
Function	This parameter defines the global leakage inductance of the connected motor. If a star connection is used, it matches with the value of the inductance of one phase; if a delta connection is used, it matches with 1/3 of the inductance of one phase.	

C024	Mutual Inductance	
Range	0 ÷ 65000	0.00 ÷ 650.00mH
Default	25000	250.00mH
Level	ADVANCED	
Address	1024	
Function	This parameter defines the mutual inductance of the connected motor. The approximate value of the mutual inductance results from no-load current according to the formula below: $M \cong (Vmot – Rstat*Io) / (2\pi fmot* Io)$	

C026	Time Constant of Bus Voltage Low-pass Filter	
Range	0 ÷ 32000	0.0 ÷ 3200.0 ms
Default	0	0.0 ms
Level	ENGINEERING	
Address	1026	
Function	This parameter defines the time constant of the low-pass filter of the bus voltage readout. Changing this value can avoid motor oscillations, especially when no load is connected to the motor.	

C028	Min. Motor Speed	
Range	–32000 ÷ 32000 (*)	–32000 ÷ 32000 rpm (*)
Default	0	0 rpm
Level	BASIC	
Address	1028	
Function	This parameter defines the minimum speed of the connected motor. This is the reference speed forced when the active speed reference is at its minimum value.	

NOTE

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

C029	Max. motor speed	
Range	0 ÷ 32000 (*see note in parameter **C028**)	0 ÷ 32000 rpm (*see note in parameter **C028**)
Default	1500	1500 rpm
Level	BASIC	
Address	1029	
Function	This parameter defines the maximum speed of the connected motor. This is the reference speed forced when the active speed reference is at its maximum value.	

NOTE

*According to factory setting, when the equipment is AC power supplied (from optional, auxiliary AC grid), the motor speed reference is equal to the value in parameter **C029**.*

C031	Max. Speed Alarm	
Range	0 ÷ 32000	0: [Disabled] ÷ 32000 rpm
Default	0	0: Disabled
Level	ADVANCED	
Address	1031	
Function	If it is not set to zero, this parameter determines the speed value to be entered for the maximum speed alarm (**A076**).	

C032	Reduction in Quadratic Torque Curve	
Range	0 ÷ 1000	0 ÷ 100.0%
Default	300	30.0%
Level	ADVANCED	
Address	1032	
Control	IFD	
Function	If the V/f curve pattern **C013 (C056, C099) = Quadratic**, this parameter defines the maximum voltage reduction in terms of theoretical V/f pattern, which is implemented at the frequency programmed in **C033** (see section 6.6.4.3).	

C033	Rated Revs Referring to Reduction in Quadratic Torque Curve	
Range	1 ÷ 100	1 ÷ 100%
Default	20	20%
Level	ADVANCED	
Address	1033	
Control	IFD	
Function	If the V/f curve pattern **C013 = Quadratic**, this parameter defines the frequency implementing the max. torque reduction in terms of theoretical V/f pattern set in **C032** (see section 6.6.4.3).	

C034	Voltage Preboost for IFD	
Range	0 ÷ 50	0.0 ÷ 5.0 %
Default	Depending on the size	
Level	BASIC	
Address	1034	
Control	IFD	
Function	Torque compensation at minimum frequency produced by the drive. IFD control: determines the increase of the output voltage at 0Hz.	

C035	Voltage Boost 0 at Programmable Frequency	
Range	–100 ÷ +100	–100 ÷ +100 %
Default	Depending on the size	
Level	ADVANCED	
Address	1035	
Control	IFD	
Function	Torque compensation at preset frequency (parameter **C035a**). This parameter defines the output voltage variation at preset frequency in respect to the frequency resulting from the constant V/f ratio (voltage/frequency constant). It is expressed as a percentage of the nominal motor voltage (**C019**).	

C035a	Frequency for Boost 0 Application	
Range	0 ÷ 99	0 ÷ 99 %
Default	5	5%
Level	ADVANCED	
Address	1052	
Control	IFD	
Function	Frequency for the application of the boost preset with parameter **C035**. It is expressed as a percentage of the nominal motor frequency (**C015**).	

C036	Voltage Boost 1 at Programmable Frequency	
Range	–100 ÷ +400	–100 ÷ +400 %
Default	Depending on the size	
Level	ADVANCED	
Address	1036	
Control	IFD	
Function	Torque compensation at preset frequency (parameter **C037**). Determines how output voltage varies at preset frequency with respect to voltage obtained with a constant V/f pattern (constant voltage frequency). It is expressed as a percentage of the nominal motor frequency (**C019**).	

C037	Frequency for Application of Voltage Boost 1	
Range	6 ÷ 99	6 ÷ 99 %
Default	Depending on the size	
Level	ADVANCED	
Address	1037	
Control	IFD	
Function	Frequency for application of voltage Boost with parameter **C036**. This is expressed as a percentage of the motor rated frequency (**C015**).	

C038	Autoboost	
Range	0 ÷ 10	0 ÷ 10 %
Default	Depending on the size	
Level	ADVANCED	
Address	1038	
Control	IFD	
Function	Variable torque compensation expressed as a percentage of the motor rated voltage. The preset value expresses the voltage increase when the motor is running at its rated torque.	

C039	Slip Compensation	
Range	0 ÷ 200	[0: Disabled] ÷ 200 %
Default	0	[0: Disabled]
Level	ADVANCED	
Address	1039	
Control	IFD	
Function	This parameter represents the motor rated slip expressed as a value percent. If set to 0, this function is disabled.	

C040	Voltage Drop at Rated Current	
Range	0÷500	0÷50.0%
Default	0	0: Disabled
Level	ADVANCED	
Address	1040	
Control	IFD	
Function	Defines the voltage increase required to compensate the voltage drop between the inverter and the motor due to the presence of a filter. The voltage increase is given by: DeltaV = (**C040**/100) * Vmot * Iout/Imot * fout/fmot, where Iout is the output current, fout is the output frequency, Vmot, Imot and fmot are the rated motor voltage, rated motor current and rated motor frequency respectively (parameters **C019**, **C018** and **C015**). Example: **C040 = 10%** Voltage drop at rated current **C013 = Constant torque** Type of V/f pattern **C015 = 50 Hz** Rated frequency **C019 = 380 V** Rated voltage **C018 = 50 A** Rated current If the drive output frequency is 25 Hz, it should deliver 190V. When the output current is 40A (**C018**) the voltage actually produced is Vout = 190 + ((10/100 * 380) * 40/50 * 25/50) = 190 + 15.2 = 205.2 V.	

C042	Vout Saturation Percentage	
Range	10 ÷ 120	10 ÷ 120 %
Default	100	100%
Level	ENGINEERING	
Address	1042	
Function	This parameter sets the bus voltage value percent used to generate the output voltage of the drive. Changes made to this parameter affect the motor performance in terms of flux weakening.	

6.6.5. Limits Menu

6.6.5.1. Overview

The **Limits Menu** defines the current/torque limits applied to the control functions (IFD, VTC or FOC controls) selected for the connected motor.

For IFD control, **current** limits are used. Three limit current levels are available, which are expressed as a percentage of the motor rated current:

1) Current limit while accelerating;
2) Current limit at constant rpm;
3) Current limit while decelerating.

Two special parameters are also available; one sets the decrease of the limit current value when the motor runs at constant power (flux weakening), while the other parameter disables the frequency decrease in case of acceleration current limit (this is useful for inertial loads).

6.6.5.2. List of Parameters C043 to C050

Parameter	Function	User Level	Default Value	MODBUS Address
C043	Current limit while accelerating	BASIC	150%	1043
C044	Current limit at constant rpm	BASIC	150%	1044
C045	Current limit while decelerating	BASIC	Depending on size	1045
C046	Current limit decrease in flux weakening	ADVANCED	0: Disabled	1046
C050	Frequency decrease during acceleration limit	ADVANCED	0: Enabled	1050

C043	Current Limit while Accelerating	
Range	0 ÷ 400 (*)	0: Disabled 1.0% ÷ 400.0% (*)
Default	150	150%
Level	BASIC	
Address	1043	
Control	IFD	
Function	This parameter defines the current limit while accelerating; it is expressed as a percentage of the rated current of the motor. No limit is applied if this parameter is set to 0: Disabled.	

(*)*The maximum allowable value depends on the drive size.*

C044	Current Limit at Constant rpm	
Range	0 ÷ 400 (*)	0: Disabled 1.0% ÷ 400.0% (*)
Default	150	150%
Level	BASIC	
Address	1044	
Control	IFD	
Function	This parameter defines the current limit at constant rpm; it is expressed as a percentage of the rated current of the motor. No limit is applied if this parameter is set to 0: Disabled.	

(*)*The maximum allowable value depends on the drive size.*

C045	Current Limit while Decelerating	
Range	0 ÷ 400 (*)	0: Disabled 1.0% ÷ 400.0% (*)
Default	Depending on the size	
Level	BASIC	
Address	1045	
Control	IFD	
Function	This parameter defines the current limit while decelerating; it is expressed as a percentage of the rated current of the motor. No limit is applied if this parameter is set to 0: Disabled.	

(*)*The maximum allowable value depends on the drive size.*

C046	Current Limit Decrease in Flux Weakening	
Range	0 ÷ 1	0: Disabled 1: Enabled
Default	0	0: Disabled
Level	ADVANCED	
Address	1046	
Control	IFD	
Function	This parameter enables the current limit decrease function in flux weakening. The current limit is multiplied by the ratio between the motor rated torque and the frequency forced to the drive: limit = current limit being used * (Fmot/ Fout).	

C050	Frequency Decrease during Acceleration Limit	
Range	0 ÷ 1	0: Enabled 1: Disabled
Default	0	0: Enabled
Level	ADVANCED	
Address	1050	
Control	IFD	
Function	This parameter enables output frequency decrease during acceleration limit.	

6.6.6. Control Method Menu

NOTE

For a detailed description on parameters that are not described in this manual, please contact Elettronica Santerno S.p.A.

6.6.6.1. Overview

As per factory setting, the drive receives digital commands from the terminal board and the speed references:

- From the internal MPPT regulator, if DC power supply from PV field is active (PV mode);
- From REF analog input if AC power supply is active (AC mode – if available).

6.6.6.2. List of Parameters C140 to C148

Parameter	Function	User Level	Default Value	MODBUS Address
C140	Selection of Command Source 1	ADVANCED	1: Terminals	1140
C141	Selection of Command Source 2	ADVANCED	1: Terminals	1141
C142	Selection of Command Source 3	ENGINEERING	0	1142
C143	Selection of Reference when PV	ADVANCED	12: MPPT	1143
C144	Selection of Reference when AC	ADVANCED	1: REF	1144
C145	Selection of Reference Source 3	ENGINEERING	0	1145
C146	Selection of Reference Source 4	ENGINEERING	0	1146
C147	Selection of Limit Source	ENGINEERING	0	1147
C148	Switching from Remote to Local Control	ENGINEERING	0: Stand-by or Fluxing	1148

C140 C141 C142	**Selection of Command Source 1, 2, 3**	
Range	0 ÷ 5	0: Disabled, 1: Terminals 2: Serial Link, 3: Fieldbus, 4: Terminals B, 5: Keypad
Default	**C140** ÷ **C141**= 1 **C142** = 0	**C140** ÷ **C141**= 1: Terminals **C142** = 0: Disabled
Level	**C140** ÷ **C141** ADVANCED; **C142** ENGINEERING	
Address	1140 (1141,1142)	
Function	Selection of the drive command source.	

C143	Selection of Reference when PV	
Range	0 ÷ 12	0: Disabled 1: REF 2: AIN1 3: AIN2 4: Frequency input 5: Serial Link 6: Fieldbus 7: Keypad 8: Encoder 9: UpDown from MDI 10: XAIN4 12: MPPT
Default	12	12: MPPT
Level	ADVANCED	
Address	1143	
Function	This parameter selects the reference source when DC power supply (PV field) is active. If 12: MPPT, the motor speed reference is generated by the internal regulator in order to guarantee operation at the Maximum Power Point Tracking of the PV field.	

NOTE

If parameter **C143** *is set other than* **12: MPPT**, *the equipment might not run correctly.*

C144	Selection of Reference when AC	
Range	0 ÷ 9	0: Disabled 1: REF 2: AIN1 3: AIN2 4: Frequency input 5: Serial Link 6: Fieldbus 7: Keypad 8: Encoder 9: UpDown from MDI
Default	1	1: REF
Level	ADVANCED	
Address	1144	
Function	This parameter selects the reference source when AC power supply (optional) is active. If set to 1: REF, the motor speed reference is taken from REF analog input. Factory setting: +10 V DC to REF input produces a speed reference for the motor equal to the speed value set in parameter **C029** (see section 6.6.4).	

6.6.7. Autoreset Menu

6.6.7.1. Overview

The Autoreset function can be enabled in case an alarm trips. You can enter the maximum number of autoreset attempts and the time required for resetting the attempt number. If the Autoreset function is disabled, you can program an autoreset procedure at power on, which resets an active alarm when the drive is shut off. Undervoltage alarms or mains loss alarms can be saved in the fault list in the Autoreset Menu.

To activate the Autoreset function, set a number of attempts other than zero in parameter **C255**. When the number of reset attempts is the same as the value set in **C255**, the autoreset function is disabled. It will be enabled again only when a time equal to or longer than the time set in **C256** has passed.

If the drive is turned off when an alarm is active, the alarm tripped is stored to memory and will be active at next power on. Regardless of the Autoreset function setup, an automatic reset of the last alarm stored can be obtained when the drive is next turned on (**C257** [Yes]). Undervoltage alarm **A047** (DC bus voltage below allowable threshold with motor running) or Mains Loss alarm **A064** (mains loss when the motor is running and the Power Down function is disabled) are not stored in the fault list when the drive is powered off (factory-setting). To enable parameter storage, set **C258** to [Yes].

The Solardrive Plus is factory-set to alarm autoreset functionality (when an alarm trips, it is automatically reset when the alarm reset conditions occur). When the alarm is reset, the motor starts after a timeout set in **P802** (see section 6.6.11).

6.6.7.2. List of Parameters C255 to C258

Parameter	FUNCTION	User Level	Default Value	MODBUS Address
C255	Autoreset attempt number	ENGINEERING	4	1255
C256	Attempt counting reset time	ENGINEERING	300 sec	1256
C257	Alarm reset at Power On	ENGINEERING	1: [Yes]	1257
C258	Enable Undervoltage and Mains Loss alarms	ENGINEERING	0: [Disabled]	1258

C255	**Autoreset Attempt Number**	
Range	0 ÷ 100	0 ÷ 100
Default	4	4
Level	ENGINEERING	
Address	1255	
Function	If set other than 0, this parameter enables the Autoreset function and sets the max. allowable number of reset attempts. The autoreset attempt count is reset when a time equal to the time set in **C256** passes starting from the last alarm tripped.	

C256	**Attempt Counting Reset Time**	
Range	0; 1000	0; 1000 sec
Default	300	300 sec
Level	ENGINEERING	
Address	1256	
Function	Determines the time that passes from the last alarm tripped to reset the autoreset attempt number.	

C257	Alarm Reset at Power On	
Range	0; 1	0: [Disabled]; 1: [Yes]
Default	0	1: [Yes]
Level	ENGINEERING	
Address	1257	
Function	At power on, this parameter enables the automatic reset of the alarms tripped when the drive is powered off.	

C258	Enable Undervoltage and Mains Loss Alarms	
Range	0; 1	0: [Disabled]; 1: [Yes]
Default	0	0: [Disabled]
Level	ENGINEERING	
Address	1258	
Function	This parameter saves Undervoltage and Mains Loss alarms to the fault list.	

6.6.8. Motor Thermal Protection Menu

6.6.8.1. Overview

The Motor Thermal Protection function protects the motor against overloads.

It is also possible to set the heatsink temperature to make cooling fans start operating (this function is not available for all models).

For each programmable motor, thermal protection can be configured in 3 modes, which can be selected with parameter **C265**, depending on the cooling system being used (configuration modes 1, 2 and 3):

Value	Descr.	IEC 34-6 Compliance	Description
0:NO	[Disable]	-	The Motor Thermal Protection function is disabled.
1:YES	[No Derating]	IC410	The Motor Thermal Protection function is active with trip current **I*t** independent of operating speed (No derating);
2:YES A	[Forced Cooling]	IC411	The Motor Thermal Protection function is active with trip current **I*t** depending on operating speed, with fan-cooled motor de-rating (Forced Cooling);
3:YES B	[Fan on Shaft]	IC416	The Motor Thermal Protection function is active; trip current **I*t** depends on operating speed and de-rating is suitable for motors having a fan keyed to the shaft (Fan on Shaft) (factory setting).

When **C265**=1, 2 and 3, the motor thermal model is considered. The heating of a motor is proportional to the square of the current flowing (I_o^2). The Motor overheated alarm (**A075**) will trip after the time "t" computed based on the motor thermal model is over.

The alarm can be reset only after a given time depending on the thermal constant (**C267**) of the motor, thus allowing for the correct cooling of the motor.

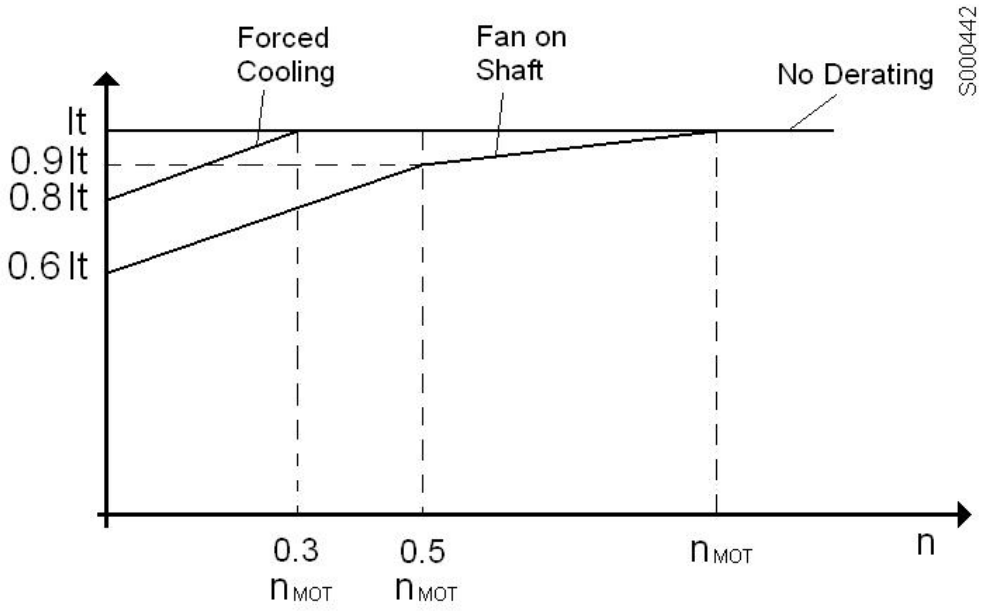


Figure 32: Trip current drop depending on speed values

The graph above shows how trip current **I*t** drops depending on the generated speed based on the value set in parameter **C265**.

NOTE

*The motor heating can be monitored with measure **M026a**.*
This value is expressed as a percentage of the asymptotic value that can be attained.

When **C274**=Enabled, the thermal protection function is implemented from a PTC sensor: the PTC alarm (**A055**) trips when voltage acquired by AIN2 used as a PTC signal input exceeds a preset threshold value when the characteristic temperature is attained. Alarm A055 can be reset only if temperature decreases by 5% with respect to the trip temperature.

6.6.8.2. List of Parameters C264 to C274

Parameter	Function	User Level	Default Value	MODBUS Address
C264	Heatsink Temperature for Fan Activation	ADVANCED	50°C	1264
C264a	Fan Activation Logic Selector	AVDANCED	0: Default	1280
C265	Thermal Protection Mode for Motor 1	BASIC	3: [Fan Shaft]	1265
C266	Pick-Up Current for Motor 1[Imot%]	ADVANCED	105%	1266
C267	Thermal Time Constant for Motor 1	BASIC	720 s	1267
C274	PTC Thermal Protection Enable	BASIC	0:[Disabled]	1274

C264	Heatsink Temperature for Fan Activation	
Range	0 ÷ 50	0 ÷ 50°C
Default	50	50°C
Level	ADVANCED	
Address	1264	
Function	This parameter sets the heatsink threshold for the activation of its cooling fans according to the control logic set in **C264a**. This parameter is active only if **C264a**=0: Default or 2: By Temperature Only. The actual temperature of the heatsink can be displayed in measure parameter **M064**.	

C264a	Fan Activation Logic Selector	
Range	0 ÷ 2	0: [Default] 1: [Always On] 2: [By Temperature Only]
Default	0	0: [Default]
Level	ADVANCED	
Address	1280	
Function	This parameter defines the control logic of the heatsink cooling fans. 0: [Default]: The heatsink cooling fans are on whenever the drive is enabled (and IGBTs are switching); when the drive is disabled, fans are off only if the heatsink temperature drops below **C264**. 1: [Always On]: Fans are always on. 2: [By Temperature Only]: Fans are on only if the heatsink temperature is higher than the value set in **C264**, regardless of the drive status.	

C265	Thermal Protection Mode for Motor 1	
Range	0 ÷ 3	0 : [Disabled] 1 : [No Derating] 2 : [Forced Cooling] 3: [Fan on Shaft]
Default	1	1 : [No Derating]
Level	BASIC	
Address	1265	
Function	This parameter enables the Motor Thermal Protection function. It also selects the type of thermal protection among different trip patterns.	

C266	Pick-Up Current for Motor 1	
Range	1 ÷ min [120; [((Imax/Imot)*100)].	1 ÷ min [120%; [((Imax/Imot)*100) %].
Default	105	105%
Level	ADVANCED	
Address	1266	
Function	This parameter sets the thermal protection trip current expressed as a percentage of the motor rated current.	

C267	Thermal Time Constant for Motor 1	
Range	1 ÷ 10800	1 ÷ 10.800s
Default	720	720s (corresponding to Class IEC 20)
Level	BASIC	
Address	1267	
Function	This parameter sets the thermal time constant of the connected motor. The time constant is the time within which the calculated thermal stage has reached 63% of its final value. The motor attains its thermal time constant when it operates in constant load conditions for a time equal to approx. 5 times the constant set in this parameter.	

C274	PTC Thermal Protection Enable	
Range	0 ÷ 1	0: Disabled ÷ 1: Enabled
Default	0	Disabled
Level	ADVANCED	
Address	1274	
Function	This parameter enables the PTC probe (AIN2 analog input)	

6.6.9. Solardrive – Configuration Parameters Menu

NOTE

This section is applicable to software versions starting from 4.050.

6.6.9.1. Overview

This menu includes the configuration parameters of the equipment, namely:

- The configuration of the digital inputs controlling external information;
- The minimum speed of the pump motor;
- The setting of the current decrease based on the heatsink temperature.

Digital Input Configuration

Some digital inputs (MDIs) are allocated to specific functions of the Solardrive Plus Box/Cabinet. In particular:

MDI	FUNCTION	DESCRIPTION
MDI1	Motor start command	Full tank sensor (see section 3.2.3)
MDI4 (*)	PV Field isolation loss	– Signal from isolation control board (see 3.3.3) – Signal for PV field earthing fuse auxiliary contact (see section 3.3.2)
MDI5 (*)	DC/AC switch auxiliary contact	Determines the drive operation in PV mode (power supply from PV field) or AC power supply (auxiliary AC power supply)
MDI6 (*)	SPD tripped	Signal from SPD tripped (see section 3.3.4)

(*) Optional functions

Table 29: Digital inputs

NOTE

The Solardrive Plus Box/Cabinet is standard supplied with the parameters above already set to the value fitting the application required.

Minimum Pump Speed

Centrifugal pumps typically feature minimum speed ratings affecting adequate flow rate. If flow rate is inadequate, the pumps might get damaged. If power made available from the PV field is not adequate to guarantee this minimum speed, the drive stops the motor until power is adequate to run the motor. How the connected motor is restarted is described in section 6.6.10.

Current Reduction based on Heatsink Temperature

If the heatsink temperature exceeds a safety parameter, the output current is limited to a preset value so that the pump may operate even when high temperatures are achieved without stopping the drive due to overtemperature (alarm A094).

Current vs temperature is described in the figure below:

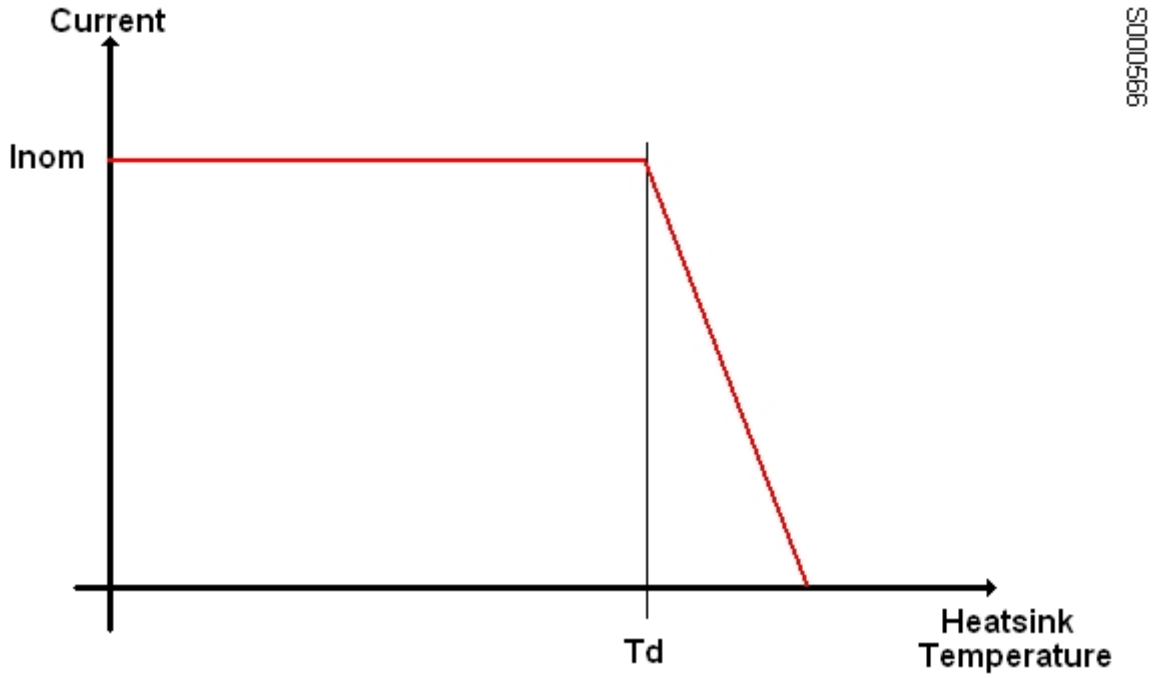


Figure 33: Current reduction based on heatsink temperature

Parameterization enables setting Td (initial current reduction) and the curve slope for temperature values >Td.

6.6.9.2. List of Parameters C800 to C810

Parameter	Function	User Level	Default Value	MODBUS Address
C800	Minimum Pump Speed	BASIC	0 rpm	755
C801	MDI Switch PV/AC Supply	ADVANCED	5: MDI5	753
C802	Mains Loss Alarm Enabled	ENGINEERING	Yes	754
C803	MDI for PV Isolation Loss Detection	ADVANCED	0: Disable	1165
C804	Delay for PV Isolation Loss Detection	ADVANCED	0 ms	1306
C805	PV Isolation Type	ADVANCED	1: PV isolation	774
C806	MDI for Surge Protection Device	ADVANCED	0: Disable	1166
C807	Delay for Surge Protection Device Tripped	ADVANCED	0 ms	1307
C808	Action Selector for Surge Protection Device Tripped	ADVANCED	0: Warning	751
C809	Heatsink Temperature for Initial Current Decrease	ADVANCED	80°C	775
C810	Current Decrease Percent for Heatsink Temperature	ADVANCED	10%/°C	772

C800	**Minimum Pump Speed**	
Range	0÷32000	0÷32000 rpm
Default	0	0 rpm
Level	BASIC	
Address	755	
Function	This is the minimum speed for the speed operation in DC current when the MPPT function is enabled. If speed drops below this threshold for a time 6 * **P812** (6-fold the MPPT Activation Period), the pump is stopped during the ramp according to the preset ramps (see section 6.6.1) and is restarted when the time set in parameter **P802** has elapsed.	

C801	MDI Switch PV/AC Supply	
Range	0 ÷ 16 0 ÷ 24 when ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
Default	5	5: MDI5
Level	ADVANCED	
Address	753	
Function	This parameter sets the digital input to the switch for DC or AC operation of the Solardrive Plus. The programmed input is active if the switch is in DC position, while it is inactive if in AC position. **If your Solardrive Plus is not equipped with the DC/AC switch, the input is to be programmed as 0 → Inactive.**	

C802	Mains Loss Alarm Enabled	
Range	0÷1	0: No 1: Yes
Default	1	1: Yes
Level	ENGINEERING	
Address	754	
Function	Set **C802** = [1: Yes] to enable **A064** Mains Loss alarm. This parameter is helpful only if the equipment is provided with the DC/AC switch, and it takes effect only when the switch is in AC position.	

C803	MDI for PV Isolation Loss Detection	
Range	0 ÷ 16 0 ÷ 24 when ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
Default	0	0: Disable
Level	ADVANCED	
Address	1165	
Function	This parameter sets the digital input allocated to isolation loss control. If the programmed input is inactive, the drive operation is as described in parameter **C805** after the time set in parameter **C805**. **If your Solardrive Plus does not feature the isolation loss control functionality, set this parameter to 0: Disable.**	

C804	Delay for PV Isolation Loss Detection	
Range	0 ÷ 32000	0 ÷ 32000 ms
Default	0	0: Disable
Level	ADVANCED	
Address	1306	
Function	Delay associated with parameter **C803**.	

C805	PV Isolation Type	
Range	0÷4	0: No control 1: PV isolation 2: PV isolation + Alarm 3: PV Earthed
Default	1	1: PV isolation
Level	ADVANCED	
Address	774	
Function	This parameter sets the type of isolation control implemented on the PV field: **0**: No isolation control **1**: Isolated field; isolation control implemented by way of ES942 board. In case of isolation loss, warning **W53** appears. **2**: Isolated field; isolation control implemented by way of ES942 board. In case of isolation loss, alarm **A134** trips. **3**: Earthed field with isolation control by way of earthing fuse. If the fuse blows, alarm **A134** trips.	

C806	MDI for Surge Protection Device	
Range	0 ÷ 16 0 ÷ 24 when ES847 or ES870 is fitted	0 → Inactive 1 ÷ 8 → MDI1 ÷ MDI8 9 ÷ 12 → MPL1 ÷ MPL4 13 ÷ 16 → TFL1 ÷TFL4 17 ÷ 24 → XMDI1 ÷ XMDI8
Default	0	0: Disable
Level	ADVANCED	
Address	1166	
Function	This parameter sets the digital input allocated to the SPD. If the programmed input is inactive, alarm **A135** trips, or warning **W54** is displayed when the timeout set in **C807** has elapsed based on parameter **C808**. **If your Solardrive Plus is not equipped with a SPD, this parameter is to be set to 0: Disable.**	

C807	Delay for Surge Protection Device Tripped	
Range	0 ÷ 32000	0 ÷ 32000 ms
Default	0	0: Disable
Level	ADVANCED	
Address	1307	
Function	Delay associated with parameter **C806**.	

C808	Action Selector for Surge Protection Device Tripped	
Range	0 ÷ 1	0: Warning 1: Alarm
Default	0	0: Warning
Level	ADVANCED	
Address	751	
Function	This parameter sets the action of the system when the SPD trips: based on its value, a warning appears, that does not stop the motor, or an alarm trips, that stops the motor.	

C809	Heatsink Temperature for Initial Current Decrease	
Range	0 ÷ 90	0: Disable 1 ÷ 90°C
Default	80	80°C
Level	ADVANCED	
Address	775	
Function	Heatsink temperature for current decrease. If set to "0", this function is disabled. The current heatsink temperature may be displayed in measure **M064** (see section 6.5.5). If the detected temperature exceeds the preset value, the nominal current is reduced by a given percentage per extra degree equal to the value set in parameter **C810**. The typical effect of current decrease is a slower motor speed of rotation.	

C810	Current Decrease Percent for Heatsink Temperature	
Range	0 ÷ 100	0 ÷ 100%/°C
Default	10	10%/°C
Level	ADVANCED	
Address	772	
Function	If the temperature detected on the heatsink (measure **M064**) is higher than the value set in **C809**, the nominal current is reduced by a given percentage per extra degree equal to the value set in this parameter.	

NOTE

*If the motor speed drops below the value set in parameter **C800** due to current decrease for overtemperature, alarm **A074** – Overload (see section 6.7.3) trips after a timeout set in parameters **P018**, **P019** (see section 6.6.1).*

6.6.10. Solardrive – General Parameters Menu

NOTE

This section is applicable to software versions starting from 4.050.

6.6.10.1. Overview

This menu includes the parameters determining the motor startup based on PV field solar radiation conditions.

If the motor starts when the power made available from the PV field is inadequate to keep it running, the motor will immediately stop. In order to extend durability of the connected motor, the number of false starts is to be reduced to a minimum. For that reason, before activating the Maximum Power Point Tracking (MPPT) algorithm and make the motor start at the speed determined by this algorithm, DC voltage delivered from the PV field has to exceed a preset threshold (**P800**) and this condition is to be maintained for the time set in **P801**; this function will reduce to a minimum the false starts of the motor.

Once the motor has started, it is kept running until power made available from the PV field is adequate to ensure that the motor speed exceeds the minimum allowable speed set in parameter **C800** (see section 6.6.9).

6.6.10.2. List of Parameters P800 to P802

Parameter	Function	User Level	Default Value	MODBUS Address
P800	Minimum Solar Radiation Voltage	ENGINEERING	610 V	634
P801	Minimum Time for Radiation OK	ENGINEERING	240.0 s	635
P802	Delay Start after Alarm	ENGINEERING	300 s	756

P800	**Minimum Solar Radiation Voltage**	
Range	550 ÷ 1198	550 ÷ 1198 V
Default	610	610 V
Level	ENGINEERING	
Address	634	
Function	If DC voltage is kept over this value for a value higher than **P801**, the MPPT control is activated and the motor starts. When minimum voltage MPPT (parameter **P810**, see section 6.6.11) power is not adequate to keep power over parameter **C800** (see section 6.6.9) or voltage drops below the value ensuring the drive correct operation, the motor stops.	

P801	**Minimum Time for Radiation OK**	
Range	0÷30000	0.0÷3000.0 s
Default	2400	240.0 s
Level	ENGINEERING	
Address	635	
Function	Time when DC voltage is to be kept over **P800** in order to activate MPPT control and start the motor. Each time the motor stops due to low power conditions, time **P801** is applied again. This parameter also sets the maximum number of restarts/hour forced by the connected pump. For example, if the pump is to be restarted 10 times, parameter **P801** must be set to a value not lower than: **P801** = 3600/10 = 360.0 s.	

P802	Delay Start after Alarm	
Range	0÷65000	0÷65000 s
Default	300	300 s
Level	ENGINEERING	
Address	756	
Function	When an alarm trips and the motor stops, the motor will be restarted when the timeout set in this parameter has elapsed if the operating conditions of the system are restored. The motor will be restarted also based on parameters **P801** and **P802**.	

6.6.11. Solardrive – MPPT Parameters Menu

NOTE

This section is applicable to software versions starting from 4.050.

6.6.11.1. Overview

This menu contains the parameters to configure the MPPT algorithm.

Parameters **P810** and **P811** set the operating range of the Maximum Power Point Tracking (MPPT) algorithm. Parameter **P812** defines when the Maximum Power Point Tracking (MPPT). This control algorithm acts on the motor speed in order to keep DC voltage at this value. The MPPT control algorithm is given in Figure 34.

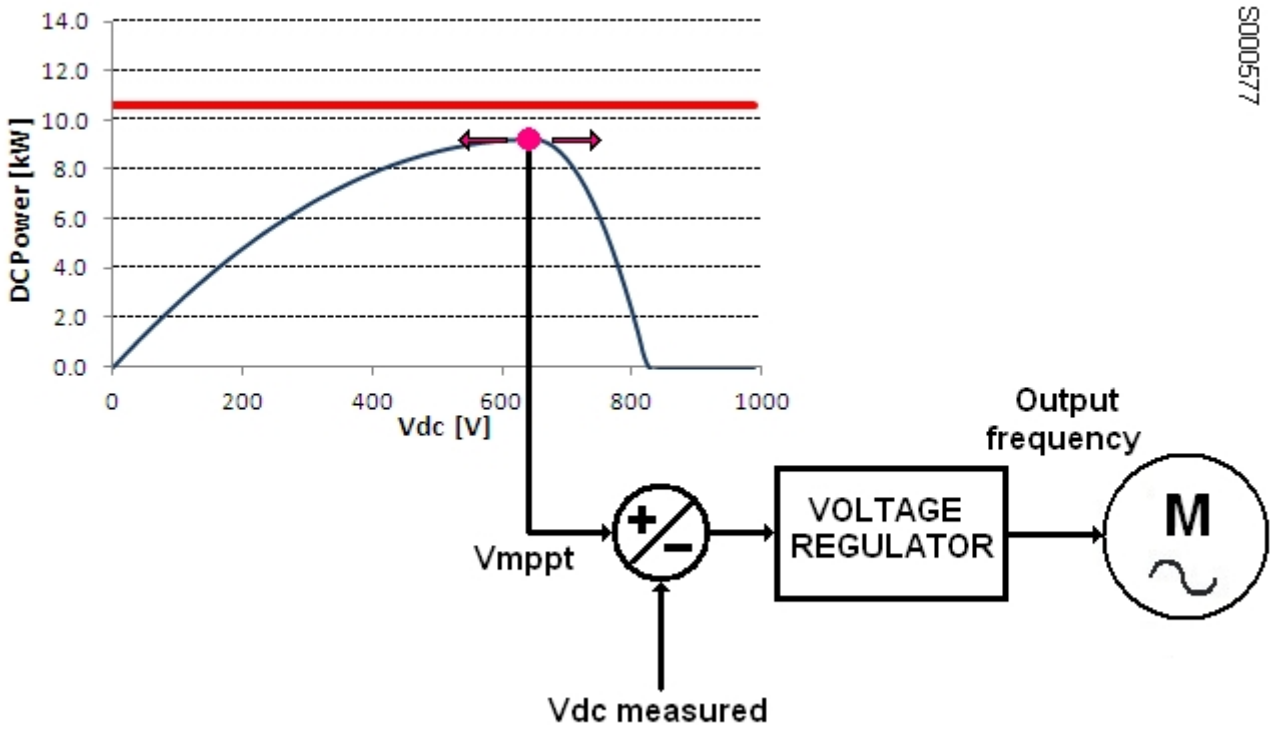


Figure 34: Voltage control algorithm

If the power made available from the PV field is equal to or lower than the power required to drive the motor at its nominal frequency, the algorithm will reduce frequency to exploit the maximum available power.

Otherwise, if the available power exceeds the power required to drive the motor at its nominal frequency, the motor will controlled at this frequency and DC voltage will not be adjusted. Figure 35 shows how the working point varies based on the available power.

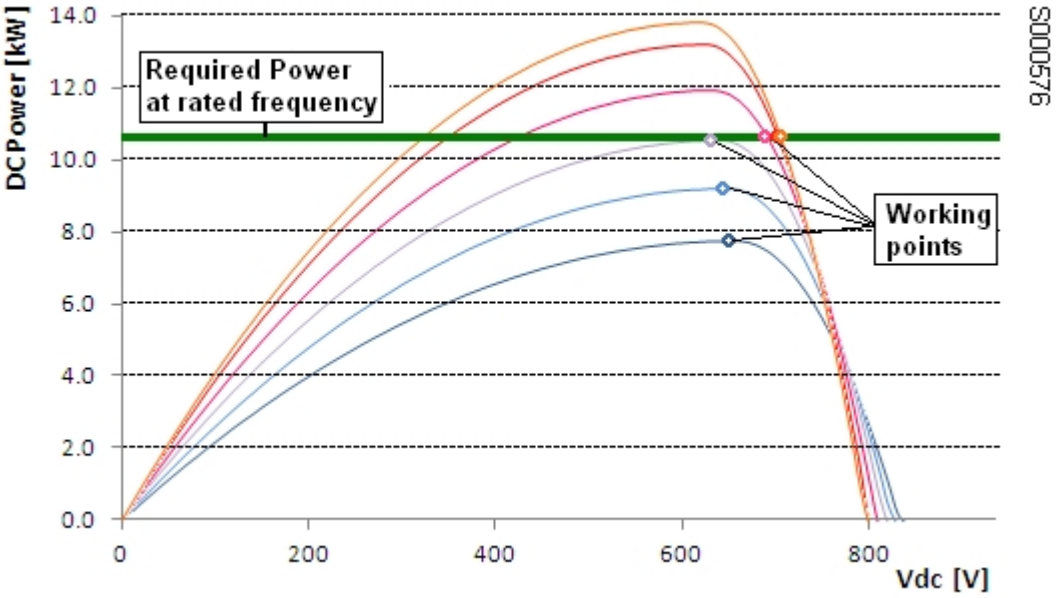


Figure 35: Working point based on DC power

6.6.11.2. List of Parameters P810 to P824

Parameter	Function	User Level	Default Value	MODBUS Address
P810	Minimum MPPT Voltage	ENGINEERING	550.0 V	636
P811	Maximum MPPT Voltage	ENGINEERING	900.0 V	637
P812	MPPT Execution Period	ENGINEERING	10.00 s	638
P813	Load Curve Exponent	ENGINEERING	3.00	737
P814	Voltage Regulator Integral Gain	ENGINEERING	1.60	722
P815	Voltage Regulator Proportional Gain	ENGINEERING	0.20	723
P816	Time Constant Vdc Filter	ENGINEERING	200 ms	724
P817	MPPT Manual Voltage Reference	ENGINEERING	700.0 V	732
P818	MPPT in Manual Mode	ENGINEERING	0: No	733
P819	Maximum Delta V MPPT	ENGINEERING	4.0 V	734
P820	Minimum Delta V MPPT	ENGINEERING	1.0 V	742
P821	Time Constant Electric Power Filter	ENGINEERING	500 ms	743
P822	MPPT Start Voltage Gain	ENGINEERING	90 %	744
P823	Undervoltage Dynamic Limitation – Delta V	ENGINEERING	30 V	640
P824	Undervoltage Dynamic Limitation – Delta Freq	ENGINEERING	2.00 %	641
P825	Undervoltage Protection	ENGINEERING	2: Disabled and Smart MPPT	639

P810	**Minimum MPPT Voltage**	
Range	5500÷9000	550.0÷900.0 V
Default	5500	550.0 V
Level	ENGINEERING	
Address	636	
Function	Minimum output value of the MPPT algorithm. The DC voltage value forced to the PV field is limited to this value. The maximum value that can be set is limited by the value set in **P811**.	

P811	Maximum MPPT Voltage	
Range	5500÷9000	550.0÷900.0 V
Default	9000	900.0 V
Level	ENGINEERING	
Address	637	
Function	Maximum output value of the MPPT algorithm. The DC voltage value forced to the PV field is limited to this value. The minimum value that can be set is limited by the value set in **P810.**	

P812	MPPT Execution Period	
Range	20÷12000	0.20÷120.00 s
Default	1000	10.00 s
Level	ENGINEERING	
Address	638	
Function	Execution time period of the MPPT algorithm.	

P813	Load Curve Exponent	
Range	0÷65000	0.00÷650.00
Default	300	3.00
Level	ENGINEERING	
Address	737	
Function	Within the control algorithm, the pump motor load function is as follows: $P = k * v^a$ Where **P** is power, **k** a constant, **v** the motor speed of rotation, **a** an exponent represented by this parameter. This is worth 3.00 by default, so power is represented as a cubic function of speed.	

P814	Voltage Regulator Integral Gain	
Range	0÷30000	0.00÷300.00
Default	1600	1.60
Level	ENGINEERING	
Address	722	
Function	Voltage regulator integral constant. This regulator has the voltage value detected by the MMPT algorithm as the setpoint and the motor supply voltage frequency as the output.	

P815	Voltage Regulator Proportional Gain	
Range	0÷30000	0.00÷300.00
Default	20	0.20
Level	ENGINEERING	
Address	723	
Function	Voltage regulator proportional constant. This regulator has the voltage value detected by the MMPT algorithm as the setpoint and the motor supply voltage frequency as the output.	

P816	Vdc Filter Time Constant	
Range	0÷30000	0÷30000 ms
Default	200	200 ms
Level	ENGINEERING	
Address	724	
Function	Time constant of the low-pass filter applied to the DC voltage measure at the voltage regulator input.	

P817	MPPT Manual Voltage Reference	
Range	2100÷11000	210.0÷1100.0 V
Default	7000	700.0 V
Level	ENGINEERING	
Address	732	
Function	Reference for voltage regulator if manual MPPT has been enabled by setting **P818** = Yes.	

P818	MPPT in Manual Mode	
Range	0÷1	0: No 1: Yes
Default	0	1: No
Level	ENGINEERING	
Address	733	
Function	Set **P818** = [1: Yes] to disable the MPPT algorithm. The reference value of the DC voltage is given by parameter **P817**.	

P819	Maximum MPPT Delta V	
Range	1÷200	0.1÷20.0 V
Default	40	4.0 V
Level	ENGINEERING	
Address	734	
Function	Maximum variation of the voltage reference between two cycles of the MPPT algorithm.	

P820	Minimum MPPT Delta V	
Range	1÷200	0.1÷20.0 V
Default	10	1.0 V
Level	ENGINEERING	
Address	742	
Function	Minimum variation of the voltage reference between two cycles of the MPPT algorithm.	

P821	Electric Power Time Constant Filter	
Range	0÷30000	0÷30000 ms
Default	500	500 ms
Level	ENGINEERING	
Address	743	
Function	Time constant of the low-pass filter applied to the estimation of the PV field input power utilized by the MPPT control algorithm.	

P822	MPPT Start Voltage Gain	
Range	70÷99	70÷99 %
Default	90	90 %
Level	ENGINEERING	
Address	744	
Function	When the motor is started, this is the initial value of the voltage reference of the MPPT algorithm intended as a percentage of the DC voltage measured at start. The optimum value for **P822** is the ratio between MPPT voltage and open-circuit voltage of the PV field. The value obtained is the lower limit for **P822**. Example: from the datasheet of the PV panel: Open-circuit voltage: 38.58 V Voltage at maximum power: 30.90 V Minimum value for **P822** = 30.90/38.58*100 = 80.09%. If **P822** is set to higher values, the maximum power at start takes longer time to be attained. The closer the value to the theoretical value, the quicker the maximum power is attained. If **P822** is set too low, the motor might stop even when solar radiation is strong and the system might restart frequently at dawn. It is therefore recommended that a value approx. 5% higher than the theoretical value be set (as far as the example is concerned, **P822** = 85%).	

P823	Undervoltage Dynamic Limitation – Delta V	
Range	0÷1000	0÷1000 V
Default	30	30 V
Level	ENGINEERING	
Address	640	
Function	This parameter sets the range disabling the undervoltage protection (see parameter **P825**). It is to be considered as the deviation between the reference voltage and the actual voltage.	

P824	Undervoltage Dynamic Limitation – Delta Freq	
Range	0÷10000	0÷100.00 %
Default	200	2.00 %
Level	ENGINEERING	
Address	641	
Function	This parameter sets the range disabling the undervoltage protection (see parameter **P825**). It is to be considered as the deviation between the reference frequency and the actual frequency.	

P825	Undervoltage Protection	
Range	0÷3	0: Disabled 1: Dynamic Limitation and Vout MPPT 2: Disabled and Smart MPPT 3: Dynamic Lim+Vout MPPT+Smart MPPT
Default	2	2: Disabled and Smart MPPT
Level	ENGINEERING	
Address	639	
Function	This parameter allows enabling two functions preventing the MPPT algorithm from operating in the positive slope Power/Voltage characteristic intrinsically unstable. The functions are as follows: • Dynamic limitation and MPPT Vout: optimum control of the rapid variation in solar radiation conditions obtained by applying output frequency reductions in order to avoid voltage drops that could power off the drive. Parameters **P823** and **P824** allow configuring the responsiveness of the undervoltage protection. It is enabled for values 1 and 3 of the parameter. • Smart MPPT: An optimized MPPT function is utilized for hydraulic applications. It is enabled for values 2 and 3.	

6.7. Alarms and Warnings

WARNING

If a protection trips or the drive enters the emergency mode, the drive is locked and the motor starts idling!

6.7.1. What Happens When a Protection Trips

NOTE

Before operating the drive in emergency conditions, carefully read this section and the following section, ***What To Do When an Alarm Trips****.*

The drive alarms are detailed below.

When a protection / alarm trips:

1) the **ALARM** LED on the keypad comes on;
2) the page displayed on the keypad is the root page of the **FAULT LIST**;
3) the **FAULT LIST** is refreshed;

In factory-setting, when the drive is switched on after an alarm has tripped—which has not been reset—it is kept in emergency condition.

If the drive is in emergency mode when switched on, this could be due to an alarm tripped before the drive was reset.

To avoid storing the alarms tripped before the drive is switched off, set parameter **C257** in the Autoreset Menu, section 6.6.7.

The drive stores the moment when an alarm trips to the **FAULT LIST** (supply–time and operation–time). The drive status when the alarm tripped and some measures sampled when the alarm tripped are also stored to the Fault List.

The readout and storage of the fault list can be very useful to detect the cause responsible for the alarm and its possible solution (see also section 6.5.6).

NOTE

Alarms ***A001*** *to* ***A039*** *relate to the main microcontroller (DSP Motorola) of the control board, which detected a fault on the control board itself. No fault list is available for Alarms* ***A001*** *to* ***A039*** *and no Reset command can be sent via serial link; alarms can be reset through the* ***RESET*** *terminal on the terminal board or the* ***RESET*** *key on the keypad. No software for the keypad interface is available; the drive parameters and measures cannot be accessed via serial link.*

Avoid resetting alarms ***A033*** *and* ***A039****, as they trip when the flash memory is not provided with its correct software. Alarms* ***A033*** *and* ***A039*** *can be reset only when proper software is downloaded for the inverter flash memory.*

6.7.2. What To Do When an Alarm Trips

WARNING

If a protection trips or the drive is in emergency condition, the drive is locked and the motor starts idling!

WARNING

Before resetting an alarm, press the emergency button to disable the drive and to prevent the connected motor from running at uncontrolled speed.

Proceed as follows:

1. Press the Emergency Button, as to deactivate the **ENABLE-A** and **ENABLE-B** signals on terminal **MDI2** and to disable the drive and to lock the motor, unless parameter **C181**=1 (the Safety Start function is active): after resetting an alarm or after supplying the drive, this will start only if the **ENABLE-A** and **ENABLE-B** contacts are open and closed.
2. If the motor is idling, wait until it stops.

Check the **FAULT LIST** carefully for any information about the alarm tripped, in order to determine the cause responsible for the alarm and its possible solutions.

Any information stored to the FAULT LIST is also required when contacting Elettronica Santerno's Customer Service.

3. In the following sections, find the relative alarm code and follow the instructions.
4. Solve any external problems that may have been responsible for the protection trip.
5. If the alarm tripped due to the entry of wrong parameter values, set new correct values and save them.
6. Reset the alarm.
7. If the alarm condition persists, please contact Elettronica Santerno Customer Service.

A **RESET** command must be sent to reset the alarms tripped. Do one of the following:

- Enable the **RESET** signal in MDI3 terminal in the hardware terminal board;
- Press the RESET key on the keypad;
  To activate the **Autoreset** function, enable parameter **C255** (see section 6.6.7); the drive will automatically try to reset the alarms tripped.

WARNING

The autoreset function is factory set as active. See section 6.6.7.

6.7.3. Alarm List

The alarm list is given below. The alarms that are not significant to the Solardrive Plus are given in brackets and are not described in detail.

Table 30: List of the possible alarms

Alarm	Name	Description
A001 ÷ A032	…	*Control board failure*
A033	TEXAS VER KO	Incompatible Texas Software Version
A039	FLASH KO	Texas Flash not programmed
A040	User Fault	Alarm caused by the user
A041	PWMA Fault	General hardware fault from IGBT, side A
A042	Illegal XMDI in DGI	Illegal configuration of XMDI in the Digital Inputs Menu
A043	False Interrupt	*Control board failure*
A044	SW OverCurrent	Software overcurrent
A045	Bypass Circuit Fault	Fault of the precharge By–Pass
A046	Bypass Connector Fault	Precharge By–Pass connector fault
A047	UnderVoltage	Dc bus voltage lower than Vdc_min
A048	OverVoltage	Dc bus voltage exceeding Vdc_max
A049	RAM Fault	*Control board failure*
A050	PWMA0 Fault	Hardware Fault from IGBT converter, side A
A051	PWMA1 Fault	Hardware overcurrent, side A
A052	Illegal XMDI in DGO	Illegal configuration of XMDI in the Digital Outputs Menu
A053	PWMA Not ON	Hardware failure, IGBT A power on impossible
A054	Option Board not in	Failure in detecting preset optional I/O board
A055	PTC Alarm	External PTC tripped
A056	PTC Short Circuit	External PTC in short circuit
A057	Illegal XMDI in MPL	Illegal configuration of XMDI in the Virtual Digital Outputs (MPL) Menu
A059	(Encoder Fault)	(Error of motor speed measure)
A060	(NoCurrent Fault)	(Current is zero in FOC control)
A061	Ser WatchDog	Watchdog tripped in serial link 0 (9-pole D connector)
A062	SR1 WatchDog	Watchdog tripped in serial link 1 (RJ45)
A063	Generic Motorola	*Control board failure*
A064	Mains Loss	No power is supplied from the mains
A065	(AutoTune Fault)	(Autotune failed)
A066	REF < 4mA	REF Current input (4÷20mA) lower than 4mA
A067	AIN1 < 4mA	AIN1 Current input (4÷20mA) lower than 4mA
A068	AIN2 < 4mA	AIN2 Current input (4÷20mA) lower than 4mA
A069	XAIN5 < 4mA	XAIN5 Current input (4÷20mA) lower than 4mA
A070	(Fbs WatchDog)	(Fieldbus Watchdog tripped)
A071	1ms Interrupt OverTime	*Control board failure*
A072	Parm Lost Chk	Parameter download/upload error
A073	Parm Lost COM1	Parameter download/upload error
A074	Drive OverHeated	Drive thermal protection tripped
A075	Motor OverHeated	Motor thermal protection tripped
A076	(Speed Alarm)	(Motor speed too high)
A078	MMI Trouble	*Control board failure*
A079	(Encoder not conf.)	(FOC control but Encoder not properly configured)
A080	(Tracking Error)	(Encoder speed tracking error)
A081	KeyPad WatchDog	Communication watchdog via keypad
A082	Illegal Encoder Cfg	Functions programmed for MDI6 and MDI7 or encoder B selected and encoder board not detected.
A083	External Alarm 1	External alarm 1
A086	XAIN5 > 20mA	XAIN5 Current input (4÷20mA or 0÷20mA) greater than 20mA
A087	±15V LOSS	± 15V Loss
A088	ADC Not Tuned	*Control board failure*
A089	Parm Lost COM2	Parameter download/upload error
A090	Parm Lost COM3	Parameter download/upload error
A091	(Braking Resistor Overload)	(Overvoltage tripped with braking resistor activated due to continuous operation time exceeding the max. programmed time)

Alarm	Name	Description
A092	SW Version KO	*Control board failure*
A093	Bypass Circuit Open	By-Pass relay open
A094	HeatSink OverTemperature	IGBT heatsink temperature too high
A095	(Illegal Drive Profile Board)	(Drive Profile board not correctly configured)
A096	Fan Fault	Fault of the cooling fans
A097	(Motor Not Connected)	(Motor not connected)
A098	(Illegal Motor Selected)	(Illegal motor selected via MDI)
A099	2nd Sensor Fault	Fault of fan sensor 2
A100	(MDI6 Illegal Configuration)	Function programmed for MDI6 along with frequency input A
A101	(MDI8 Illegal Configuration)	Function programmed for MDI8 along with frequency input B
A102	REF > 20mA	REF Current input (4÷20mA or 0÷20mA) greater than 20mA
A103	AIN1 > 20mA	AIN1 Current input (4÷20mA or 0÷20mA) greater than 20mA
A104	AIN2 > 20mA	AIN2 Current input (4÷20mA or 0÷20mA) greater than 20mA
A105	PT100 Channel 1 Fault	Hardware address out of measure range of the drive
A106	PT100 Channel 2 Fault	Hardware address out of measure range of the drive
A107	PT100 Channel 3 Fault	Hardware address out of measure range of the drive
A108	PT100 Channel 4 Fault	Hardware address out of measure range of the drive
A109	Amb.Overtemp.	Ambient overtemperature
A110 ÷ A120	…	*Control board failure*
A129	No Output Phase	Output phase loss
A134	PV Isolation KO	PV field isolation loss
A135	SPD Input Triggered	Surge Protective Device (SPD) tripped
A140	Torque Off not Safe	Malfunctioning of ENABLE-A and ENABLE-B inputs for STO function

A001 ÷ A032 A043 A049 A063 A071 A078 A088 A092 A110 ÷ A120	
Description	Control board failure
Event	There may be several causes: the board autodiagnostics file constantly checks its operating conditions.
Possible cause	• Strong electromagnetic disturbance or radiated interference. • Possible failure of the microcontroller or other circuits on the control board.
Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A033	**Texas Software KO**
Description	Incompatible Software Texas version
Event	When switched on, DSP Motorola detected an incompatible version of the software downloaded to Flash Texas (software version incompatible with Motorola).
Possible cause	The wrong software was downloaded.
Solution	1. Download the correct DSP Texas software version. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A039	Texas Flash not Programmed
Description	Texas Flash not programmed
Event	When switched on, DSP Motorola detected that Flash Texas is not correctly programmed.
Possible cause	A prior attempt to download DSP Texas software failed.
Solution	1. Download the correct DSP Texas software version. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A040	User Alarm
Description	Alarm trip caused by the user (as a testing procedure)
Event	The user has forced the alarm to trip.
Possible cause	Value 1 was entered to address MODBUS 1400 via serial link.
Solution	Reset the alarm: send a **RESET** command.

A041	IGBT Fault Side A
Description	General hardware fault from IGBT, side A
Event	Power converter A generated a general alarm.
Possible cause	• Electromagnetic disturbance or radiated interference. • Overcurrent, IGBT overtemperature, IGBT fault.
Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A042	Illegal XMDI in DGI
Description	Illegal configuration of XMDI in the Digital Inputs Menu.
Event	The drive has detected a parameter configuration error.
Possible cause	Wrong settings.
Solution	Check settings and enter correct settings. Contact ELETTRONICA SANTERNO's Customer Service.

A044	SW Overcurrent
Description	Software overcurrent detection.
Event	Immediate current limit tripped
Possible cause	• Abrupt variations of the connected load • Output short-circuit or ground short-circuit • Strong electromagnetic disturbance or radiated interference. If alarm **A044** tripped while accelerating: • Too short acceleration ramp; If alarm **A044** tripped while decelerating: • Too short deceleration ramp.
Solution	1. Check if the drive and the motor are properly dimensioned with respect to the connected load. 2. Make sure that no output short-circuit is to be found between two phases or between one phase and the grounding (terminals U, V, W). (Remove voltage from the motor, set IFD control and operate the drive in no-load conditions.) 3. Check if the command signals are sent to the drive using screened cables where required. Detect external sources for electromagnetic disturbance, check wiring and make sure that antidisturbance filters are installed on the coils of contactors and electrovalves (if fitted inside the cabinet). 4. If necessary, set longer acceleration times (see section 6.6.1). 5. If necessary, set longer deceleration times (see section 6.6.1). 6. If necessary, decrease the values set in the Limits Menu, section 6.6.5.

A045	Bypass Circuit Fault
Description	Bypass precharge Fault
Event	The drive forced to close its relay or contactor for the short-circuit of the precharge resistors in DC-link capacitors (DC bus), but it did not detect the relevant closing signal while precharging. See also **A046**.
Possible cause	• Disconnection of auxiliary signal. • Precharge relay/contactor failure.
Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A046	Bypass Connector Fault
Description	Precharge bypass connector fault.
Event	Auxiliary signal for the closing of the bypass connector of the short-circuit precharge resistor is considered as closed before the relevant closing command is sent. See also **A045**.
Possible cause	• Precharge bypass connector reversed. • Precharge relay/contactor failure.
Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A047	Undervoltage
Description	DC bus voltage lower than Vdc_min
Event	Voltage measured in DC bus (DC-link) capacitors has exceeded the minimum allowable value for proper operation of the drive class being used.
Possible cause	• Check that voltage has not dropped below 400 Vac. • This alarm may trip even when grid voltage temporarily drops below this threshold (e.g. direct load input). • If the drive is powered directly by the bus bar, the bus feeder is responsible for the alarm trip. • Failure in DC bus voltage measurement circuit.
Solution	1. Check voltage in terminals **R**, **S**, **T**. V Check mains voltage value **M030** and DC bus voltage value **M029**. Also check the values of **M030** and **M029** sampled in the FAULT LIST when the alarm tripped. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A048	Overvoltage
Description	Overvoltage in DC bus (voltage in DC-link).
Event	Voltage measured in DC bus (DC-link) capacitors has exceeded the maximum allowable value for proper operation of the drive class being used.
Possible cause	• Check that voltage does not exceed 1198 Vdc. • Very inertial loads and a too short deceleration ramp (see section 6.6.1). • Alarm **A048** can trip even when the motor is pulled by the load (eccentric load). • If the drive is powered directly by the bus bar, the bus feeder is responsible for the alarm trip. • Failure in DC bus voltage measurement circuit.
Solution	1. Check voltage in terminals **R**, **S**, **T**. Check mains voltage value M030 and DC bus voltage value M029. Also check the values of M030 and M029 sampled in the FAULT LIST when the alarm tripped. 2. In case of very inertial loads and if the alarm tripped when decelerating, try to set a longer deceleration ramp. If short stop times are needed or if the motor is pulled by the load, activate the resistive braking unit. 3. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A050	IGBT Fault A
Description	Hardware fault from IGBT converter, side A, or brake overcurrent
Event	The IGBT drivers of power converter A have detected IGBT failure or overcurrent conditions in the brake circuit (models S14, S22, S32 5T/6T only)
Possible cause	• Strong electromagnetic disturbance or radiated interference. • Overcurrent, Overtemperature, IGBTs, IGBT fault. • Unsuitable braking resistor (models S14, S22, S32 5T/6T only).
Solution	1. Reset the alarm: send a RESET command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A051	Overcurrent HW A
Description	Hardware overcurrent, side A.
Event	Hardware overcurrent detected by the drive output current circuit.
Possible cause	See **A044 SW Overcurrent**.
Solution	See **A044 SW Overcurrent**.

A052	Illegal XMDI in DGO
Description	Illegal configuration of XMDI in the Digital Outputs Menu.
Event	The drive has detected a parameter configuration error.
Possible cause	Wrong settings.
Solution	Check settings and enter correct settings. Contact ELETTRONICA SANTERNO's Customer Service.

A053	Not PWONA
Description	Hardware failure; IGBT A power on failure.
Event	IGBT A power on controlled by Motorola microcontroller has failed.
Possible cause	Control board failure.
Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A054	Optional Board not In
Description	ES847 or ES870 not in.
Event	The drive has detected a parameter configuration error.
Possible cause	Wrong settings.
Solution	1. Check consistency of parameter **R023** (for further detail, please contact ELETTRONICA SANTERNO's Customer Service). 2. Reset the alarm: send a **RESET** command. 3. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A055	PTC Alarm
Description	External PTC resistor tripped.
Event	The drive detected the opening of the PTC connected to **AIN2** input (R > 3600 ohm)
Possible cause	• Opening of the PTC due to motor overheating. • Incorrect wiring of PTC. • Incorrect setting of **SW1** hardware switch on the control board.
Solution	1. Allow the motor to cool, then reset the alarm. 2. Make sure that the PTC is correctly connected to **AIN2** analog input (for further detail, please contact ELETTRONICA SANTERNO's Customer Service). 3. Make sure that **SW1** hardware switch is correctly set.

A056	PTC Short Circuit
Description	External PTC resistor short circuit.
Event	Detected the short circuit of the PTC connected to **AIN2** input (R < 10 ohm).
Possible cause	• Short circuit in the PTC. • Incorrect wiring of PTC. • Incorrect setting of **SW1** hardware switch on the control board.
Solution	1. Make sure that the PTC is correctly connected to **AIN2** analog input (for further detail, please contact ELETTRONICA SANTERNO's Customer Service). 2. Make sure that **SW1** hardware switch is correctly set..

A057	Illegal XMDI in MPL
Description	Illegal configuration of XMDI in the Virtual Digital Outputs (MPL) Menu.
Event	The drive has detected a parameter configuration error.
Possible cause	Wrong settings.
Solution	Check settings and enter correct settings. Contact ELETTRONICA SANTERNO's Customer Service.

A061 A062	Serial Link Watchdog
Description	**A061**: Serial Link Watchdog 0 tripped **A062**: Serial Link Watchdog 1 tripped
Event	The serial link watchdog has tripped. Communication failure: no read/write query sent to serial link for a time longer than the time set in the parameters relating to serial link watchdog. This alarm does not trip if, due to parameters in the Control Method Menu – section 6.6.6, or due to the status of the source selection or LOC/REM inputs (Digital Input Menu), the information sent from serial link is not currently used for the commands or the references.
Possible cause	• Serial link is disconnected. • Communication failure on remote master side. • Watchdog operating times too short.
Solution	1. Check serial link. 2. Make sure that the remote master constantly sends read/write queries with max. intervals between two queries lower than the preset watchdog operating time. 3. Set longer watchdog operating times (see **R005** for serial link 0 and **R012** for serial link 1).

A064	Mains Loss
Description	Mains loss.
Event	Mains loss (only if AC power supply is available and parameter **C802** = 1: Yes).
Possible cause	• One supply cable is disconnected. • Mains supply too weak. • Mains gap.
Solution	1. Check voltage in terminals R, S, T. Check mains voltage value M030. Also check the value of M030 sampled in the FAULT LIST when the alarm tripped. 2. This alarm can be disabled by means of parameter **C802** (see section 6.6.9).

A066 A067 A068 A069	Current input < 4mA
Description	A066: REF Current input (4÷20mA) lower than 4mA A067: AIN1 Current input (4÷20mA) lower than 4mA **A068**: AIN2 Current input (4÷20mA) lower than 4mA **A069:** XAIN5 current input (4÷20mA) lower than 4mA
Event	A current value lower than 4 mA has been detected over one input (REF, AIN1, AIN2, XAIN5) set with the following range: 4÷20mA.
Possible cause	• Wrong setting of SW1 on the control board (except for A069). (for further detail, please contact ELETTRONICA SANTERNO's Customer Service) • Signal cable disconnected. • Failure in the current signal source.
Solution	1. Check correct setting of switches **SW1** (except for **A069**). 2. Check if the current signal cable is correctly connected to the relative terminal. 3. Check the source of the current signal.

A072 A073 A089 A090	Parameter Upload/Download Error from Keypad to Drive
Description	Upload/download failed, one of the controls of the parameter consistency detected a fault.
Event	A communication error occurred while uploading/downloading the programming parameters from the keypad to the drive.
Possible cause	Temporary interruption to the serial link between keypad and control board.
Solution	Check the connection between the keypad and the control board, reset the alarm and perform a new upload/download procedure.

A074	Overload
Description	Drive thermal protection tripped.
Event	The output current has been exceeding the drive rated current for long time periods.
Possible cause	• Current equal to **Ipeak** + 20% for **3 seconds**, or • Current equal to **Imax** for **60 seconds** • Current reduction due to overtemperature (parameters **C809**, **C810**) has caused speed to drop below the value set in **C800** (see section 6.6.9).
Solution	Check the drive current output during ordinary operation (**M026**, see section 6.5.2); check the mechanical conditions of the connected load (load locked / overload).

A075	Motor Overheated
Description	Motor thermal protection tripped.
Event	The software motor thermal protection tripped. Output current has been exceeding the motor rated current for long periods.
Possible cause	• Poor mechanical conditions of the connected load • Wrong setting of parameters in the Motor Thermal Protection Menu, section 6.6.8).
Solution	1. Check mechanical conditions of the connected load. 2. Check parameters **C265**, **C266**, **C267** in the Motor Thermal Protection Menu, section 6.6.8.

A081	Keypad Watchdog
Description	Watchdog for the communication to the keypad.
Event	Communication failed when the keypad was enabled as a reference source or a command source or when it was in Local mode (Watchdog time is equal to approx. 1.6 seconds)
Possible cause	• Keypad cable disconnected. • Failure of one of the two connectors of the keypad. • Strong electromagnetic disturbance or radiated interference. • Keypad failure. • Incorrect setting in parameters relating to serial link 1 (see the Serial Link Menu – contact ELETTRONICA SANTERNO's Customer Service).
Solution	1. Check the connection of the keypad cable. 2. Make sure that the keypad cable connectors are intact (on both drive side and keypad side). 3. Check communication parameters of serial link 1.

A083	External Alarm
Description	External alarm 1
Event	The External Alarm functionality has been programmed, but the relevant digital input is disabled (see the Digital Inputs Menu – for more details contact ELETTRONICA SANTERNO's Customer Service). If multiple digital command sources are programmed, the alarm trips if one of the terminals in the active sources is disabled (see section 6.6.6).
Possible cause	The cause for the alarm trip does not depend on the drive; check for the reason why the contact connected to terminal **MDIx** where the External Alarm function is programmed opens.
Solution	Check external signal.

A087	±15V Loss
Description	Loss of ±15V.
Event	The voltage level of ±15V is inadequate.
Possible cause	Possible failure of the control board or other circuits in the Solardrive Plus.
Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A093	Precharge: Bypass open
Description	Bypass relay open.
Event	The control board requested the closure of the bypass relay (or contactor) for the short-circuit of the DC-link capacitor precharge resistors, **but no closing signal is sent** (auxiliary of the relay) during functioning (precharge already closed).
Possible cause	Failure in the relay control circuit or in the auxiliary signal circuit detecting relay closing.
Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A094	Heatsink Overheated
Description	IGBT heatsink temperature too high.
Event	IGBT power heatsink overheated even if the cooling fan is on (see also **A096** and **A099**).
Possible cause	• Ambient temperature exceeding 40 °C. • Too high motor current. • Excessive carrier frequency for the application required.
Solution	1. Check ambient temperature. 2. Check motor current. 3. Decrease IGBT carrier frequency (contact ELETTRONICA SANTERNO's Customer Service).

A096	Fan Fault
Description	Fan alarm.
Event	Power heatsink overheated with fan locked or disconnected or faulty (see also **A094** and **A099**).
Possible cause	Fan locked or disconnected or faulty.
Solution	Replace fan.

A099	Sensor 2 Fault
Description	Fan sensor 2 fault.
Event	Power heatsink overheated with cooling fan off (see also **A094** and **A096**).
Possible cause	Failure in temperature control device and/or cooling system.
Solution	Please contact ELETTRONICA SANTERNO's Customer Service.

A102 A103 A104 A086	Current Input > 20 mA
Description	**A102:** REF Current input (4÷20mA or 0÷20mA) greater than 20mA **A103:** AIN1 Current input (4÷20mA or 0÷20mA) greater than 20mA **A104:** AIN2 Current input (4÷20mA or 0÷20mA) greater than 20mA **A086:** XAIN5 Current input (4÷20mA or 0÷20mA) greater than 20mA
Event	A current value greater than 20mA has been detected over one input (REF, AIN1, AIN2, XAIN5) set with the following ranges: 4÷20mA or 0÷20mA.
Possible cause	• Wrong setting of **SW1** on the control board (except for **A086**). • Failure in the current signal source.
Solution	1. Check setting of SW1(except for A086). 2. Check the current signal source.

A105 A106 A107 A108	PT100 Channel 1,2,3,4 Fault
Description	**A105**: PT100 Channel 1 fault **A106**: PT100 Channel 2 fault **A107**: PT100 Channel 3 fault **A108**: PT100 Channel 4 fault
Event	Hardware input out of the measure range of the drive.
Possible cause	• Wrong setting of SW1 or SW2 on optional control board ES847 • Failure in the current signal source.
Solution	1. Check setting of SW1 and SW2. 2. Check the current signal source.

A109	Ambient Overtemperature
Description	The ambient temperature is too high.
Event	The control board has detected a too high ambient temperature.
Possible cause	Inverter or cabinet overheated; failure of control board NTC.
Solution	1. Open the cabinet and check its conditions. Also check measure M062. 2. Reset the alarm: send a RESET command. 3. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

A134	PV Isolation KO
Description	PV field isolation loss.
Event	• Eearthed PV field: Fuse blown on one of the PV field poles. • Isolated PV field: Isolation loss detected by isolation loss control board.
Possible cause	• PV field earth fault. • PV field isolation loss. • Fault in the digital input detecting PV field isolation loss (see parameter **C803** in section 6.6.9).
Solution	1. Power off the inverter immediately. 2. Try to assess the cause of the PV isolation loss fault. 3. Restore the fuse (in case of earthed PV field). 4. Reset the alarm: send a **RESET** command.

A135	Input SPD Triggered
Description	SPD tripped.
Event	The SPD has tripped due to overvoltage detected between the PV field poles.
Possible cause	• PV field overvoltage (lightning, electric discharge). • Wrong PV field dimensioning causing overvoltage. • Fault in the digital input detecting PV field isolation loss (see parameter **C803** in section 6.6.9).
Solution	1. Power off the inverter immediately. 2. Try to assess the cause of the PV isolation loss fault 3. Restore the SPD by replacing its cartridges. 4. Reset the alarm: send a **RESET** command.

A140	Torque Off not Safe
Description	Malfunctioning of **ENABLE-A** and **ENABLE-B** inputs for the STO function
Event	The redundant circuitry for the drive enable (simultaneous activation of the **ENABLE-A** and **ENABLE-B** inputs) is no longer active, so opening those inputs does not guarantee that the STO function is properly implemented. For more details, please consult the Safe Torque Off Function - Application Manual.
Possible cause	Fault in the circuitry dedicated to the Safe Torque Off function.
Solution	1. Reset the alarm: send a **RESET** command. 2. If the alarm persists, please contact ELETTRONICA SANTERNO's Customer Service.

6.7.4. Warnings

Warning messages are displayed on the display/keypad. They are flashing messages that usually appear in line 1 or 2 of the first three lines of the display.

When a warning occurs, the Warning LED on the display/keypad turns on.

NOTE

Warnings are neither protections nor alarms, and are not stored to the fault list.

Some warnings simply state what's happening or suggest what to do when using the keypad.

However, most of the warning messages are **Coded warnings**: they are displayed with letter **"W" followed by two digits** stating which warning is active at that moment. Example:

W 3 2 O P E N E N A B L E

Warning messages are detailed in the following section.

6.7.5. Warning List

Table 31: Warning list

Warning	Message	Description
W03	SEARCHING…	The user interface is searching the data of the next page to display.
W04	DATA READ KO	SOFTWARE WARNINGS CONCERNING DATA READING.
W06	HOME SAVED	The page displayed has been saved as the home page displayed at power on.
W07	DOWNLOADING	The keypad is **writing** to the drive the WORK zone parameters saved on its own flash memory.
W08	UPLOADING	The keypad is **reading** from the drive the WORK zone parameters that will be saved on its own flash memory.
W09	DOWNLOAD OK	Parameters were successfully downloaded (**written**) from the keypad to the drive.
W11	UPLOAD OK	Parameters were successfully uploaded (**read**) from the drive to the keypad.
W12	UPLOAD KO	The keypad interrupted parameter upload to the drive. Parameter **reading** has failed.
W13	NO DOWNLOAD	A Download procedure was queried, but no parameter is saved to the flash memory.
W16	PLEASE WAIT…	Wait until the system completes the operation required.
W17	SAVE IMPOSSIBLE	Parameter save is not allowed.
W18	PARAMETERS LOST	The keypad interrupted parameter download to the drive. Parameter **writing** has failed. As a result, not all parameters have been updated (parameter inconsistency).
W19	NO PARAMETERS LOAD	UPLOAD impossible.
W20	NOT NOW	The required function is not available at the moment.
W21	CONTROL ON	The required function is inhibited because the drive is running: **ENABLE-A** and **ENABLE-B** are active.
W23	DOWNLOAD VER. KO	Download failed because parameters saved to keypad memory relate to a SW version or product ID incompatible with the drive SW version or product ID.
W24	VERIFY DATA	Download preliminary operation underway, the system is checking the integrity and compatibility of the parameters saved in the keypad memory.
W28	OPEN START	Open and close the **START** signal to start the drive.
W31	ENCODER OK	Encoder tuning procedure finished: the encoder is correctly connected.
W32	OPEN ENABLE	Open and close the **ENABLE-A** and **ENABLE-B** signals to enable the drive.
W33	WRITE IMPOSSIBLE	Writing procedure impossible.
W34	ILLEGAL DATA	Illegal value entered, operation failed.
W35	NO WRITE CONTROL	Writing procedure impossible because Control is active and the drive is running.
W36	ILLEGAL ADDRESS	Illegal address entered, operation failed.
W37	ENABLE LOCKED	The drive is disabled and does not acknowledge the **ENABLE-A** and **ENABLE-B** commands because it is writing a **Cxxx** parameter.  **WARNING** **The drive will start up as soon as writing is over!!!**
W38	LOCKED	Editing mode cannot be accessed because parameter modification is disabled: **P000** is different from **P002**.
W39	KEYPAD DISABLED	Editing mode cannot be accessed because the keypad is disabled.
W40	FAN FAULT	Fan locked or disconnected or faulty.
W41	SW VERSION KO	Download impossible because of different SW Versions.
W42	IDP KO	Download impossible because of different IDPs (Identification Products).
W43	PIN KO	Download impossible because of different PINs (Part Identification Numbers).
W44	CURRENT CLASS KO	Download impossible because of different current classes.
W45	VOLTAGE CLASS KO	Download impossible because of different voltage classes.
W46	DOWNLOAD KO	Download impossible (generic cause).
W48	OT Time over	The preset threshold for the drive Operation Time has been exceeded.
W49	ST Time over	The preset threshold for the drive Supply Time has been exceeded.

Warning	Message	Description
W50	NTC Fault	NTC sensor for heatsink temperature disconnected or faulty.
W51	DRY RUN	The pump is operating in Dry-run mode.
W53	PV ISOL. KO	PV field isolation loss.
W54	SPD TRIGGERED	SPD tripped.

6.7.6. State List

The state of the Solardrive appears in the first row of the display on the root page (see section 6.2).

Table 32: State list

Number	State	Description
0	ALARM!!!	Alarm tripped
1	STARTING UP	The drive is starting up
2	MAINS LOSS	Mains loss
3	TUNING	The drive is tuning
4	SPEED SEARCHING	Searching for motor speed
5	DCB at START	DC Braking at start
6	DCB at STOP	DC Braking at stop
7	DCB HOLD	DC current for Hold function
8	MANUAL DCB	Manual DC Braking
9	LIMIT WHILE ACCEL.	Current/torque limit while accelerating
10	LIMIT WHILE DECEL.	Current/torque limit while decelerating
11	LIMIT AT ST. SPD	Current/torque limit at constant rpm
12	BRAKING	Braking module startup or deceleration ramp extension
13	RUN AT ST. SPEED	Drive running at speed set point
14	ACCELERATING	Drive running with motor in acceleration stage
15	DECELERATING	Drive running with motor in deceleration stage
16	INVERTER OK	Drive on Stand-by with no alarms tripped
17	FLUXING	Motor fluxing stage
18	FLUXED MOTOR	Motor fluxed
19	FIRE MODE RUN	Constant rpm in Fire Mode
20	FIRE MODE ACC.	Acceleration in Fire Mode
21	FIRE MODE DEC.	Deceleration in Fire Mode
22	INVERTER OK*	Drive on Stand-by with no alarms tripped; void warranty due to alarm trip in Fire Mode
25	SPARE	Board in Spare mode
27	WAIT NO ENABLE	Waiting for opening **ENABLE-A** and **ENABLE-B** commands
28	WAIT NO START	Waiting for opening **START** command
29	PIDOUT min DISAB	Drive disabled due to PID output < Min.
30	REF min DISABLED	Drive disabled due to REF < Min.
31	IFD WAIT REF.	Drive enabled with IFD control waiting for reference in order to start
32	IFD WAIT START	Drive enabled with IFD control waiting for START in order to start
33	DISABLE NO START	When fluxing, the RUN command was not given within the max. time set in **C183**. The drive is kept disabled until the RUN command is given.
40	IFD WAIT MPPT	Waiting for adequate solar radiation conditions able to start the motor
41	INSOLATION KO	Waiting for adequate solar radiation conditions able to start the motor
42	INSOLATION OK	PV field power adequate to start the motor; waiting for timeout set in **P801** (section 6.6.10). Press **RESET** to reset the value and start the motor.
43	STARTING	Timeout set in **P802** (section 6.6.10) after an alarm is reset. Press **RESET** to reset the value and start the motor.