AFE Plus XL
User's Manual
Firmware Version 80.31

Manual Code: MW02101E00 V_0.2

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1 INTRODUCTION

To assist the customer in configuring the power converter, the manual is organized to closely follow the structure of the configurator (OPDExplorer). This organization allows, in a logical sequence, all necessary settings for the proper functioning of the drive to be configured.

Each chapter corresponds to a specific folder within OPDExplorer, containing all relevant parameters. At the beginning of each chapter, the location of the corresponding folder in the OPDExplorer tree is displayed, along with the full table of parameters in that folder.

The control values are divided into the following categories:

- Parameters
- Connections
- Input logic functions
- Internal values
- Output logic functions

In the tables of control values, the last column on the right, titled "Scale," indicates the internal representation base of the parameters. This scale factor is important when parameters need to be read or written via a serial line or fieldbus. It represents the factor by which the stored value should be divided to obtain the actual value set, as detailed below:

$$Value = \frac{Internal\ Representation}{Scale}$$

1.1 PARAMETERS (P)

The parameters in the system are configuration values that are displayed as numbers within a specific range. These parameters are categorized into three types: **free**, **reserved**, and **BDF DIGITAL reserved**. The rules for modifying these parameters are as follows:

1. **Free parameters** (displayed in black text in OPDExplorer): These can be changed at any time without needing to open any special key, even while the system is running.

2. **Reserved parameters** (displayed in blue text in OPDExplorer): These can only be changed when the system is at a standstill (i.e., not running). You must open the "reserved parameter" key in **P60** before making any changes.

3. **BDF DIGITAL reserved parameters** (displayed in violet text in OPDExplorer): Like reserved parameters, these can only be changed when the system is at a standstill. You must first open the "BDF DIGITAL reserved parameters" key in **P99** to access these parameters. When this key is closed, these parameters will not be visible in the display.

It is important to carefully note the reference values for each parameter to ensure they are set correctly for proper system operation.

1.2 CONNECTIONS (C)

Connections are essentially configuration parameters for the drive, displayed as whole numbers, much like digital selectors. These parameters are divided into three categories: **free**, **reserved**, and **BDF DIGITAL reserved**, and they are handled in the same way as other parameters in the system.

- **Free connections** (shown in black text in OPDExplorer) can be modified freely without any restrictions, even while the drive is running.
- **Reserved connections** (shown in blue text in OPDExplorer) can only be adjusted when the drive is in a standstill condition. Additionally, these parameters can only be accessed after unlocking the **reserved parameter key** in **P60** (or through the BDF DIGITAL reserved parameters key in **P99**).
- **BDF DIGITAL reserved connections** (shown in violet text in OPDExplorer) are even more restricted. They can only be changed when the drive is not running, and access to these connections requires unlocking the **BDF DIGITAL reserved parameters key** in **P99**. These parameters will not be visible in the display unless the key is open.

1.3 INPUT LOGIC FUNCTIONS (I)

The input logic functions are 32 commands that come from configured terminal board logic inputs, from the serial line, and from the fieldbus. The meaning of this logical functions depends on the application, so please refer to specific documentation.

1.4 INTERNAL VALUES (D)

Internal values are 128 variables within the drive that can be shown on the display or via serial on the supervisor. They are also available from the fieldbus.
The first 64 values are referred to power converter control part and are always present. The second 64 values are application specific.
Pay close attention to the internal representation base of these values as it is important if readings are made via serial line or fieldbus.

1.5 OUTPUT LOGIC FUNCTIONS (O)

The logic functions are 64, the first 32 display drive status and second 32 are application specific.
All output functions can be assigned to one of the 4 logic outputs.

1.6 AFE DESCRIPTION AND START-UP

The **Regenerative AC-DC Converter (Active Front End, AFE)** operates as an AC-DC rectifier, with line input voltages **L1, L2, L3** and an output of **V_BUS DC**, which is set by the user. The power exchanged with the grid can flow in both directions, either absorbed from the grid or regenerated back to the grid, depending on the load requirements.

The control of the AFE is managed through two main loops:

1. **Voltage loop (DC link ctrl loop)**: This controls the DC bus voltage.
2. **Current loop**: This ensures sinusoidal current is drawn from or supplied to the grid, depending on load conditions. The portion of **reactive power** exchanged with the mains can be adjusted by the user. When the reactive power is set to zero, only **active power** is exchanged with the grid, resulting in a **power factor of 1**.

Caution: The AFE unit uses a three-phase **IGBT bridge** (with anti-parallel diodes). It's important to note that the **DC Bus** voltage can be charged even when the converter is in a **stop** state. In this condition, the DC Bus voltage is equal to the rectified AC input voltage, as it is passed through the diodes.

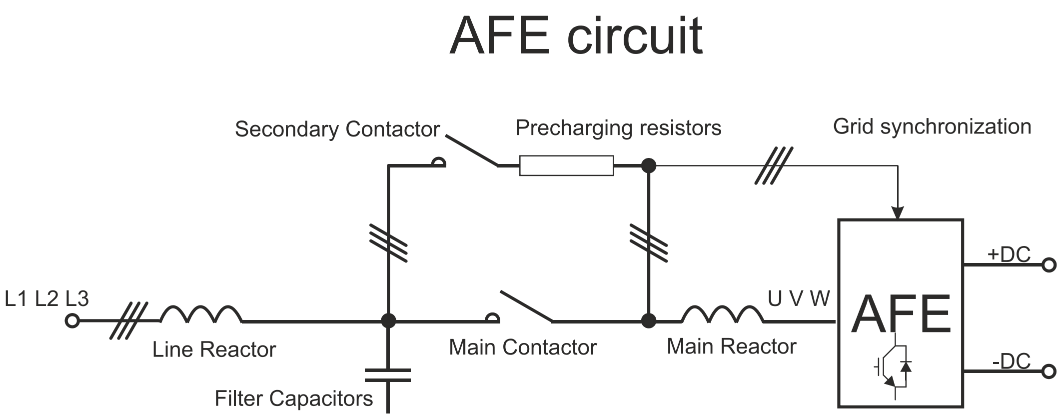


Figure 1 AFE Circuit

NOTE: AFE is part of OPDE family. This manual is intended to describe the AFE Parameters and Settings. For further information about the hardware of the OPDE family and functionality, please refer to OPDE PLUS AFE INSTALLATION manuals.

Here are the basic 5 steps for setting up the AFE (Active Front-End) system:

1) **Connections Setup and Verification**
   - **Power +24 V of the Converter**: Ensure that only the 24V power supply for the converter is connected. Do **not** power the 400V AC input yet.
   - **Verify the Connections**: Follow the instructions in the manual (OPDE PLUS AFE INSTALLATION) to ensure all connections are correct, particularly the feedback synchronism with the mains.

2) **Setup of Converter/Grid Plate**
   - **Converter Plate Setup**: Verify the setup of the converter grid plate.
   - **Check Parameters**: Confirm the settings for the following parameters:
     - **P61**: Rated Reactor Current
     - **P62**: Nominal Grid Voltage
     - **P63**: Rated Grid Frequency
   - **Voltage Drop and Time Constant**: Check **P77** and **P78** for voltage drop and time constant, ensuring they match the specifications of the chosen main reactor.

3) **Verify the DC Precharging**
   - **DC Precharging Circuit Setup**: Verify the settings for the DC precharging circuit parameters:
     - **P65**: Wait Time After Converter Ready
     - **P64**: Filter Time Constant for V_GRID
   - **DC Precharging Circuit Connections**: Ensure that the DC precharging circuit is correctly wired according to the instructions in OPDE PLUS AFE INSTALLATION.

4) **Power the 400V AC of the Converter**
   - **Powering the 400V AC**: Once the previous steps are verified, power the 400V AC to the AFE converter. The AFE should now complete the precharging of the DC Bus, bringing it to a level equivalent to the AC Grid voltage rectified (e.g., 400V * $\sqrt{2} \approx$ 565V DC).
   - **Verify AC Voltage**: Check that the AC voltage is correct and matches the value displayed in **D21** (Grid AC Voltage).
   - **Verify DC Bus Voltage**: Ensure that the voltage of the DC Bus matches the value shown in **D24** (Bus Voltage).

5) **BUS Control**
   - **Start Operating the AFE**: Once the DC Bus voltage is stable, you can begin operating the AFE.
   - **Voltage Regulator Control Setup**: Verify the configuration of the voltage regulator control parameters, particularly **P31**, **P32**, and **P33**.
   - **Bus Voltage Regulation**: With the converter running, ensure that the Bus Voltage remains at the value set in **P08** (DC Bus Voltage Reference).

<u>THESE STEPS ENSURE THAT THE AFE SYSTEM IS PROPERLY SET UP, VERIFIED, AND READY FOR OPERATION.</u>

2 AFE PARAMETERS

2.1 CONVERTER AND GRID

2.1.1 CONVERTER PLATE

Name	Description	Min	Max	Default	UM	Scale
CONV_I_NOM	P53 - Rated Converter current	0.0	400	0	A	10
CONV_F_PWM	P101 - PWM frequency	1000	16000	5000	Hz	1
PRC_CONV_I_MAX	P103 - Converter limit current	0.0	800.0	200	% I_CONV_NOM	40.96
T_RAD	P104 - Heat sink time constant	10.0	360.0	80	s	10
CONV_I_PEAK	P113 - Maximum converter current	0.0	3000.0	0	A	10
T_JUNC	P116 - Junction time constant	0.1	10.0	3.5	s	10
OVR_LOAD_T_ENV	P155 - Ambient temperature reference value during overload	0.0	150.0	40.0	C°	10
CONV_F_PWM_CARATT	P156 - PWM frequency for converter definition	1000	16000	5000	Hz	1
DEAD_TIME	P157 - Dead time duration	0.0	20.0	4	µs	10
CONV_E_CARATT	P167 - Characterization voltage	200.0	690.0	400	V rms	10
DEAD_TIME_HW	P198 - Dead time hardware duration	0.0	20.0	0.0	µs	10
MIN_PULSE	P199 - Minimum command pulse duration	0.0	20.0	1.0	µs	10
DC_BUS_FULL_SCALE	C24 - DC Voltage converter full scale	0	2	0	V	1
PWM_MOD_TYPE_SEL	C27 - PWM Modulation type selection	Range		0		1
		0	SPWM-1			
		1	DPWM-1			
		2	SPWM-2			
		3	DPWM-2			
		4	Disable zero seq. injection			
I_OVR_LOAD_SEL	C56 - Current overload	Range		1		1
		0	120%x30			
		1	150%x30			
		2	200%x30			
		3	200%x30+155%x30			
FW_REV	D00 - Software version			0		256

Precharge: When the regenerative AC-DC converter is powered on, an **external AC precharging circuit** is used to limit the current going into the bus capacitors, preventing excessive inrush current that could damage the system. Here's a breakdown of the process and key parameters involved:

1) **AC Precharge Circuit Operation**:
   - The precharge circuit gradually charges the DC bus capacitors as the mains voltage is applied.
   - To ensure safe and controlled charging, a **contact relay** (X1_2; X1_3) is used. This relay remains open during the precharge phase and only closes when the **DC bus voltage** exceeds a specific threshold and the system has waited for the necessary time to stabilize.

2) **P39 - Minimum Bus Voltage Charge Level**:
   - **P39** is a parameter that defines the **minimum level of charge** the DC bus must reach before the precharge phase can be considered complete. It is expressed as a percentage of the rectified mains voltage.
   - For example, if **P39**is set to **90%**, the system will wait until the DC bus voltage reaches 90% of the rectified mains voltage before proceeding to the next stage.

3) **Threshold Voltage and Time Requirement**:
   - Once the DC bus voltage exceeds the threshold (based on **P(39)**), the system waits for the **time of 3 RC time constants** to ensure that the voltage has stabilized and that the bus capacitors are properly charged.
   - The **RC time constant** is a measure of how long it takes for the voltage to stabilize.

4) **Completion of Precharge**:
   - Once the bus voltage reaches the specified level, the **contact relay X1_2; X1_3** closes, indicating that the precharge is complete.
   - If there are no faults or alarms detected, the control system will then enable the **Converter Ready** output at a high logic level, signaling that the converter is ready to begin normal operation.

5) **P65 - Delay time for Enabling Converter Ready**:
   - The **time delay** between the closing of the precharge relay (X1_2; X1_3) and the enabling of the **Converter Ready** output is set by parameter **P65**.
   - **P65** is typically configured in milliseconds and should be set according to the **switch-on time** of the **remote contactor** (the contactor controlling the AC input to the converter). This delay ensures the system operates smoothly and avoids any issues related to premature converter activation.
   - A typical value for **P65** would range between **80-300ms**, depending on the system's requirements.

C27 parameter allows to configure PWM modulation type:

C27	Description	Details
0	SPWM-1	Space Vector Modulation
1	DPWM-1	Discontinuos Modulation
2	SPWM-2	Near State / Space Vector Modulation
3	DPWM-2	Near State / Discontinuos Modulation
0	Disable zero seq. injection	Space Vector Modulation without 3rd harmonic injection

2.1.1.1 NEW CURRENT OVERLOAD FUNCTION

With connection **C94 "DRV_TH_MODEL" = 2 (New Th_model)** is possible to enable a new current overload management.

2.1.1.2 CONVERTER CURRENT OVERLOAD SELECTION

Four types of drive overload can be set on **C56**

C56	Overload type for rated drive current (P53)
0	120% for 30 seconds
1	150% for 30 seconds
2	200% for 30 seconds
3	200% for 3 seconds and 155% for 30 seconds

The choice of settings also affects the rated converter current, which is detailed in the installation manual of each type of power module.
The correct rated current value is always displayed in **P53** as the **rms value in amperes**. The current delivered by the converter is also used to estimate the **operating temperature** of the power component junctions, assuming that the converter is operating with standard ventilation and at the maximum allowable ambient temperature.
If the junction temperature reaches the **maximum allowable value** (as indicated in **D06 - Drive Inner Connection Limit**), the delivered power is limited to a value just above the **rated drive current**, which is known as the **effective thermal current**. This means the converter will operate below the maximum power limit to prevent overheating.
The converter can only exceed the rated power if the junction temperature drops below the rated value, which typically happens after a period of operation with currents lower than the rated value, allowing the temperature to cool down

The **overload time** is determined by the **power converter output current** just before the overload request and the duration for which this current is delivered. If the overload request is made more frequently (i.e., the time between overload requests is reduced), the available overload time will decrease.

Conversely, if the **average current** delivered before the overload request is lower than the rated reactor current, the overload time will increase, meaning the overload can be sustained for a longer period (or at least as long as shown in the specifications).

It is important to note that if the overload current is equal to the **converter's thermal current**, it can be delivered indefinitely, as the system will not exceed the thermal limits of the components.

2.1.2 REACTOR-GRID PLATE

Name	Description	Min	Max	Default	UM	Scale
IN_LINE_REACT	P61 - Rated current of the Reactor	10.0	100.0	100	% I_CONV_NOM	10
V_GRID_NOM	P62 - Nominal Grid Voltage	30.0	1000.0	400	V	
GRID_FREQ_NOM	P63 - Rated grid frequency	5.0	100.0	50.0	Hz	
REACT_TF_THERM	P71 - Main reactor thermal time constant	30	2400	600	s	1
VFilt	P64 - Filter Time Constant for V_GRID	0.0	30.0	0.0	ms	10
WaitAfeReady	P65 - Wait after Converter Ready	20	2000	1000	ms	1
GRID_F	D04 - Measured grid frequency			0	Hz	16
GRID_SEL	D14 - Grid type			0		1
GRID_V	D21 - Grid AC Voltage			0	V rms	1
MAIN_GRID_F	D30 - Measured main grid frequency			0	Hz	16
MAIN_GRID_V	D31 - Main grid AC voltage			0	V rms	1

For the correct operation of the converter it is important to set some fundamental parameters. These parameters are:

P61	Rated current of the line reactor in % of the rated current of the converter
P62	Rated voltage of the line in Volts
P63	Rated frequency of line in Hz

P61 is calculated as follows:

P61 = Rated current of the Inductor as percentage of I_CONV_NOM (i.e. % I_CONV_NOM)

2.1.3 GRID SYNCHRONIZATION SENSE

Name	Description	Min	Max	Default	UM	Scale
PLL_ERR_TF	P81 - TfPLLerr PLL error filter time constant	0.0	300.0	5.0	ms	10
GRID_F_TF	P82 - TfGridF Grid frequency filter time constant	0.0	30.0	0.0	ms	10
PLL_KP_STOP	P86 - KpPLL PLL regulator proportional gain at stop	0.1	10.0	1.0		10
PLL_TI_STOP	P87 - TiPLL PLL regulator lead time constant at stop	0.0	300.0	2.5	ms	10
PLL_KP_RUN	P88 - KpPLL PLL regulator proportional gain at run	0.1	10.0	1.0		10
PLL_TI_RUN	P89 - TiPLL PLL regulator lead time constant at run	0.0	300.0	250.0	ms	10
GRID_V_TF	P90 - TfGridV Grid voltage filter time constant	0.0	300.0	30.0	ms	10

2.1.4 TUNING

The **mains synchronism signals** (used for synchronizing the inverter with the grid) must be properly calibrated for both **offset** and **amplitude**. The **autotuning function** helps achieve this calibration.
The Autotuning Function Works as follow:

1) **Initial Setup**:
   - The autotuning function needs to be performed **only once**, typically when the **inverter is powered on for the first time** and the mains synchronism signals are properly connected.
   - This autotuning process is **enabled by setting C68 = YES**.

2) **Requirements**:
   - The autotuning function can only be executed when the **inverter is not in alarm status**. If the inverter is in alarm mode, the autotuning will not be carried out.

3) **Execution**:
   - Once C68 is set to **YES**, and the inverter is powered on (RUN mode), the autotuning function begins.
   - The process lasts **5 seconds** and automatically adjusts the mains synchronism signals, calculating both **offsets** and **amplitude**.
   - During this time, the function tunes the primary set of synchronism signals and also evaluates the secondary set, which is used for the **secondary PLL (Phase-Locked Loop)**.

4) **Post-Tuning**:
   - After the autotuning process is completed, the **C68** parameter is automatically reset to **NO**, indicating the function has finished.
   - The inverter will then operate with the calibrated synchronism signals.

For **microgrid resynchronization**, the inverter uses a second set of synchronization signals to re-establish synchronization with the grid after a disturbance or islanding event. These signals are crucial for ensuring smooth transition and operation when the microgrid is reconnected to the main grid. The second set of synchronization signals is calculated and stored in the following parameters:

P152: Contains one of the synchronization signal values.
P153: Contains another synchronization signal value.
P154: Contains the third synchronization signal value.

These parameters are critical for the correct phase alignment when the microgrid is resynchronized. The calculated values that are generated during the autotuning and synchronization process must be stored in the **EEPROM** memory of the converter to ensure persistence of the settings across reboots.

P164: Represents a specific calculated value.
P165: Another calculated synchronization value.
P166: The third synchronization-related value.

Name	Description	Min	Max	Default	UM	Scale
EN_V_GRID_TUNING	C68 - Enable line voltage tuning	0	1	0		1
V_GRID_AMPL_COEFF_RESYNC	P152 - Line voltage amplitude coefficient (PLL for resync)	0.0	200.0	100	%	163.84
OFFSET_L1_RESYNC	P153 - Line voltage L1 offset (PLL for resync)	-16383	16383	0		1
OFFSET_L2_RESYNC	P154 - Line voltage L2 offset (PLL for resync)	-16383	16383	0		1
V_GRID_AMPL_COEFF	P164 - Line voltage amplitude coefficient	0.0	200.0	100	%	163.84
OFFSET_L1	P165 - Line voltage L1 offset	-16383	16383	0		1
OFFSET_L2	P166 - Line voltage L2 offset	-16383	16383	0		1

2.1.5 GRID MODEL

Name	Description	Min	Max	Default	UM	Scale
PHASE_ANG	P75 - Grid Phase Shift	-180.0	180.0	0	°	10
PRC_DELTA_VLS	P77 - Voltage drop due to leakage inductance	5.0	100.0	10.0	% V_GRID_NOM	327.67
T_REACT	P78 - Main Reactor time constant Ts	0.0	50.0	50.0	ms	10
PRC_DEAD_TIME_CMP	P102 - Dead time compensation	0.0	100.0	0	‰ PRC_V_MAX	32.76
PRC_DEAD_TIME_CMP_XB	P151 - Xb = cubic coupling zone amplitude	0.0	50.0	12.0	% DRV_I_NOM	10

P77	ΔV LS % Voltage drop on the total line reactor due to the rated line current in % of the rated line voltage
P78	Time constant τ_S in milliseconds

These parameters are very important in order to correctly model the system. To obtain these parameters, it is necessary to start from the nameplate data of the line reactor:

Rs = Resistance of the line reactor in Ohms
Ls = inductance of the line reactor in mHenry
I_CONV_NOM = Rated current of the reactor in Amperes
V_GRID_NOM = Line voltage in Volts

It is possible then to calculate:

$$P77 = \frac{2\pi \cdot F_{GRID\ NOM} \cdot Ls \cdot I_{CONV\ NOM} \cdot \sqrt{3}}{V_{CONV\ NOM}} \qquad P78 = \frac{Ls}{Rs}\ [ms]$$

Example:

I_{CONV_NOM}= 60A
V_{GRID_NOM}= 380V
f_{GRID_NOM}= 50Hz
Rs = 0,05 Ω
Ls= 1,4mH

Performing the calculations yields:

P77=11,4% P78=28ms

2.1.6 ACTIVE FILTER

<table>
<tr><th>Name</th><th>Description</th><th colspan="2">Min</th><th>Max</th><th>Default</th><th>UM</th><th>Scale</th></tr>
<tr><td>GRID_CURRENT_OFFSET_U</td><td>P55 - Grid current sensor offset U</td><td colspan="2">-100.0</td><td>100.0</td><td>0.0</td><td>%</td><td>327.67</td></tr>
<tr><td>GRID_CURRENT_OFFSET_W</td><td>P56 - Grid current sensor offset W</td><td colspan="2">-100.0</td><td>100.0</td><td>0.0</td><td>%</td><td>327.67</td></tr>
<tr><td>GRID_LEM_I_NOM</td><td>P128 - Full-scale RMS current for grid LEM (Active Filter option)</td><td colspan="2">0.0</td><td>3000.0</td><td>0.0</td><td>A</td><td>10</td></tr>
<tr><td rowspan="4">EN_HARMONICS_COMP</td><td rowspan="4">C69 - Enable Harmonics compensation</td><td colspan="3">Range</td><td rowspan="4">0</td><td rowspan="4"></td><td rowspan="4">1</td></tr>
<tr><td>0</td><td colspan="2">Disabled</td></tr>
<tr><td>1</td><td colspan="2">Enable the 5th and 7th Harmonics comp.</td></tr>
<tr><td>2</td><td colspan="2">Enable the 5th, 7th, 11th and 13th Harmonics comp.</td></tr>
<tr><td rowspan="3">GRID_LEM_OFF_COMP_EN</td><td rowspan="3">U01 - Enable AT offset compensation for grid LEM (Active Filter)</td><td colspan="3">Range</td><td rowspan="3">0</td><td rowspan="3"></td><td rowspan="3">1</td></tr>
<tr><td>0</td><td colspan="2">No</td></tr>
<tr><td>1</td><td colspan="2">Yes</td></tr>
<tr><td>GRID_LEM_I</td><td>D23 - Current module on external sensors (Active filter)</td><td colspan="2"></td><td></td><td></td><td>A rms</td><td>16</td></tr>
</table>

AFE can be operated as Series Active Filter by setting C00 to “3 – Active filter”: in this case, parameters of this section are used to configure the active filter operation, otherwise these parameters are ignored.
Active Filter can compensate distorted current absorption of a non-linear local load in order to improve Total Hormonic Distortion (THD) of line current: for this reason, non-linear load is connected in parallel to the Active Filter and additional external current sensors shall be installed upstream the power converter and the non-linear load. For more details regarding electric connection please refer to AHF Installation manual.

2.2 VOLTAGE AND CURRENT CONTROL

2.2.1 DC BUS VOLTAGE CONTROL

Name	Description	Min	Max	Default	UM	Scale
DC_BUS_REF	P08 - DC Bus Voltage Reference	300.0	1200.0	650.0	V	10
V_REG_KP	P31 - KpV voltage regulator proportional gain	0.1	400.0	6		10
V_REG_TI	P32 - TiV voltage regulator lead time constant	0.1	3000.0	30	ms	10
V_REG_TF	P33 - TfV voltage regulator filter time constant	0.0	25.0	0.4	ms	10
MOD_INDEX_MAX	P122 - Max. modulation index	0.500	0.995	0.98		1000
V_BUS_NORM	D05 - V bus Norm	0	500	0	% VBUS_NOM	163.84
PRC_CONV_V	D18 - Reference voltage module	-100	100	0	% V_GRID_NOM	40.96
MOD_INDEX	D19 - Modulation index	-100	100	0		40.96
DC_BUS	D24 - Bus voltage			0	V	16
VBUS_REF_NORM	D33 - DC Voltage Reference (Norm)	0	100	0	% DC_BUS_NOM	163.84

The **voltage regulator** in an AFE (Active Front End) system is responsible for ensuring the DC bus voltage (V_BUS) remains at the value set by the user, as specified in parameter **P08**.
This voltage control is crucial for maintaining stable operation and optimizing performance.

P08 defines the desired **DC bus voltage**. The operating range for **P08** must be within a specific range:

- **Minimum**: 1.1×1.41 times the grid RMS voltage (P62), which equates to ≈1.55×Vrms. This is because the minimum bus voltage that the AFE can control should be the peak value of the grid RMS voltage.
- **Maximum**: Limited by the **maximum bus voltage** (**P107**) minus a **control margin**. This ensures that the system operates within safe voltage limits and prevents over-voltage conditions.

The AFE can only control a DC bus voltage that is at least the **peak RMS value** of the grid voltage multiplied by **1.1**. The reason for the multiplier is to account for the characteristics of the **mains** supply. The parameters Involved in Voltage Regulation are:

1) **P31 (Proportional Gain Kp)**: Sets the proportional gain for the regulator, determining the system's response to voltage deviations.
2) **P32 (Lead Time Constant)**: Defines the lead time constant of the regulator, which is used to optimize the system's response time.
3) **P33 (Integral Filter Constant)**: Sets the first-order filter constant for the **error signal** (in milliseconds), helping to smooth out any high-frequency noise in the voltage error.

Together, these constants ensure that the AFE maintains the desired bus voltage, compensating for variations in the grid and load conditions. By a properly tuning of these parameters, the voltage regulator can provide stable operation and prevent over-voltage or under-voltage conditions, ensuring that the AFE operates within safe limits while supplying the required power to the load.

2.2.2 CURRENT CONTROL

Name	Description	Min	Max	Default	UM	Scale
REF_ID	P68 - Reference Reactive Current	-80.0	80.0	0.0	% I_CONV_NOM	10
I_REG_KP	P83 - Kpc current regulator proportional gain	0.1	100.0	1.9		10
I_REG_TI	P84 - Tic current regulator lead time constant	0.0	1000.0	20	ms	10
I_REG_TF	P85 - Tfc current regulator (filter) time constant	0.0	25.0	0	ms	10
PRC_I_ZERO_KP_COEFF	P124 - Corrective coeff. estimated Kp for zero current loop	0.1	200.0	50	%	40.96
PRC_I_ZERO_TI_COEFF	P125 - Corrective coeff. estimated Ti for zero current loop	0.1	200.0	10	%	40.96
PRC_I_REG_KP_COEFF	P126 - KpI Corrective coeff. estimated Kp for current loops	0.0	200.0	50	%	40.96
PRC_I_DECOUP	P158 - Corrective coefficient for decoupling terms	0.0	200.0	0	%	40.96
PI_AC_TI	P181 - TiPIac PI_AC regulator lead time constant	0.0	1000.0	50.0	ms	10
DIS_I_DECOUP	C59 - Disable dynamic decoupling + feedforward	0	1	0		1
I_CTRL_SEL	C80 - Current control type selection	Range 0 1 2	 dq control ac control PR ac control P	0		1
3PH_CTRL_EN	C86 - Enable control on V phase	Range 0 1	 No Yes	0		1
ACTV_POW	D01 - Active power delivered			0	kW	16
PRC_IQ_REF	D07 - Request of active current Iq rif	-100	100	0	% I_NOM	40.96
PRC_ID_REF	D08 - Request of reactive current Id rif	-100	100	0	% I_NOM	40.96
REACT_I	D11 - Current module			0	A rms	16
PRC_IQ	D15 - Active current Iq	-100	100	0	% I_NOM	40.96
PRC_ID	D16 - Reactive current Id	-100	100	0	% I_NOM	40.96
PRC_VQ_REF	D20 - Vq rif	-100	100	0	% V_GRID_NOM	40.96
PRC_VD_REF	D22 - Vd rif	-100	100	0	% V_GRID_NOM	40.96
PRC_APP_T_MAX	D32 - Maximum current limit by application	-400	400	0	% I_NOM	40.96
PRC_APP_T_MIN	D48 - Minimum current limit by application	-400	400	0	% I_NOM	40.96

The AFE current control system allows compensation for external reactive power, such as due from filters or other reactive loads, that are inductive or capacitive in nature. This is achieved using **parameter P68**, which represents the reactive portion of the reference current (**Id_rif**) as a percentage of the rated line current.
Once the value of these reactive currents has been estimated (for example, the capacitive currents from line filters), they can be compensated by setting **P68** to a value equal in magnitude but opposite in sign to the reactive current.
The sign of the current is considered positive if the current is flowing out of the converter.
This allows for dynamic compensation of reactive power, ensuring the system operates with improved power factor and without excessive reactive power exchange with the grid

A positive value set in **P68** means that the current produced by the converter can compensate for **inductive loads** (i.e., the AFE acts like a capacitor). On the other hand, a negative value in **P68** means that the current produced compensates for **capacitive loads** (i.e., the AFE acts like an inductor).
By setting **P68 = 0** (the default setting), the converter exchanges only **active power** with the mains, resulting in a **unity power factor** (no reactive power exchange).

The C86 setting controls the number of current controllers in the Active Front-End (AFE) system:

- C86 = 0: Only two PID controllers are active.
- C86 = 1: Three PID controllers are activated, allowing control over a third current component, typically the zero-sequence current.

The Impact of C80 Setting:

- C80 = 0: The system uses dq0 controllers for current control, which operates in a rotating reference frame.
    - C86 = 0: Only the two main dq controllers are active, managing active and reactive current components.
    - C86 = 1: All three dq0 controllers are active, including one for the zero-sequence current.
- C80 = 1 or 2: The system switches to Proportional Resonant (PR) controllers, which work in the abc or uvw state spaces instead of dq0.
    - C86 = 0: Only two current controllers are active, controlling the u and w phases, with the v phase current inferred based on balance.
    - C86 = 1: Three independent controllers are active, providing control over all three phases (u, v, and w), including the v phase.

In summary:

- C86 = 1:
    - Enables independent current control for all three phases (u, v, and w).
    - If C80 > 0, you can directly control and read the v phase current.
    - If C80 = 0, it enables control of the zero-sequence current within the dq0 frame.
- C86 = 0:
    - Restricts control to just the u and w phases, assuming the v phase is balanced with them.

The meaning of P124 and P125, when C86 = 1 and C80 = 0, the system uses dq0 controllers to regulate the current. P124 and P125 can be used to adjust the proportional-integral (PI) controller settings for the zero-sequence current component in the dq0 space.
These parameters act as scaling factors for the PI controllers, allowing for fine-tuning based on the standard dq0 component controllers.
By adjusting P124 and P125, you can optimize the control of the zero current component, improving system performance under varying conditions.

2.3 PROTECTIONS

2.3.1 VOLTAGE LIMITS

Name	Description	Min	Max	Default	UM	Scale
MinVDcSStart	P39 - Min Volt DC for End Soft Start	60	95	80	% V_GRID_NOM	10
TIMER_NO_BYPASS	P44 - Precharge debounce time - remain on bypass	50	1000	200	ms	1
TIMER_AGAIN_BYPASS	P45 - Precharge debounce time - reject bypass	50	1000	500	ms	1
MIN_V_GRID	P50 - Alarm level for minimum grid voltage	5.0	95.0	70.0	% V_GRID_NOM	10
MAX_V_GRID	P51 - Alarm level for maximum grid voltage	105.0	135.0	130.0	% V_GRID_NOM	10
K_V_GRID	P52 - Corrective Factor for AC Grid Voltage	25.0	200.0	100.0	%	10
K_V_GRID_EXT	P54 - Corrective Factor for AC Grid Voltage of external grid	25.0	200.0	100.0	%	10
DCBUS_MIN_GRID_LOST	P97 - Minimum voltage level for forced grid off	100.0	1200.0	425	V	10
KP_DCBUS	P105 - Corrective factor for Bus voltage	80.0	200.0	100	%	10
DCBUS_MIN	P106 - Minimum DC Bus voltage	100.0	1200.0	400	V	10
DCBUS_MAX	P107 - Maximum DC Bus voltage	350.0	1200.0	760	V	10
ALL_RST_ON_GRID	C35 - Automatic alarm reset when grid back on	0	1	0		1
EN_PW_SOFT_START	C37 - Enable soft start	0	1	1		1
GRID_SEL	C70 - Grid type selection	Range		0		1
		0	THREE PHASE (U-V-W)			
		1	SINGLE PHASE (U-V)			
CONTROL_SEL	D02 - Control Selected	Range				1
		0	AFE standard control			
		1	FFE control			
		2	MicroGrid control			
		3	Active Filter			
GRID_SEQUENCE	D03 - Positive/negative L1,L2,L3 - sequence	Range		0		1
		0	Inverso			
		1	Diretto			

2.3.1.1 DC BUS RIPPLE ALARM

This function protects the drive from issues such as rectifier bridge problems, unbalanced mains, and phase losses. It uses a 100Hz pass-band filter to measure the DC Bus ripple, which is displayed as "DC_BUS_RIPPLE."

- **If the DC Bus Ripple exceeds 100V**, the drive triggers alarm **A13.2** within 100ms.
- **If the DC Bus Ripple is between 60V and 100V**, the drive triggers alarm **A13.2** within 5 seconds.

Connection **C31** can be used to disable the DC Bus Ripple alarm if necessary.

2.3.2 CURRENT LIMITS

Name	Description	Min	Max	Default	UM	Scale
PRC_CONV_I_PEAK	P40 - Current limit	0.0	250.0	200	% I_CONV_NOM	40.96
MAX_REGEN_I	P42 - Maximum regeneration current	0	400	200	% I_CONV_NOM	40.96
MAX_ABSORPT_I	P43 - Maximum absorption current	-400	0	-200	% I_CONV_NOM	40.96
PRC_CONV_I_MAX	D29 - Current limit	-100	100	0	% I_CONV_NOM	40.96

The converter is equipped with a maximum current limiting algorithm that activates when the current exceeds a predefined threshold, restricting the maximum current delivered. The limiting value is determined by the lowest value among the following:

- **P40**: The programmed maximum current limit set by the user, ranging from 0% to the maximum value allowed, depending on the type of overload defined by connection **C56**.
- The value calculated by the converter's thermal image circuit.
- The line thermal protection circuit.

Additionally, the active current can be limited in different ways using the following parameters:

- **P42**: Sets the maximum limit for active current regeneration.
- **P43**: Sets the maximum limit for active current absorption

2.3.3 THERMAL PROTECTION

Name	Description	Min	Max	Default	UM	Scale
REACT_THERM_PRB_SEL	C46 - Enable reactor thermal probe management (PT100/PTC/NTC)	Range 0 1 2 3 4 5	 No PTC NTC I23 KTY84-130 PT1000	0		1
REACT_TEMP_MAX	P91 - Maximum reactor temperature (if read with PT100)	0.0	150.0	130	°C	10
PRC_REACT_DO_TEMP_THR	P96 - Reactor thermal logic output 14 cut-in threshold	0.0	200.0	100	% PRC_REACT_I_THERM	40.96
CONV_THERM_PRB_SEL	C57 - Enable heat sink heat probe management (PTC/NTC)	0	4	1		1
REACT_PRB_RES_THR	P95 - Reactor NTC or PTC resistance value for alarm	0	19999	1500	Ohm	1
KP_REACT_THERM_PRB	P115 - Multiplication factor for reactor PTC/NTC/PT100 analog reference value	0.00	200.00	100		163.84
KP_DRV_THERM_PRB	P117 - Multiplication factor for heat sink PTC/NTC analog reference value	0.00	200.00	100		163.84
CONV_TEMP_MAX	P118 - Max. temperature permitted by heat sink PTC/NTC	0.0	150.0	90	°C	10
CONV_START_TEMP_MAX	P119 - Max. temperature permitted by heat sink PTC/NTC for start-up	0.0	150.0	75	°C	10
CONV_DO_TEMP_THR	P120 - Heat sink temperature threshold for logic output o.15	0.0	150.0	80	°C	10
EN_REACT_THERMAL_ALL	C32 - Reactor thermal switch “Block converter?”	0	1	1		1
REACT_THERM_CURV_SEL	C33 - Choice of reactor thermal curve	Range 0 1 2 3	 No reduction -limitative Self-ventilated +limitative	0		1
KP_CARD_THERM_PRB	P138 - Corrective factor for card thermal sensor	0.0	200.0	100	%	168.84

Name	Description	Min	Max	Default	UM	Scale
CONV_TEMP	D25 - Heat sink temperature reading			0	°C	16
REACT_TEMP	D26 - Reactor temperature			0	°C	16
REG_CARD_TEMP	D40 - Regulation card temperature			0	°C	16
REACT_PRB_RES	D41 - Thermal probe resistance			0	kOhm	16
PRC_DRV_I_THERM	D28 - Reactor thermal current	-100	100	0	% soglia All	40.96
IGBT_J_TEMP	D45 - IGBT junction temperature			0	°C	16
IGBT_J_TEMP_MARGIN	D46 - IGBT junction temperature margin with its limit			0	°C	16
DRV_I_CONN_TH_MODEL	D06 - Drive inner connection limit			0	% DRV_I_CONN_MAX	163.84

Four types of converter overload can be set on **C56**:

C56	Overload type for rated converter current (P53)
0	120% for 30 seconds
1	150% for 30 seconds
2	200% for 30 seconds
3	200% for 3 seconds and 155% for 30 seconds

NB: the choice also changes the rated converter current as shown by the tables in the installation file and the correct value is always displayed in ampere rms in **P53**.

The delivered current is used to calculate the operating temperature reached by the power device junctions. The converter is supposed to work with standard ventilation at the maximum allowed ambient temperature.
If this junction estimated temperature reaches the maximum allowed value, the delivered power limit is reduced to a value that is just larger than the converter rated current, i.e. the system's effective thermal current (see following table).
In this condition, a converter overload is possible only if the temperature drops below the rated value: this will only occur when the converter operates for a certain period at current levels smaller than the rated ones.

C56	Max. converter current	converter thermal current
0	120% I NOM CONV for 30 seconds	103% I NOM AZ
1	150% I NOM CONV for 30 seconds	108% I NOM AZ
2	200% I NOM CONV for 30 seconds	120% I NOM AZ
3 (*)	200% I NOM CONV for 3 seconds 155% I NOM CONV for 30 seconds	110% I NOM AZ

Note = the overload times are calculated with the converter running continuously at the rated line reactor current. If the average delivered current is lower than the rated line reactor current, then the overload time will increase. This means that the actual overload times can be longer or identical to those shown in the Table.

Note (*) = the 200% overload is available until junction temperatures remain smaller than 95% of the rated value; at the rated value the maximum limit becomes 180%. For repeated work cycles, BDF DIGITAL is available to estimate the converter's actual overload capacity.

Note = automatic current derating is also provided due to the line Voltage (P62) compared with the converter characteristic voltage (P174) and due to PWM frequency (P101) compared with the converter characteristic frequency (P156). For more details please contact BDF DIGITAL.

Line reactor nominal current, parameter **P71** (reactor thermal constant in seconds), and the current delivered by the converter are used to estimate the line reactor temperature considering maximum ambient temperature; the losses are evaluated with the square of the absorbed current and filtered with the line reactor thermal constant. When this value exceeds the maximum thermal current, the thermal protection cuts in, enabling logic output **o.L.1** and alarm A06.

The reaction may be programmed via connection **C32** and by enabling alarm **A06**:

- If A06 is disabled, no action will be taken.
- If A06 is enabled, action will depend on C32:
    - C32 = 0 (default value) the thermal alarm will cut in and reduce the current limit to match the line reactor thermal current.
    - C32 = 1 the thermal alarm cuts in and stops the converter immediately.

Internal value d28 and analog output 28 display a second-by-second reading of the line reactor thermal current as a percentage of the rated line reactor current. When 100% is reached, the line reactor thermal switch cuts in.

3 STANDARD APPLICATION

3.1 INPUT

3.1.1 DIGITAL INPUTS CONFIGURATIONS

The control requires up to 8 optically insulated digital inputs (L.I.1 … L.I.8) whose logic functions can be configured by means of connection **C1** ÷ **C8**.

Name	Description	Min	Max	Default	UM	Scale
LI1_SEL	C01 - Meaning of logic input 1	-1	31	8		1
LI2_SEL	C02 - Meaning of logic input 2	-1	31	2		1
LI3_SEL	C03 - Meaning of logic input 3	-1	31	3		1
LI4_SEL	C04 - Meaning of logic input 4	-1	31	0		1
LI5_SEL	C05 - Meaning of logic input 5	-1	31	4		1
LI6_SEL	C06 - Meaning of logic input 6	-1	31	12		1
LI7_SEL	C07 - Meaning of logic input 7	-1	31	5		1
LI8_SEL	C08 - Meaning of logic input 8	-1	31	22		1
TF_LI6-7-8	P15 - I06, 07, 08 logical inputs digital filter	0.0	20.0	2.2	ms	10
EN_NOT_LI	C79 - Enable negative logic for digital inputs	0	255	0		1

The following table shows the logic functions managed by standard application:

		NAME	INPUT LOGIC FUNCTIONS	DEFAULT INPUT	DEFAULT STATUS
I	00	ID_RUN	Run command	P.I.4	L
I	02	ID_EN_EXT	External enable	P.I.2	H
I	03	ID_SWAP_ISL_EN	Swap to Island Enable	P.I.3	L
I	07	ID_UGRID_CONT_STS	Microgrid external contactor status		L
I	08	ID_RESET_ALR	Alarms reset	P.I.1	L
I	09	ID_UGRID_RESYNC_REQ	Microgrid resynch request		L
I	10	ID_EN_REST_OVC_S	Enable Restart After OVC (Software detect)		L
I	16	ID_EN_PAR_DB2	Enable second parameter bank		L
I	20	ID_EN_CSI	Enable PLL on CSI control		L
I	21	ID_EN_DROOP	Enable droop control		L
I	31	ID_PWM_SYNCH	PWM synchronization input		L

Note: It is crucial to ensure that the same logic function is not assigned to two different logic inputs. After modifying the connection value for a specific input, verify that the value has been correctly accepted. If it has not, check whether another input has already been allocated the same function. To disable a logic input, assign it the logic function -1. This is the only value that can be assigned to multiple inputs simultaneously.

3.1.1.1 INPUT LOGIC FUNCTIONS SET IN OTHER WAYS

In practice, the input logic functions can also be configured via serial connection and fieldbus, with the following logic:

- **I00 Run**: This function operates independently. It must be confirmed through terminal board inputs, serial communication, and fieldbus. However, by default, the fieldbus is active. If it remains unaltered, it will only control the terminal board input.

- **I01 to I31**: These functions are a parallel configuration of the corresponding functions that can be set through the terminal board, serial communication, or fieldbus.

3.1.2 ANALOG INPUTS CONFIGURATIONS

Name	Description	Min	Max	Default	UM	Scale
KP_AI1	P01 - Corrective factor for analog reference 1 (AUX1)	-400.0	400.0	100		10
OFFSET_AI1	P02 - Corrective offset for analog reference 1 (AUX1)	-100.0	100.0	0	%	163.84
KP_AI2	P03 - Corrective factor for analog reference 2 (AUX2)	-400.0	400.0	100		10
OFFSET_AI2	P04 - Corrective offset for analog reference 2 (AUX2)	-100.0	100.0	0	%	163.84
KP_AI3	P05 - Corrective factor for analog reference 3 (AUX3)	-400.0	400.0	100		10
OFFSET_AI3	P06 - Corrective offset for analog reference 3 (AUX3)	-100.0	100.0	0	%	163.84
KP_AI16	P13 - Corrective factor for 16 bit analog reference (AUX16)	-400.0	400.0	100		10
OFFSET_AI16	P14 - Corrective offset for 16 bit analog reference (AUX16)	-100.0	100.0	0	%	163.84
EN_AI1_4_20mA	C95 - Enable AI1 4-20mA	0	1	0		1
EN_AI2_4_20mA	C96 - Enable AI1 4-20mA	0	1	0		1
EN_AI3_4_20mA	C97 - Enable AI1 4-20mA	0	1	0		1
AI1	D42 - Analog Input AI1	-100	100	0	%	163.84
AI2	D43 - Analog Input AI2	-100	100	0	%	163.84
AI3	D44 - Analog Input AI3	-100	100	0	%	163.84
AI16	16 bit Analog input (optional)	-100	100	0	%	40.96

If the user wants to use current references (4-20 mA signals), it is necessary to correctly set the dip-switch **SW1** on the keypad (4T0008 board - refer to the installation manual, section 5.2.17). Once this is done, each analog input can be configured using connections **C95 to C97** to enable the appropriate software management for these inputs.

When the 4-20 mA function is enabled, the system automatically sets **KP_Ax = 125%** and **OFFSET_Aix = -25%**, which means:

- With **4 mA**, the reference is set to **0**.
- With **20 mA**, the reference is set to **100%**.

Additionally, a software lower limit of **0%** is applied. This means that if the current reference falls below 4 mA, the actual reference will still be treated as **0%**.
It is also possible to enable each reference separately using connections or logic input functions.

3.2 OUTPUT

3.2.1 DIGITAL OUTPUT CONFIGURATIONS

Name	Description	Min	Max	Default	UM	Scale
LO1_SEL	C10 - Meaning of logic output 1	-64	63	3		1
LO2_SEL	C11 - Meaning of logic output 2	-64	63	0		1
LO3_SEL	C12 - Meaning of logic output 3	-64	63	6		1
LO4_SEL	C13 - Meaning of logic output 4	-64	63	19		1

The control can have up to 4 optically insulated digital outputs (L.O.1 … L.O.4) whose logic functions can be configured as active high (H) by means of connection **C10** ÷ **C13**.

The following table shows the logic functions managed by standard application:

		NAME	OUTPUT LOGIC FUNCTIONS	DEFAULT OUTPUT
O	00	OD_CONV_READY	Converter ready	P.O.2
O	01	OD_ALR_KT_MOT	Reactor thermal alarm	
O	03	OD_DRV_RUN	Converter running	P.O.1
O	07	OD_LIM_I_BASE	Converter in current limit (thermal + P40)	
O	08	OD_LIM_I_ALL	Converter in current limit (all)	
O	10	OD_PREC_OK	Insertion of the active soft-start	
O	12	OD_POW_OFF	Grid fault	
O	13	OD_BUS_RIG	Single Phase Grid	
O	15	OD_KT_DRV	Heat sink overheating (higher than P120 threshold)	
O	16	OD_IDC_OVERCURR	Idc overcurrent	
O	19	OD_POS_INI_POL	Regulation card supplied and DSP not in reset state	P.O.4
O	20	OD_SNS1_ABS	Power recovery into the Grid (generation)	
O	21	OD_CONV_OK	Converter ready and Power Soft start active	
O	22	OD_LL_ACTV	LogicLab application active	
O	30	OD_UGRID_CONT_CMD	Microgrid external contactor command	
O	31	OD_PWM_SYNCH	PWM synchronization output	
O	32	OD_EN_CONV_FANS	Enable converter fans	

To configure the logic outputs to be active at the low level (L), you need to set the corresponding connection for the chosen logic function with a denied value. For example, if you want to associate the function **"Grid fault"** with **logic output 1** to be active low, you would program **connection C10** with the value **-12** (**C10 = -12**).

Note: To configure **Output logic 0** to be active low, you should set the corresponding connection to **-32**.

3.2.2 ANALOG OUTPUTS CONFIGURATIONS

Name	Description	Min	Max	Default	UM	Scale
AO1_SEL	C15 - Meaning of programmable analog output 1	-99	100	11		1
AO2_SEL	C16 - Meaning of programmable analog output 2	-99	100	4		1
PRC_AO1_10V	P57 - % value of 10V for analog output A	100.0	400.0	200	%	10
PRC_AO2_10V	P58 - % value of 10V for analog output B	100.0	400.0	200	%	10
OFFSET_AO1	P110 - Offset A/D 1	-100.0	100.0	0		327.67
OFFSET_AO2	P111 - Offset A/D 2	-100.0	100.0	0	%	327.67

		OUTPUT LOGIC FUNCTIONS	DEFAULT OUTPUT
o	00	Angle read [100%=180°]	
o	01	Delta m [100%=180°]	
o	02	Zero sequence of current	
o	03	V Bus Ref Norm [100%=Vgrid*1,41]	
o	05	out0 [% I NOM CONV]	
o	06	Internal value: status (MONITOR only)	
o	07	Iq rif [% I NOM CONV]	
o	08	Id rif [% I NOM CONV]	
o	09	Request voltage at maximum rev. [% VNOM MOT]	
o	10	Internal value: alarms (MONITOR only)	
o	11	Current module [% I NOM CONV]	A.O.1
o	13	U phase current reading [% I MAX CONV]	
o	14	Internal value: inputs (MONITOR only)	
o	15	Iq component of current reading [% I NOM CONV]	
o	16	Id component of current reading [% I NOM CONV]	
o	17	U phase voltage duty-cycle	
o	18	Module of the reference voltage [% V NOM CONV]	
o	19	Modulation index [0<->1]	
o	20	Request Q axis voltage (Vq_rif) [% V NOM]	
o	21	Power Delivered [% Nominal Power]	
o	22	Request D axis voltage (Vd_rif) [% VNOM]	
o	24	Bus voltage [100%=900V]	
o	25	Heat sink temperature reading [% 37,6°]	
o	26	Reactor temperature reading [% 80°]	
o	28	Reactor thermal current [% alarm threshold A6]	
o	29	Current limit [% I MAX CONV]	
o	30	Max active current limit	
o	32	Internal value: outputs (MONITOR only)	
o	31	Zero sequence of phase voltage duty-cycle	
o	33	Internal value: inputs_hw (MONITOR only)	
o	34	V phase current reading [% I MAX CONV]	
o	35	W phase current reading [% I MAX CONV]	
o	36	alfa_fi [100%=180°]	
o	37	Analog input A.I.1 [100%=16383]	
o	38	Analog input A.I.2 [100%=16383]	
o	39	Analog input A.I.3 [100%=16383]	
o	40	Grid current module	
o	43	Max active current limit by app	
o	44	Frequency [% F_GRID_NOM]	
o	46	Grid voltage module filtered [% V NOM CONV]	
o	47	U phase voltage reading Vu1 [100%=16383]	
o	48	V phase voltage reading Vu2 [100%=16383]	
o	49	V Bus Norm %Vgrid*1,41 [100%=16383]	
o	51	out0 (%I NOM CONV)	
o	53	Frequency of main grid [% F_GRID_NOM]	
o	54	Main grid voltage module filtered [% V NOM CONV]	
o	56	Main Grid U phase voltage reading Vg1	
o	57	Main Grid V phase voltage reading Vg2	

o	58	I_Alpha_Rif (abc Control)	
o	61	Grid W phase current reading	
o	62	Grid U phase current reading	
o	64	Min active current limit by app	
o	67	I_Beta_Rif (abc Control)	

There can be a maximum of two analog outputs, **VOUTA** and **VOUTB**, each with a range of **±10 V** and a maximum current of **2 mA**. Each of these outputs can be associated with an internally regulated variable, which can be selected from a predefined list.

To allocate a specific variable to each output:

- Program the connection corresponding to the output, **C15** for **VOUTA** and **C16** for **VOUTB**, with the number associated with the desired variable from the table below.

By using the parameters:

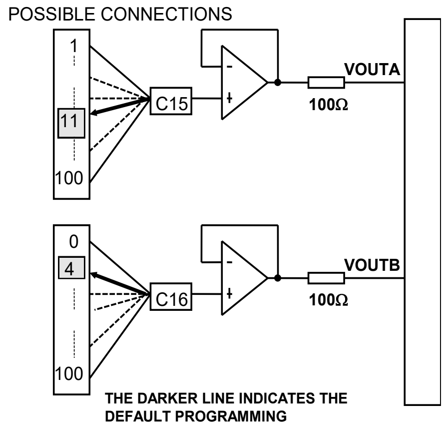
- **P57** (for **VOUTA**) and **P58** (for **VOUTB**), you can set the percentage of the selected variable that corresponds to the maximum output voltage. The default values for both parameters are **P57 = P58 = 200%**, which means that when the output reaches **10V**, it corresponds to **200%** of the selected variable.

To configure an **absolute internal variable value** for the output:

- Program the corresponding connection with the specific desired value.

To set an **analog output to a fixed value of +10V**:

- Simply program the connection corresponding to the value **100**.



3.3 GFM/GFL Mode

A **microgrid** is a localized energy system consisting of electrical sources (such as renewable energy sources, energy storage systems, and conventional generators) that can either operate independently or work in conjunction with the main utility grid. The **AFE Plus inverter** plays a critical role in managing energy flows within the microgrid, ensuring efficient power conversion, storage, and supply to both local loads and the grid.

A typical configuration where the AFE Plus operates in a microgrid setup is as follows:

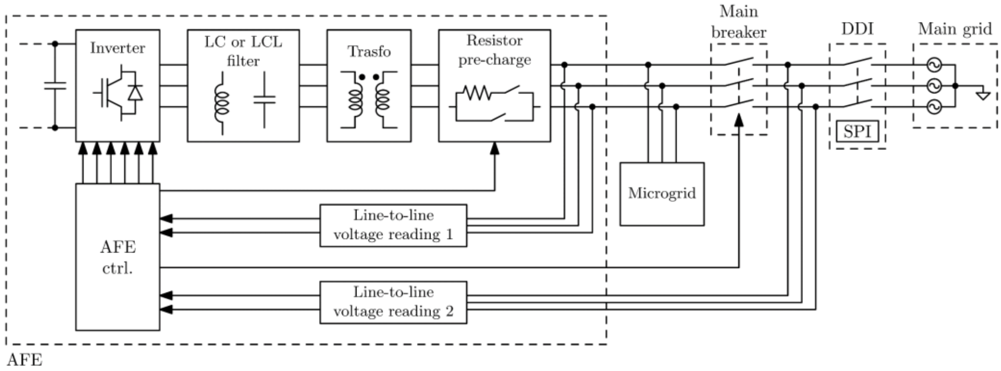


Figure 2 - System layout, DDI block is optional

3.3.1 MAIN COMPONENTS

- **AFE Plus Inverter:** The AFE Plus inverter is responsible for active power conversion and control within the microgrid. It connects and interfaces with energy sources (such as solar panels or wind turbines) and energy storage systems (like batteries), ensuring efficient energy flow to the grid or local loads. It also controls the charging and discharging of batteries in the system.
- **Energy Sources:** Renewable energy sources, such as **solar panels** or **wind turbines**, are integrated into the microgrid. The AFE Plus inverter converts the generated DC power into AC power, making it compatible with the grid or local loads.
- **Energy Storage: Battery Energy Storage Systems (BESS):** store excess energy generated during periods of high production (e.g., when the sun is shining or wind is blowing) to be used during times of low generation. The AFE Plus inverter also manages the charging and discharging of these batteries, ensuring that energy is efficiently stored and dispatched.
- **Grid Connection:** The microgrid can be connected to the **main utility grid** through an interconnection point. The AFE Plus inverter manages the power flow between the microgrid and the main grid, ensuring that the energy exchanged complies with grid codes. This setup allows the microgrid to operate in both **grid-connected** and **islanded** modes.
- **Local Loads:** Local loads within the microgrid can be residential, commercial, or industrial consumers. The AFE Plus inverter ensures a stable and reliable power supply to these loads by balancing the supply of power from renewable generation, storage, and grid connection, particularly in islanded mode when disconnected from the main grid.
- **Main Breaker:** The **main breaker** allows the microgrid to be connected or disconnected from the main grid. It is controlled based on the operation mode (grid-connected or islanded) and is critical for safe operation and seamless transitions.
- **Optional Interface Protection Device (DDI):** The **DDI (Dispositivo Di Interfaccia)** is an optional protection device in compliance with the **CEI-021 Standard**. It may disconnect the microgrid when the main grid frequency or voltage deviates outside specified thresholds, protecting both the microgrid and the main grid.
- **Three-Phase System without Neutral:** The described configuration assumes a **three-phase system without neutral**. However, the system's functionalities can also apply to three-phase systems with a neutral connection. Currently, **single-phase systems** are not supported.

3.3.2 CONTROL FUNCTIONS:

- **Grid Support (CSI Mode – Grid following mode GFL):**
  In **GFL mode**, the AFE Plus inverter supports the main grid by injecting power when the renewable generation exceeds the local demand. It also contributes to grid stability by managing reactive power and providing voltage regulation. The inverter operates as a **Current Source Inverter (CSI)**, providing both active and reactive currents as per the defined current references. In this mode, the grid dictates the frequency and voltage amplitude.
  In this mode, when the **main breaker** and optional **DDI** are closed, the AFE Plus inverter works in parallel with the main grid, while the frequency and voltage amplitude of the grid are determined by the main grid.
- **Islanded Operation (VSI Mode – Grid Forming Mode GFM):**
  When the microgrid is disconnected from the main grid (due to a fault or intentional operation), the AFE Plus inverter operates in **islanded mode**. In this mode, it acts as a **Voltage Source Inverter (VSI)**, imposing voltage amplitude and frequency to the microgrid. The AFE Plus inverter generates voltage and frequency references internally, ensuring reliable power supply to local loads and balancing power generation with storage.
- **Seamless Transition Between Islanded Mode and Grid-Connected Mode:**
  For a seamless transition between **islanded mode** and **grid-connected mode**, the following components are required:
  1. **Main Breaker Control:** The AFE control unit directly controls the main breaker, which is triggered by a digital output from the inverter regulator.
  2. **Main Breaker Status:** The AFE controller reads the status of the main breaker through a dedicated digital input to determine whether the microgrid is connected or disconnected from the main grid.
  3. **Voltage Measurement:** The AFE controller reads the line-to-line voltages from both upstream and downstream of the main breaker via two dedicated input channels. These readings are critical for ensuring smooth transitions between grid-connected and islanded modes.
  4. **Optional DDI Integration:** The optional DDI protection device can be connected upstream of the main breaker, ensuring that the microgrid disconnects from the main grid in case of voltage or frequency deviations.

- **Energy Management System (EMS):**
  The **Energy Management System (EMS)** is responsible for overseeing the energy flow within the microgrid. It ensures that power is efficiently used, balancing the demand and supply from renewable generation, storage systems, and grid power. The EMS can also prioritize local energy consumption, optimize energy storage, and communicate with the AFE Plus inverter to control energy exchanges with the grid.

3.3.3 AFE HW CONTROL LOGIC

The **AFE (Active Front-End)** inverter operates in two primary modes—**Voltage Source Inverter (VSI)** mode and **Current Source Inverter (CSI)** mode—depending on the status of the **main breaker** and other associated components, such as the **DDI (Dispositivo Di Interfaccia)** protection device. The configuration of these modes and the necessary hardware connections are outlined below. The operation of the **main breaker** is controlled by a digital output from the AFE controller. This breaker connects or disconnects the microgrid from the main grid. The details for controlling and monitoring the main breaker's status are as follows:

- **Digital Output O30:** The main breaker's state is controlled through the **FW digital output** DigOut[30], which is mapped to **O30**.
  - **Logical High Level (DigOut[30] = High):** This signal closes the main breaker, connecting the microgrid to the main grid.
  - **Logical Low Level (DigOut[30] = Low):** This signal opens the main breaker, disconnecting the microgrid from the main grid.

- **Main Breaker Status Monitoring via Digital Input: Digital Input (DigIn[7]):** The AFE controller reads the status of the main breaker via its **clean contact** (auxiliary contact). The digital input **i07** (connected to **DigIn[7]**) detects the breaker status:
  - **Logical High Level (DigIn[7] = High):** Indicates that the main breaker is closed, meaning the microgrid is connected to the main grid.
  - **Logical Low Level (DigIn[7] = Low):** Indicates that the main breaker is open, meaning the microgrid is disconnected from the main grid.

- **DDI (Dispositivo Di Interfaccia) Protection Device Integration:** If the **DDI** protection device is installed, it is used to ensure a seamless transition between VSI and CSI modes, especially in scenarios where the microgrid transitions between **islanded** and **grid-connected** modes.

- **DDI Configuration:** The **main breaker's auxiliary contact** and the **DDI's auxiliary contact** are wired in series and connected to a digital input, **i20**, on the AFE controller. This connection allows the system to correctly manage the **VSI/CSI transition**:
    - **Logical Low Level (i20 = Low):** Indicates that either the **main breaker** or the **DDI** or both are open, signaling a transition to VSI mode.
    - **Logical High Level (i20 = High):** Indicates that both the **main breaker** and the **DDI** are closed, signaling a transition to CSI mode.

  If the **DDI** is not installed, only the **main breaker's auxiliary contact** is connected to **i20**, with the same logical definitions.

- **Line-to-Line Voltage Reading for Grid Synchronization:** To manage proper synchronization between the microgrid and the main grid, the **AFE controller** needs to monitor the **line-to-line voltages** both **upstream** and **downstream** of the **main breaker**. This ensures that the AFE inverter can operate correctly in both grid-connected and islanded modes. A proper **Voltage Sensing Configuration (4V0016 and 4S0016.3) is then mandatory.** The voltage reading chain (shown in Figure 2) should be configured and applied to both the upstream and downstream voltage sensing points, ensuring that the AFE controller has accurate voltage data for grid synchronization and mode transitions.

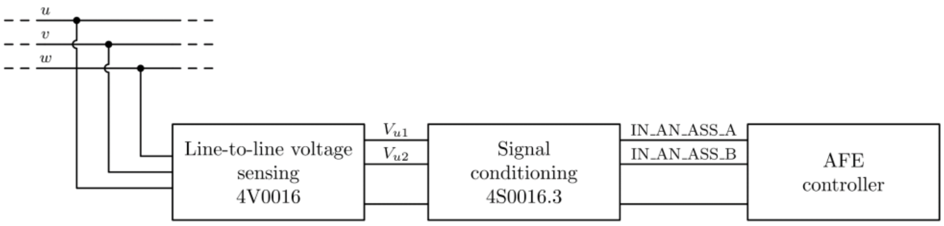


Figure xx - Line-to-line voltage acquisition channel

    - **4S0016 Board in SLOT1:** This board is used to read the **line-to-line voltage downstream** of the main breaker (on the AFE side of the system).
    - **4S0016 Board in SLOT2:** This board is used to read the **line-to-line voltage upstream** of the main breaker (on the main grid side).
    - **4V0016 Version Compatibility:** Ensure that both **upstream** and **downstream** voltage acquisition channels use the same revision of the **4V0016** board for consistent measurements.
    - **Single 4S0016 Board Configuration:** If only one board is used, the system will operate in **islanded mode** (VSI functionality) with **no transition available** between islanded and grid-connected modes.
    - **Voltage Compensation:** The acquired voltage signals are compensated for amplitude and offsets to ensure symmetry, which is crucial for accurate phase and amplitude synchronization.
    - **Phase-Locked Loop (PLL):** The PLL is used to measure the phase and amplitude differences between the microgrid and the main grid, enabling the resynchronization of voltages during the transition from islanded to grid-connected mode.
    - **Transition Process:** The AFE system synchronizes the microgrid's voltage and phase with the main grid during the resynchronization process, ensuring a stable transition between the two modes. In particular, the phase difference or phase error and the voltage amplitude difference or voltage amplitude error between the 2 breaker sides are computed.

3.3.4 MICROGRID CONTROL SYSTEM: FIRMWARE LOGIC AND STATE MACHINE

The firmware (FW) controlling the microgrid's transitions between islanded mode and grid-connected mode uses two key digital signals to manage the system's behavior: **EN** (Enable) and **REQ** (Request). These signals control whether the system operates normally, or whether it is idle, waiting for state transitions, or encountering errors.

1. **Key Signals:**
   - **EN (Enable Signal)**
     - **High Logic Level (EN = High):** Enables the microgrid's mode management, allowing the system to transition between islanded and grid-connected modes and manage the main breaker's status.
     - **Low Logic Level (EN = Low):** Disables the system's operation, putting it into an idle state where no transitions or breaker operations are allowed.

   - **REQ (Request Signal – i.09):** The **REQ** signal determines whether the system should transition the main breaker to open or close and controls the shift between islanded and grid-connected modes.

Starting Breaker Status	REQ (i.09) Logic Level	Function
Open / VSI (Islanded Mode)	0 (Opening)	Maintain operation in islanded mode (no grid connection).
Open / VSI (Islanded Mode)	1 (Closing)	Initiate transition from islanded mode to grid-connected mode (breaker closing).
Closed / CSI (Grid-Connected Mode)	0 (Opening)	Initiate transition from grid-connected mode to islanded mode (breaker opening).
Closed / CSI (Grid-Connected Mode)	1 (Closing)	Maintain operation in grid-connected mode (breaker stays closed).

2. **State Machine (SM) and States**
The system's operation is governed by a **State Machine (SM)**, and the current state of the machine is displayed on **D10**. Each state represents a different step in the transition process, or the status of the microgrid system:

State	Description
OPEN_BREAKER	The system is in **islanded mode** (disconnected from the grid), and the breaker is open.
WAIT_TO_RESYNC	The system is waiting for the **phase difference** to decrease before starting synchronization with the main grid.
MICROGRID_RESYNC	The system is **synchronizing** (adjusting voltage and phase) to match the grid during the transition from islanded mode to grid-connected mode.
READY_TO_CLOSE	The voltage and phase differences are small enough to **close the breaker** and reconnect to the grid.
REGULATOR_RESET	The resynchronization has failed or was aborted, and the system's regulators are reset.
CLOSED_BREAKER	The system is in **grid-connected mode**, with the breaker closed and the system supplying power to the grid.
BREAKER_OPENING	The breaker is being opened during the transition from grid-connected mode to islanded mode.
DISABLED_STATUS	The system is **idle** or turned off, with no operations happening.
TRANSITION_ERROR	An error occurred during the mode transition (e.g., syncing the microgrid to the grid). The system must be set to islanded mode to clear the error.
BREAKER_ERROR	There is an error where the breaker status doesn't match the command (e.g., the breaker should be open but is closed). The system is locked until the error is cleared.

3. **Transition and Error Handling**
   - **State Transitions:** The state machine controls the transition between states, for example, from **OPEN_BREAKER to WAIT_TO_RESYNC when moving from islanded mode to grid-connected mode.** Transitions between **READY_TO_CLOSE** and **CLOSED_BREAKER** occur when synchronization is complete.

   - **Error Handling:** The system can enter **TRANSITION_ERROR** or **BREAKER_ERROR** if there are inconsistencies or faults during transitions, such as the breaker not responding as commanded or synchronization issues.

3.3.5 OTHER KEY POINTS

1. **Three-Phase vs Single-Phase Systems**:
   - The state machine management described is **only applicable to three-phase systems**.
   - If the system is configured for **single-phase operation**, the state machine is automatically set to **DISABLED_STATUS**. In this case, the system is idle, and the **EN** (enable) signal is forced to a low logical level (off).
   - To exit **DISABLED_STATUS**, two **voltage reading boards** must be installed in **SLOT1** and **SLOT2**.

2. **DDI:** When a **DDI** is installed, the system's behavior can change. Specifically, the states **OPEN_BREAKER** (islanded mode) and **CLOSED_BREAKER** (grid-connected mode) do not strictly correlate with the mode of operation. The microgrid mode will depend on the **DDI's status** as well.
   - During transitions (such as when the breaker is opening), the **DDI state** (whether it's open or closed) must be directly connected to the **REQ signal** (or through a logical AND gate).
   - **When the DDI is open**, it forces the **REQ signal** to **low** (which means the breaker must be open). If this condition is violated, an **error detection** is triggered.

3. **Error Detection and Alarm**: If the system is **running** (AFE is in RUN mode), the **main breaker is closed**, the system is in **VSI mode** (Voltage Source Inverter), and the **REQ signal is high** (requesting grid connection), but the **i20 signal is low** (indicating the DDI is open), **alarm 12.2** is triggered. This **prevents the AFE from operating** and avoids potential problems with the system's status.

4. **SWAP Functionality (C83)**: allows for **fast transitions** between **CSI mode** (Current Source Inverter) and **VSI mode** (Voltage Source Inverter), even before the DDI or main breaker auxiliary contacts have changed their state. **When SWAP is active**, the **REQ signal** is forced to **low** by the firmware, which forces the **main breaker to open**. This helps in managing transitions more efficiently.

Figure 4 - OPDexplorer typical input/output settings

Name	Description	Min	Max	Default	UM	Scale
GRID_ISL_V_REF	P10 - AC GRID_ISL Voltage Reference	15.0	780.0	230.0	V	10
BLK_START_TM	P21 - Black Start Time	0.01	199.99	1	s	100
FREQ_DROOP	P22 - % Frequency Droop	-100.0	100.0	2.0	%	81.92
VOLT_DROOP	P23 - % Voltage Droop	-100.0	100.0	5.0	%	81.92
DDROOP_GAIN	P24 - % Phase droop gain	-100.0	100.0	20.0	%	81.92
GRID_ISL_KP	P35 - KpV GRID_ISL V Prop Gain	0.01	40.0	0.10		100
GRID_ISL_TI	P36 - TiV GRID_ISL V lead time constant	0.1	3000.0	5.0	ms	10
GRID_ISL_TF	P37 - TfV GRID_ISL filter time constant	0.0	25.0	0.0	ms	10
PRC_DIS_REG_GRID_ISL	P38 - Cross Coupling multiplier for GRID_ISL V ac Control	0.0	200.0	80	%	10
VOLT_REG_FF_FILTER	P41 - Time constant for voltage regulator feed-forward calculation	0.0	500.0	4.5	ms	10
K_V_GRID_EXT	P54 - Corrective Factor for AC Grid Voltage of external grid	25.0	200.0	100.0	%	10
VoltDroopFilt	P59 - Voltage Droop Filter Time const	0.0	200.0	6.0	ms	10
F_GRID_NOM	P63 - Rated grid frequency	5.0	100.0	50.0	Hz	1
DROOP_SIN	P66 - Droop sin (1=inductive 0=resistive)	0.00	1.00	1.00		100
FreqDroopFilt	P67 - Frequency Droop Filter Time const	0.0	200.0	6.0	ms	10
PRC_REAL_VRS	P69 - Voltage drop due to real resistor	0.0	25.0	0.1	% V_GRID_NOM	327.67
PRC_REAL_VLS	P70 - Voltage drop due to real inductance	0.0	50.0	3.0	% V_GRID_NOM	327.67
PRC_VIRTL_VRS	P72 - Voltage drop due to real+virtual resistor	-25.0	25.0	0.1	% V_GRID_NOM	327.67
PRC_VIRTL_VLS	P73 - Voltage drop due to real+virtual inductance	-50.0	50.0	3.0	% V_GRID_NOM	327.67
CAPAC_LINE_CURR	P74 - Capacitors Line Current	0.0	20.0	0.0	% I_CONV_NOM	327.67
DDROOP_TF	P79 - Filter time constant for phase droop	0.0	100.0	50	ms	10
DY11_ANG	P80 - Dy11 angle Phase Shift	-180.0	180.0	0	°	10
RESYNC_AMPL_KP	P129 - Voltage regulator Kp for microgrid resync	0.01	80.0	1		100
RESYNC_AMPL_TI	P130 - Voltage regulator TiV lead time constant for microgrid resync	0.1	3000.0	300	ms	10
RESYNC_AMPL_TF	P131 - Voltage error regulator filter Tf time constant for microgrid resync	0.0	500.0	150	ms	10
RESYNC_FREQ_KP	P132 - Freq. regulator Kp for microgrid resync	0.01	80.0	0.1		100
RESYNC_FREQ_TI	P133 - Freq. regulator TiV lead time constant for microgrid resync	0.1	3000.0	300	ms	10
RESYNC_FREQ_TF	P134 - Freq. regulator filter Tf time constant for microgrid resync	0.0	500.0	50.0	ms	10
RESYNC_VOLT_THR	P135 - % Voltage threshold for microgrid resync	0.0	100.0	0.0	%	81.92
RESYNC_PHASE_THR	P136 - % Phase threshold for microgrid resync	0.0	100.0	0.0	%	81.92
RESYNC_VAL_TIME	P137 - Validation time for microgrid resync	20	2000	200	ms	1
TRANSITION_ERR_TIME	P139 - Timeout for microgrid resync	0	15000	500	ms	1
SWAP_VOLT_THR	P140 - Voltage threshold for CSI to VSI swap function	0.0	100.0	10.0	%	163.84
SWAP_FREQ_THR	P141 - Frequency threshold for CSI to VSI swap function	0.0	100.0	5.0	%	163.84
CSIVSI_VOLT_MOD_FILTER	P142 - Time constant for voltage module reference filter for CSI to VSI transition	0.0	1000.0	200	ms	10
BLACK_START_INIT_TIME	P143 - Initial boost time for black-start	0.0	10000.0	0	ms	1
BLACK_START_INIT_VALUE	P144 - Initial boost value for black-start	0.0	100.0	0.0	%	163.84
CONTROL_SEL	C00 - Control Selection	0	13	0		1
I_CTRL_SEL	C80 - Current control type selection	0	1	0		1

3.4 LVFRT

The Low-Voltage Fault Ride Through (LVFRT) function allows compliance with LVFRT requirements outlined in grid connection standards (including, but not limited to, the Italian CEI 021-016 standard). To enable LVFRT support, use the parameter **C74–EN_LVFRT_MANAGE**.

The voltage vs. time characteristic for LVFRT (specified in each grid code regulament), can be configured using the following parameters:

- **P50–MIN_V_GRID**: Defines the minimum grid voltage threshold for disconnection.
- **P145–LVFRT_T_MAX**: Specifies the maximum duration that the inverter can tolerate a voltage drop before disconnecting from the grid.

This rectangular, configurable voltage-time characteristic is designed to meet the various requirements specified in national standards.

By default, the LVFRT function is inactive. In the event of a grid voltage drop, the inverter will automatically disconnect from the grid by opening the grid's main contactor when the grid voltage falls below the **P50–MIN_V_GRID** threshold.

When LVFRT is activated (C74 = Yes), the inverter will behave as follows during a grid voltage drop:

- If the grid voltage falls below **P50–MIN_V_GRID**.
- If the duration of the voltage drop is shorter than **P145–LVFRT_T_MAX**.

The inverter will stop supplying power to the grid but will not disconnect from the grid; the grid contactor will remain closed, and the inverter will trigger alarm **A02.1**.

If the grid voltage is restored within the waiting time set in **P145**, the inverter will automatically reset and resume power delivery after the wait time specified in **P65–WaitAfeReady**.

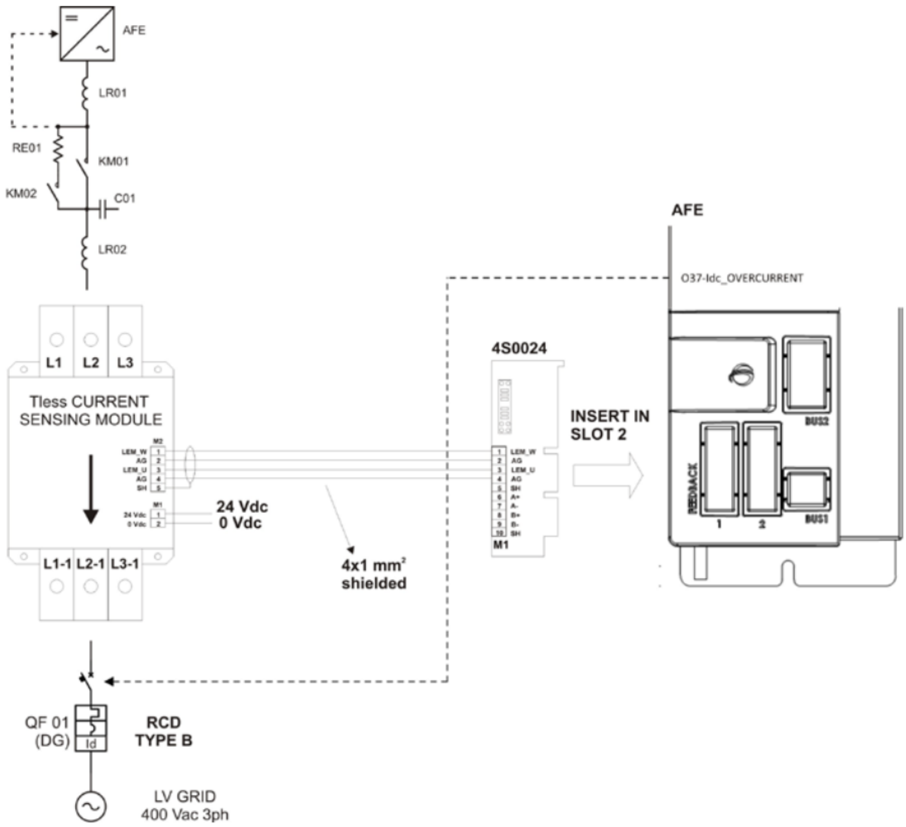
If the grid voltage is not restored within the waiting time set in **P145**, the inverter will disconnect from the grid by opening the grid main contactor, and **alarm A02.0** will be triggered.

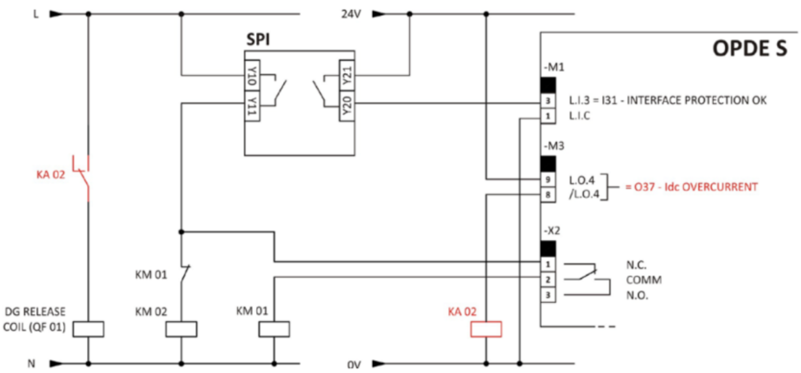
Name	Description	Min	Max	Default	UM	Scale
LVFRT_T_MAX	P145 - LVFRT maximum duration	0.10	5.00	3.00	s	100
GRID_UNB_MAX	P146 - Maximum grid voltage unbalance for enabling run	0.1	100.0	10.0	% V_GRID_NOM	10
V_GRID_MAX_UNB	P147 - Maximum grid voltage with unbalanced grid for enabling run	0.0	200.0	115.0	% V_GRID_NOM	10
V_GRID_MIN_UNB	P148 - Minimum grid voltage with unbalanced grid for enabling run	0.0	200.0	80.0	% V_GRID_NOM	10
EN_LVFRT_MANAGE	C74 - Enable LVFRT manage	0	1	0		1

3.5 TRANSFORMERLESS

The transformerless function (AFE Tless) limits the DC current injected into the grid and can be used as an alternative to an insulation transformer when the grid code requires limiting the DC current.

To enable this function, a current sensing module and an optional 4S0024 card must be connected according to the diagram provided.





The transformer should be replaced with secondary inductance (as detailed in the AFE Energy installation manual). Logic output O16-Idc Overcurrent is used to trigger the grid circuit breaker (DG) if the DC current on phase U, V, or W exceeds one of the following thresholds:

- **P319** - TLESS_IDC_THRa with Idc filter time constant **E237-TLESS_LPF2a_TF**, or
- **P320** - TLESS_IDC_THRb with Idc filter time constant **E238-TLESS_LPF2b_TF**.

If an Idc overcurrent event occurs, alarm **A12.4 – Idc overcurrent** is generated. The status of **O16** mirrors the status of alarm **A12.4**, so **O16** stays at a high logic level until the alarm is reset.
Derivative filters on the active and reactive currents of the inverter are used to detect AFE load transients. Additionally, a derivative filter on the grid frequency measurement is used to identify grid-related transients that do not originate from the AFE. These filters help to prevent false Idc overcurrent triggers during transient events
To enable the AFE Tless function, set **C72-EN_TLESS=1** and perform the Rgrid tuning as follows:

Rgrid Tuning

The Rgrid tuning function measures the resistance that the AFE perceives towards the grid, and this data is used to automatically adjust the proportional gain of the Tless function. During the tuning, reactive current must be injected into the grid, and **P68** is used to temporarily set this value. After the tuning, **P68** must be restored to its original value.

Steps for Rgrid Tuning:

1. Connect the AFE to the grid and verify that it is in the stop state with no alarms. Set C73-EN_R_GRID_TUNING=1 and P68=30%.
2. In OPD Explorer, drag and drop P335-PRC_DELTA_VRG and D400-TLESS_IDC_U into the monitor window.
3. Start the tuning (Run the test). After approximately 5 seconds, the AFE will generate a DC voltage ramp on phase U, which will produce a DC current on phase U. The DC voltage ramp will stop when:
    - The DC current on phase U reaches +100%, or
    - The DC voltage reaches the maximum value of E227 * 5.
4. After 5 seconds, the DC voltage will return to zero, and the measured Rgrid value will be written to P335.

During the test, the value displayed in **D400** will increase. The test is complete when **D400** decreases back to approximately zero and **P335** has changed its value.
Once the tuning is complete, you can **remove the run command**. **C73** will automatically return to 0

Name	Description	Min	Max	Default	UM	Scale
EN_TLESS	C72 - Enable Transformerless	0	3	0		1
EN_R_GRID_TUNING	C73 - Enable Rgrid tuning	0	1	0		1
TLESS_DER_F_TD	P312 - Tless frequency derivative time constant	0.1	3000.0	200.0	ms	10
TLESS_DER_F_TF	P313 - Tless frequency derivative filter time constant	0	3000.0	10.0	ms	10
TLESS_DER_F_THR	P314 - Tless frequency derivative threshold	0.0	100.0	10.0	%	10
TLESS_DER_I_TD	P315 - Tless current derivative time constant	0.1	3000.0	20.0	ms	10
TLESS_DER_I_TF	P316 - Tless current derivative filter time constant	0	3000.0	10.0	ms	10
TLESS_DER_I_THR	P317 - Tless current derivative threshold	0.0	100.0	10.0	%	10
TLESS_IDC_NOM	P318 - Tless Idc rated current	0.001	32.767	0	A	1000
TLESS_IDC_THRa	P319 - Tless Idc threshold a	0.1	100.0	0.5	% I_NOM	10
TLESS_IDC_THRb	P320 - Tless Idc threshold b	0.1	100.0	1.0	A	10
TLESS_LPF2_DMP	P321 - Tless LPF2a and LPF2b damping factor	0.01	1.00	0.90		100
TLESS_LPF2a_TF	P322 - Tless LPF2a filter time constant	0.1	3000.0	200.0	ms	10
TLESS_LPF2b_TF	P323 - Tless LPF2b filter time constant	0.1	3000.0	25.0	ms	10
TLESS_NOTCH_DMP	P324 - Tless Notch filter damping factor	0.0	100.0	0.0	%	10
TLESS_NOTCH_F0	P325 - Tless Notch Filter natural frequency	0.0	100.0	50.0	Hz	10
TLESS_NOTCH_FB	P326 - Tless Notch Filter bandwidth	0.0	100.0	25.0	Hz	10
TLESS_OFF_MAX	P327 - Tless maximum voltage offset	0.1	5.0	2.0	% V_NOM	10
TLESS_REG_KP	P328 - Kp Tless regulator gain	0.01	100.00	3.5		100
TLESS_REG_MAX	P329 - Tless regulator maximum output	0	400	200	%	1
TLESS_REG_TF	P330 - Tf Tless regulator filter time constant	0.0	3000.0	0.0	ms	10
TLESS_REG_TI	P331 - Ti Tless regulator lead time constant	0.1	3000.0	50	ms	10
TLESS_U_KP	P332 - Tless U amplitude compensation	0.0	200.0	100.0	%	10
TLESS_W_KP	P333 - Tless W amplitude compensation	0.0	200.0	100.0	%	10
KT	P334 - Multiplier	1.0	100.0	1.0	p.u.	10
PRC_DELTA_VRG	P335 - Voltage drop due to total resistor toward the grid	0.01	100.00	10.0	%	100
TLESS_IDC_U	D400 - Tless Idc U current	0	32.767	0	A	1000
TLESS_IDC_W	D401 - Tless Idc W current	0	32.767	0	A	1000

4 GENERIC PARAMETERS

4.1 KEYS

Name	Description	Min	Max	Default	UM	Scale
RES_PAR_KEY	P60 - Access key to reserved parameters	0	65535	0		1
TDE_PAR_KEY	P99 - Access key to TDE parameters	0	19999	0		1
RES_PAR_KEY_VAL	P100 - Value off access key to reserved parameters	0	19999	95		1

P60 and P99 are two parameters that if correctly set allow some reserved parameter (only at a standstill). In particular:

- If the value of P60 is the same of the key is possible to modify the reserved parameters
- If the value of P99 is the same of the key is possible to modify the TDE parameters

4.2 DATA STORING

Name	Description	Min	Max	Default	UM	Scale
PAR_ACT_BANK	C60 - Parameter bank active	0	1	0		1
DEF_PAR_RD	C61 - Read default parameters	Range		0		1
		0	No			
		1	All Parameters			
		2	Only App Parameters			
EEPROM_PAR_RD	C62 - Read parameters from EEPROM	Range			1	
		0	No			
		1	Yes			
		2	Restore factory par			
EEPROM_PAR_WR	C63 - Save parameters in EEPROM	0	1	0		1
ALL_COUNT_RESET	C44 - Reset alarms counters	0	4	0		1
K_V_GRID_TDE	Factory corrective Factor for AC Grid Voltage	25.0	200.0	100.0	%	10
OFFSET_AO1_TDE	Factory corrective offset for A/D 1	-100.0	100.0	0.0	%	327.67
OFFSET_AO2_TDE	Factory corrective offset for A/D 2	-100.0	100.0	0.0	%	327.67
V_GRID_AMPL_COEFF_TDE	Factory corrective factor for Line voltage amplitude coefficient	0.0	200.0	100.0	%	163.84
OFFSET_L1_TDE	Factory corrective offset for line voltage L1	-16383	-16383	0		1
OFFSET_L2_TDE	Factory corrective offset for line voltage L2	-16383	-16383	0		1
OFFSET_AI1_TDE	Factory corrective offset for analog reference 1 (AI1)	-100.0	100.0	0.0	%	163.84
OFFSET_AI2_TDE	Factory corrective offset for analog reference 2 (AI2)	-100.0	100.0	0.0	%	163.84
OFFSET_AI3_TDE	Factory corrective offset for analog reference 3 (AI3)	-100.0	100.0	0.0	%	163.84
KP_DCBUS_TDE	Factory corrective factor for Bus voltage	0.0	200.0	100.0	%	10
KP_REACT_THERM_PRB_TDE	Factory multiplication factor for motor PTC/NTC/KTY84 analog reference value	0.0	200.0	100.0		163.84
KP_CONV_THERM_PRB_TDE	Factory multiplication factor for radiator PTC/NTC analog reference value	0.0	200.0	100.0		163.84

4.2.1 STORAGE AND RECALL OF THE WORKING PARAMETERS

In the MCU (Microcontroller Control Unit) of the power converter, there are several types of memory that coexist:

1. **Non-permanent work memory (RAM)**: This is used for the operation of the converter. Parameters are temporarily stored here during operation, but they are lost if the power supply is interrupted.
2. **Permanent work memory (EEPROM)**: This memory stores the actual working parameters, which are used in sequence. These parameters remain intact even if the power is turned off, provided **C63 = 1** (Save Parameters on EEPROM).
3. **Permanent system memory**: This memory contains the default parameters of the system.

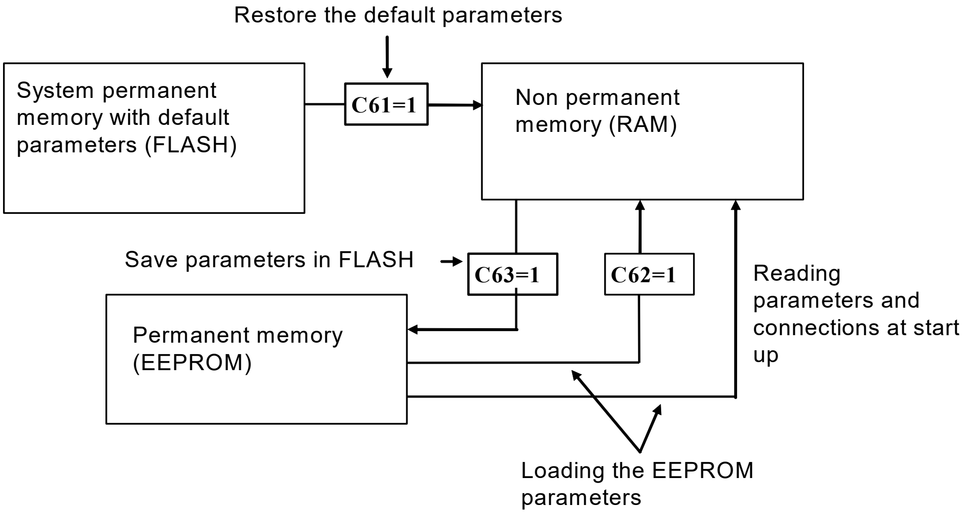
Upon startup, the drive transfers parameters from the permanent system memory to the working memory in order to begin operation. Any changes made to the parameters are stored in the work memory but will be lost if the power is interrupted unless explicitly saved to permanent memory.

If you want to restore the work memory to a previous known state after modifications, you can load the parameters from the permanent memory by setting **C62 = 1** (Load EEPROM Parameter).
In the event that the parameters in EEPROM change unexpectedly, you should load the default parameters from the system memory using **C61 = 1** (Load Default Parameters).

After correcting any issues, save the updated parameters back into the permanent work memory by setting **C63 = 1** (Save Parameters on EEPROM).

It is possible to save the data in permanent memory while the drive is in the **ON/RUN** state. However, loading parameters can only be done when the drive is in the **OFF/STOP** state, after opening the key to reserved parameters.

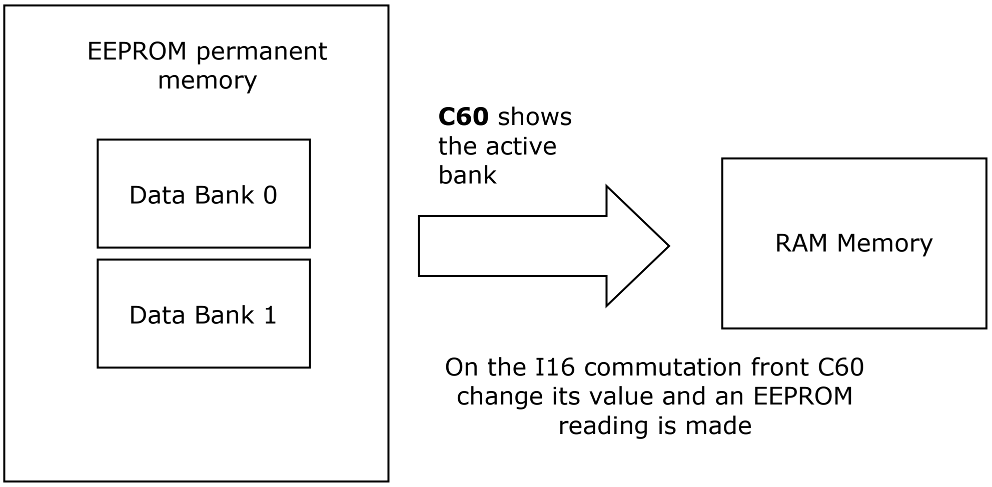
When writing to permanent memory (**C63 = 1**), the data is immediately read after it is written. If any inconsistency is detected, **alarm A1.2** will be triggered. In this case, reset the alarm and attempt to save the data again.



Since the default parameters are typically different from the personalized settings, it is important to create an accurate backup of the permanent memory parameters after the installation of each drive. This backup ensures that you can restore the exact configuration in case of a drive replacement or failure. By keeping a copy of these parameters, you can easily reproduce the settings on a new drive, minimizing downtime and ensuring that the system operates with the same parameters as before the replacement.

4.2.1.1 ACTIVE BANK PARAMETERS

This function allows to switch over the internal sets of parameters and connections between two distinct memory banks (drive must be switched off, no RUN).
To activate this function, it is necessary to use the logic input I16, configuring it on a logic input on both banks. The connection C60 indicates the actual data bank in the permanent memory: C60=0 bank 0; C60=1 bank 1. The commutation of the function logic stage I16 brings an automatic variation of data of C60 and a successive automatic reading of data from the permanent memory.



For initial configuration of the input function I16, follow these steps:

1. Prepare in RAM, the data in bank 0, configuring input function I16 and holding it to a low logic level (make sure C60=0).
2. Save to the permanent memory with C63=1.
3. Always keep I16=L, prepare in RAM the data from bank 1, configuring the same input to the function I16.
4. Set C60=1 and save the data in the permanent memory with C63=1.
5. At this point, changing the state of logic input corresponding to function I16, the bank's commutation will have automatic reading

4.2.1.2 RESTORE FACTORY PARAMETERS

When the drive exits the BDF DIGITAL mode, its data is stored in permanent memory, including factory parameters and firmware revision. These parameters can be restored later by setting **C62=2**.
The behavior of the drive during this restoration depends on the current firmware revision:

- **If the current firmware revision is the same as when the drive exited BDF DIGITAL** (i.e., the "FACTORY_FW_REV"), all core parameters and connections are reloaded, regardless of the status of the keys.
- **If the current firmware revision is different**, the drive will load the default core parameters and connections, except for certain parameters such as **P94**, **P100-P120**, **P154-P157**, **P167**, **P198**, **P199**, **C23**, **C24**, **C45**, **C58**, and **C98**. These parameters will not be overwritten.

In all cases, **application parameters** will revert to their default values, and **Profibus**, **Anybus**, and **monitor configuration data** will also be reset to their default values.
If the factory data is found to be invalid, **alarm A1.1** will be triggered, and all default parameters will be loaded.

4.3 DIGITAL COMMANDS AND CONTROL

Name	Description	Min	Max	Default	UM	Scale
DISP_WAIT_TIME	P112 - Wait time for display stand-by state	3	20	1	s	1
ALL_ENAB	P163 - Alarm enable	-32768	32767	-1	Hex	1
DISPLAY_SEL	C14 - Display selection	0	127	0		1
SW_RUN_CMD	C21 - Run software enable	0	1	1		1
CONV_SW_EN	C29 - Converter software enable	0	1	1		1
ALL_RESET	C30 - Alarms reset	0	1	0		1
ALL_COUNT_RESET	C44 - Reset alarms counters	0	4	0		1
EN_BOOT	C98 - Enable boot mode	0	1	0		1
EN_PF_RES	C99 - Enable Power Fault reset	0	1	0		1
VOLT_ISR	Voltage routine duration			0	us	64
I_ISR	Current routine duration			0	us	64
APP_FAST_ISR	Application fast task duration			0	us	64
APP_AVBLE_FAST_ISR	Application fast task available time			0	us	64
DRV_F_PWM_MAX	Max PWM frequency available			0	Hz	1
WORK_HOURS	D49 - Work Hours			0	hours	1
SERIAL_NUMBER	D59 - Converter Serial Number			0		1
PWM_COUNTER	ISR counter			0		1
SW_RESET_CNT	Software reset occurs			0		1

The “DRV_F_PWM_MAX” is the maximum PWM frequency allowed with the functions enabled.

4.3.1 CONVERTER READY

The Converter Ready condition (**o.L.0=H**) is given by alarms are not active and at the same time both the software and hardware enables:
* The software enable, given by state of the connection **C29**, (C29=1 of default).
* The external enable (the function of the input is assigned to the default input L.I.2)
If an enable is missing or an alarm is active, the ready drive signal goes into an non-active state o.L.0=L and this state remains until the causes that brought about the alarm conditions are removed and the alarms are reset. An alarm reset can be achieved by activating the function “Alarm reset” that, by default, is assigned to input L.1 (or setting C30=1).
Keep in mind that the “Alarm reset” is achieved by the active front of the signal, not on the active level.

4.3.2 CONVERTER SWITCH ON / RUN

When the converter is “Ready to switch on / RUN” o.L.0=H, AFE may start running “Converter switch on/run” o.L.3=H, by activating both the hardware and software switch on enables:
* Function “Logic switch on/RUN input” (default input 4 assigned) RUN=H
* Software switch on/RUN C21 (C21=1) is active by default.
Switch on/RUN disable and enable (from STOP offline, to RUN online) is given by the logic of the following table:

Converter ready o.L.0	Switch on / RUN	C21	ON-LINE
L	X	X	L
H	L	X	L
H	X	0	L
H	H	1	H

It is mentioned that the input function “Switch on/RUN input” can be given also via serial line or field-bus. See for details the Standard Application Manual.

4.4 PWM SYNCHRONIZATION (STANDARD APPLICATION)

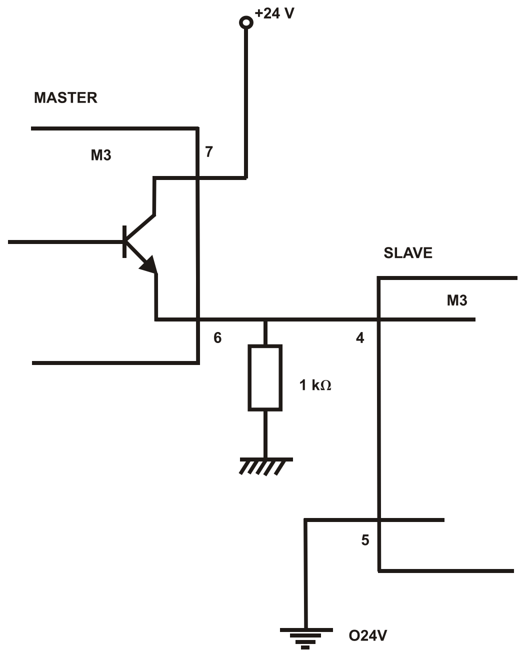
Name	Description	Min	Max	Default	UM	Scale
SYNC_REG_KP	P11 - CanOpen SYNC loop regulator Proportional gain	0	200	5		1
SYNC_REG_TA	P12 - CanOpen SYNC loop regulator lead time constant	0	20000	400		1
PWM_SYNC_OFFSET	PWM offset for SYNC delay control			0	pulses	1
PWM_SYNCHRONIZATION	C23 - Pwm Synchronization	0	10	0		1

This function allows for the synchronization of two or more power converters at the PWM level. Some parameters related to this functionality can be found in this sub-menu, while others are located in the **PWM Synchronization** menu of the Application. Please refer to this menu as well. **Parameter E87** is used to select the drive's function:

1. **Master**: Every PWM period, the third digital output (O3) is configured as the PWM synchronization output.
2. **Slave**: The eighth physical input (I08) is used to synchronize the drive.

In the slave configuration, a tracking loop is employed with a gain **Kp** (set by parameter **P11**) and a time constant **Ta** (set by parameter **P12**). Additionally, it is possible to set the phase difference between the master and slave drives using parameter **E88**.

Note 1: The master and slave drives must be set to the same PWM frequency (**P101**).
Note 2: If the PWM frequency exceeds 5 kHz, a **1 kΩ, 1 W pull-down resistor** is required.



5 CATALOG STANDARD APPLICATIONS

The functions seen in previous chapter refer to the standard application, in the application “catalog” (downloadable from AFE “application” project) these functions can’t be present, so please refer to the application manual itself for more details.
Some functions, however, depend on the core and they are otherwise present both in the standard application and in the catalog application.
Following be repeated all the functions seen previously, noting which ones are always present.

Parameters:
P00-P199 are common to all applications (standard and catalog),
E00-E99 instead depend on the type of application.

Connections:
C00-C99 are common to all applications (standard and catalog),

Internal values:
d00-d63 are common to all applications (standard and catalog),
d64-d99 instead depend on the type of application.

5.1 CURRENT REFERENCE

Name	Description	Min	Max	Default	UM	Scale
EN_CURR_REF	E25 - Enable application current reference	0	1	0		1
IQ_REF	E00 - Reference active current Iq	-100	100	0	% I_CONV_NOM	100
ID_REF	E01 - Reference reactive current Id	-100	100	0	% I_CONV_NOM	100

Alternatively, instead of using DC Bus Voltage Control, a **Current Reference Mode** of operation can be used. By setting **E25=YES**, the DC Bus Voltage Control is disabled, and the user can work exclusively with **Active** and/or **Reactive current references** using parameters **E00** and **E01**.

Note: In this mode, the current flowing from the converter to the grid is considered as a positive value.

5.2 GRID ISLAND CONTROL

Name	Description	Min	Max	Default	UM	Scale
I_PV_MAX	E30 - Maximum PV input current	0.0	2000.0	0.0	A	10
Tau_Ipv_filter	E37 - Time constant Ipv filter	10	999	10	Ms	1
Kmult_Ipv	E38 - Kmult_IPV	0	200	100	%	1
VB_MAX	E55 - V Bus Max Limit in CSI	0.0	1200.0	0.0	V	1
VB_MIN	E56 - V Bus Min Limit in CSI	0.0	1200.0	0.0	V	10
KP_VB_LIM	E57 - Kp V Bus limit in CSI	0.0	300.0	1.0		10
TI_VB_LIM	E58 - Ti V Bus Limit in CSI	0.0	3000.	60.0	Ms	10
TF_VB_LIM	E59 - Tf V Bus Limit in CSI	0.0	3000.0	0.0	Ms	10

5.3 APPLICATION INTERNAL VALUES

Name	Description	Min	Max	Default	UM	Scale
Ipv_	D65 - PV current			0	A	32

5.4 DRIVE 2 DRIVE CAN

This feature enables the operation of two or more AFE converters in parallel, where one **MASTER** node runs with both voltage and current closed loops, and the other **SLAVE** nodes operate with current control only.

The **MASTER** node calculates its own current references through its voltage closed loop and communicates these active and reactive current references to the **SLAVE** AFE converters via the CAN B network.
This function allows for the reading and writing of current references for the AFE converters via the CAN B network (please refer to the installation manual for further details).
The feature can be enabled using **E31**:

- The **MASTER** node is responsible for writing its active and reactive current references (calculated through its voltage loop, i.e., osc51) over the CAN B network.
- The **SLAVE** node reads the current references from the **MASTER** node on the CAN B network and applies them as its own current references.

E32 is used to specify the **MASTER** node addres, and **D64** and **D67** display the current references received by the **SLAVE** node.

<table>
<tr><th>Name</th><th>Description</th><th>Min</th><th>Max</th><th>Default</th><th>UM</th><th>Scale</th></tr>
<tr><td>CAN2_EN</td><td>E31 - Current reference via CAN2 config.</td><td colspan="2">Range
0 Disable
1 Master curr ref
2 Slave curr ref</td><td>0</td><td></td><td>1</td></tr>
<tr><td>CAN2_MASTER_NODEID</td><td>E32 - CAN2 Master NodeID</td><td>0</td><td>127</td><td>1</td><td>hex</td><td>1</td></tr>
<tr><td>ID_REF_CAN2</td><td>D64 - Id reference from CAN2</td><td>-200.0</td><td>200.0</td><td>0</td><td>% I_NOM</td><td>40.96</td></tr>
<tr><td>IQ_REF_CAN2</td><td>D67 - Iq reference from CAN2</td><td>-200.0</td><td>200.0</td><td>0</td><td>% I_NOM</td><td>40.96</td></tr>
</table>

6 ALARMS

6.1 MAINTENANCE AND CONTROLS

The converter is equipped with a range of protection functions that activate in the event of a fault to prevent damage. When a protection switch is triggered, the converter's output phases (U, V, W) are blocked, and the DC Bus Voltage control is disabled.

If one or more protection switches (alarms) are triggered, they are displayed on the screen, causing the display to flash. The 7-segment display will cycle through all active alarms, showing them in hexadecimal format.

In the event of a converter failure or alarm activation, check for potential causes and take appropriate action. If the cause cannot be identified or if faulty components are found, contact BDF DIGITAL and provide a detailed description of the issue and the circumstances.

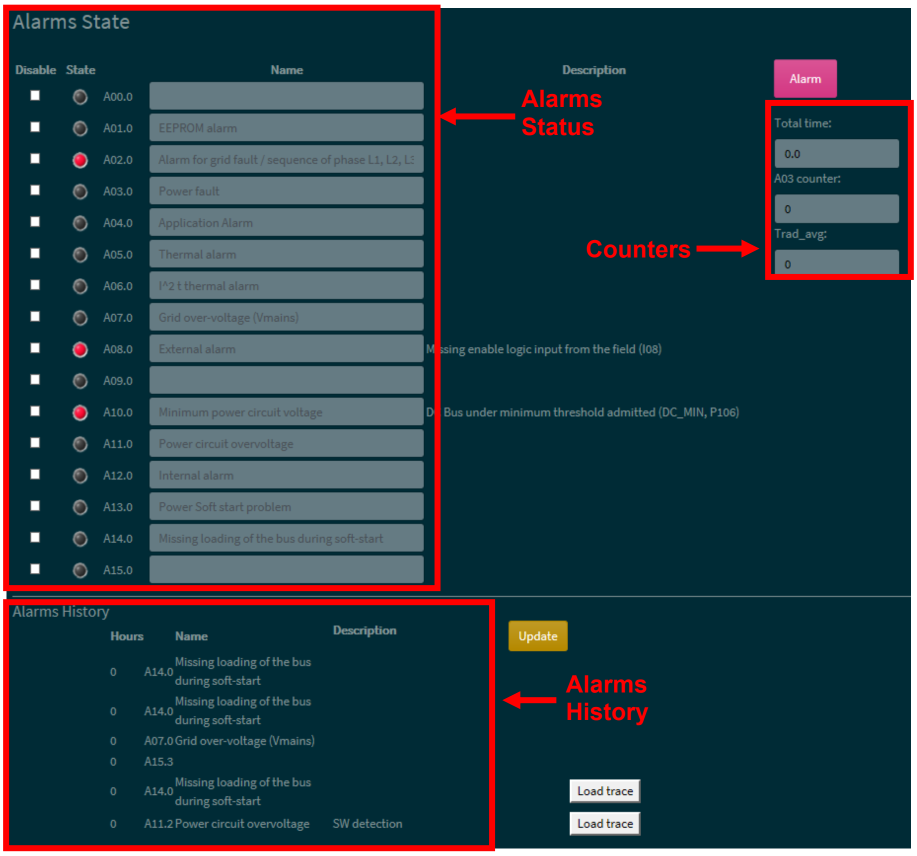
The alarm indications are categorized into 16 groups (A0–A15), and each alarm may have a specific code (AXX.YY) to further identify the nature of the fault.

ALARM			DESCRIPTION	CORRECTIVE ACTION
HEX	DEC			
A.1.0.H	A1.0	Loaded default parameters	EEPROM data related to a different core	It's possible to reset this alarm but keep attention: now all parameters have its default value.
A.1.1.H	A1.1	EEPROM Read failure	A Check Sum error occurred while the EEPROM was reading the values. Default values loaded automatically.	Try rereading the values with the EEPROM. The reading may have been disturbed in some way. If the problem continues contact TDE as there must a memory malfunction.
A.1.2.H	A1.2	EEPROM Write failure	When data is being written in the EEPROM the required values are always shown afterwards: an alarm triggers if differences are detected.	Try rewriting the values in the EEPROM. The information may have been disturbed in some way. If the problem continues contact TDE as there must be a memory malfunction.
A.1.3.H	A1.3	EEPROM Read and write failure	Alarms A1.1 and A1.2 appears	There are some problems with EEPROM.
A.1.4.H	A1.4	Data storing not completed	During data storing was switched off the regulation card	It's possible to reset this alarm but keep attention: now all parameters have its default value.
A2.0 H	A 2.0	Alarm for grid fault / sequence of phase L1, L2, L3 not connected	The grid voltage amplitude (D21) read with the synchronization signal is below threshold P50.	If the grid voltage has not been connected to the AFE, this is a normal alarm. Otherwise check the connection on the grid side and the synchronization signals.
A2.1h	A 2.1	LVFRT routine has identified a fault	A Low-Voltage Fault transient has been detected	No action The converter is waiting for grid voltage during a low-voltage fault: if the voltage will return within allowed (frequency and voltage module) thresholds, AFE will restart automatically, otherwise a A 2.0 alarm will appear
A.3.0.H	A3.0	Power fault	The converter output current has reached a level that has set off an alarm; this may be caused by an overcurrent due to leakage in the wires. There may also be a fault on the regulation card or a problem in the synchronization wires.	Check the connection wires on the line side, in particular on the terminals, in order to prevent leakages or short circuits. Check that the connections of the synchronization circuit is correct according to the Installation manual (OPDE_AFE_INSTALLATION).
A.4.0.H	A4.0	Application alarm	This alarm is application specific. Please refer to specific documentation	
A.5.0.H	A5.0	Thermal alarm. Reactor temperature too high	Connection C46 runs a range of motor heat probes. If C46=1 or 2, a PTC/NTC is being used and its Ohm value (d41) has breached the safety threshold (P95). If C46 = 3 a digital input has been configured to I23 logical input function and this input is in not active state. If C46=4, a KTY84 is being used: the temperature reading (d26) must be higher than the maximum temperature (P91).	Check the temperature reading in D26 and then check the reactor. With a KTY84, if -273.15 appears the electrical connection towards the reactor heat probe has been interrupted. If the reading is correct and the reactor is overheating, check that the reactor cooling circuit is intact. Check the fan, its power unit, the vents, and the air inlet filters on the cabinet. Replace or clean as necessary. Ensure that the ambient temperature around the reactor is within the limits permitted by its technical characteristics.

ALARM			DESCRIPTION	CORRECTIVE ACTION
HEX	DEC			
A.5.1.H	A5.1	Thermal alarm. Heat sink temperature too high	The heatsink temperature (d25) is higher than the maximum (P118).	Check the temperature read in D25 and then check the heat sink. If -273.15 is displayed, the electrical connection towards the heat sink heat probe has been interrupted. If the reading is correct and the reactor is overheating, check the converter cooling circuit being intact. Check the fan, its power unit, the vents, and the air inlet filters on the cabinet. Replace or clean as necessary. Ensure that the ambient temperature around the converter is within the limits permit-ted by its technical characteristics. Check parameter P118 is set correctly
A.5.4.H	A5.4	Thermal alarm. Reactor thermal probe not connected	Thermal probe of the reactor not detected	Check the connection of the probe.
A.5.5.H	A5.5	Thermal alarm. Run with T_heat_sink too high	Run with T_heat_sink > P119	Check the heat sink temperature (d25)
A.7.0.H	A7.0	Grid over-voltage (Vmains)	The grid voltage amplitude (d21) read with the synchronization signal increase over threshold P51.	Grid fault or distribution grid not adequate to the load conditions.
A.8.0.H	A8.0	External alarm. Missing enable logic input from the field (I08)	A digital input has been configured to I02 logical input function and this input is in not active state	The external safety switch has cut in disabling drive enable. Restore and reset. The connection has been broken. Check and eliminate the fault. Input function has been assigned, but enable has not been given. Authorize or do not assign the function.
A.8.1.H	A8.1	Watchdog alarm LogicLab	A LogicLab watchdog alarm on slow cycle appears	Check if the LogicLab slow task duration is greater than 500 ms and try to reduce this execution time
A.8.2.H	A8.2	Fast task LogicLab too long	The LogicLab fast task is too long in time	Try to reduce the LogicLab fast task execution time under admitted limit. Please refer to the specific documentation.
A.8.3.H	A8.3	Application out of service	There is no valid application running in the drive	Reload the application using OPDExplorer
A.A.0.H	A10.0	Minimum power circuit voltage. DC Bus under minimum threshold admit-ted (DC_MIN, P106)	DC Bus voltage (D24) has dropped below the minimum value (P106).	If the grid voltage has not been connected to the AFE, this is a normal alarm. Otherwise, a grid fault occurred, or the distribution grid is not adequate to the load conditions.
A.b.1.H	A11.1	Power circuit overvoltage. HW detection	DC Bus voltage (D24) has exceeded the HW threshold.	Verify if the parameter P31, P32, P33 are suitable for the application. Check if the power regenerated from the DC Bus to the grid is lower than the maximum regenerating power (P40, P42)
A.b.2.H	A11.2	Power circuit overvoltage. SW detection	DC Bus voltage (D24) has exceeded the threshold P107	
A.b.3.H	A11.3	Power circuit overvoltage. HW + SW detection	A11.0 and A11.1 appears	
A.C.0.H	A12.0	Software alarm	C29 different from 1	Check and enable connection C29 “Converter software enable”
A.C.1.H	A12.1	Run without power soft start	RUN without Power Soft start	Check why the Power Soft start isn’t enabled
A.C.2.H	A12.2	Run in VSI mode with microgrid external contactor not open	Run in VSI mode with microgrid external contactor not open for microgrid resynchronization	Check that digital signal that switches between CSI and VSI mode via i20 is connected also to i09 (at list in a logical AND) so that when the microgrid is force to work in standalone mode, a request of contractor opening arises to I09
A.C.3.H	A12.3	Mismatch of microgrid external contactor command (O30) versus status (I07)	Mismatch of microgrid external contactor command (O30) versus status (I07) for microgrid resynchronization	Check cablings from converter to external contactor used for microgrid connection to main grid (both for coils and for state contacts); check for possible damage on the external contactor or on the driving stage of the converter
A.C.4.H	A12.4	Transformer-less - Idc overcurrent	Too high DC current injection into the grid detected	Check for faults on external LEM current sensor for transformerless operation or on the cabling. Verify the setting of transformerless parameters (refer to specific paragraph on Transformer-less
A.d.2.H	A13.2	Excessive Ripple on DC Bus	A big variation on DC Bus has been detected	Verify if all three main phases are present on connector L1,L2,L3 and their rms value.
A.E.0.H	A14.0	Missing loading of the bus during precharge	The grid voltage amplitude (D21) read with the synchronization signals is within the allowable range, but the DC Bus has not been precharge.	Check the power connections towards the grid.

6.1.1 ALARM HISTORY

The alarms switched on during the normal converter running are saved into the not volatile memory. This alarm history contains all the alarm events happens during converter's life and it's very useful when converter needs a check up after a fault or a malfunction.
These info are available only by supervisor OPDExplorer (click in "Alarms" section). In a typical case it shows:



In the "Real time alarm state" are indicated the actual active alarms and, if they're present, the "Drive status" moves to "Alarm" and lights on in yellow. Every alarm has a description that help to know the cause of it.
Clicking in "Disable" the corresponding alarm is hide and it never switch on again; pay attention that disable an alarm doesn't mean that its cause is fixed.

Every time the drive goes in alarm status the event is reported and saved in the alarm history with its description and the hour of working in which the alarm signal is switch on. There is the possibility to load a trace in the "Real-time graph" in order to plot the main tracks behavior in the moment of alarm activation. To load these traces move to "Real-time graph", press the "Read Config" icon, back in "Alarms" and click in "Load trace"; now in "Real-time graph" click "download".

In the counters window are saved:

- Number of working hours;
- Number of times A.03 alarm is switched on;
- The average temperature of cooling radiator when drive running.

7 DISPLAY

7.1 PHYSICAL DISPOSITION

The keypad has three buttons, "●" (**S** selection), "▼" (**-** decrease), "▲" (**+** increase) and a four numbers and half display, with the decimal points and the sign "**-**".

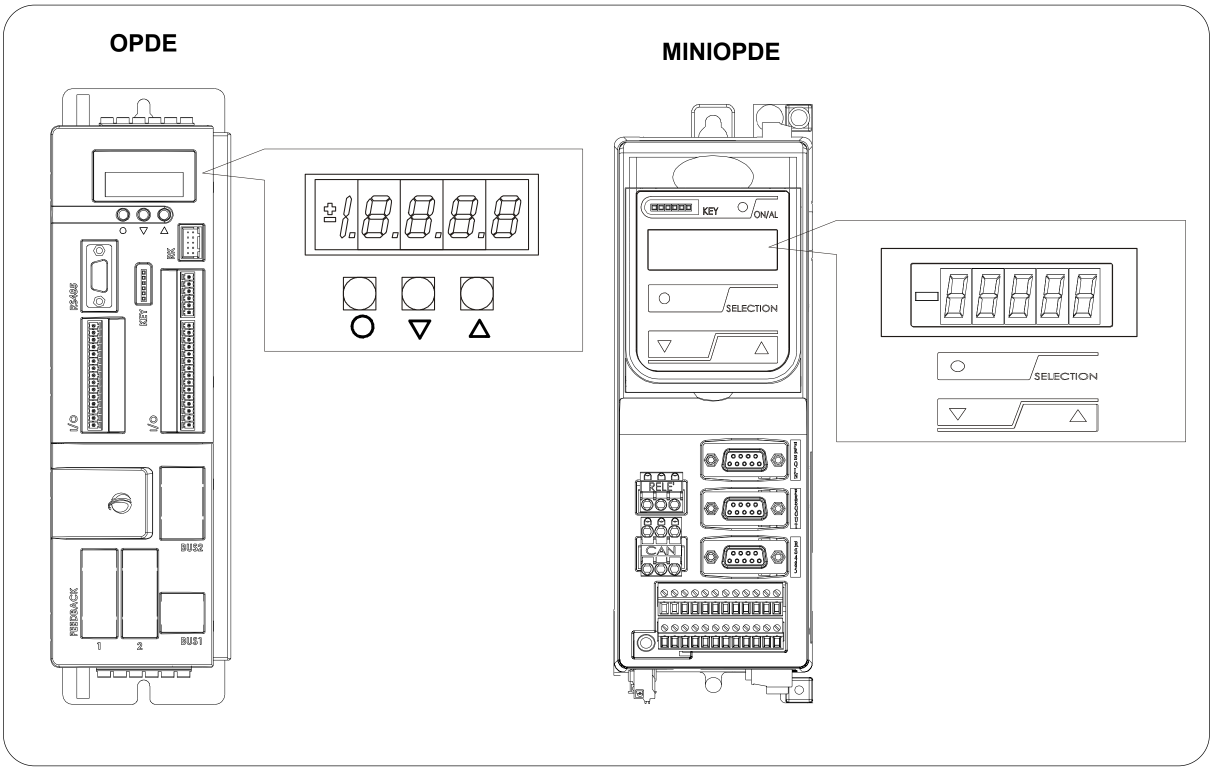


FIG. 1 (Physical disposition)

7.2 LAYOUT OF THE INTERNAL VARIABLES

The converter is fully digital, so no additional hardware settings are required, unless configured at the factory. All setups, configurations, and visualizations are managed digitally via the keypad and display, serial line, or fieldbus. To facilitate easy access to various parameters and mnemonics, all accessible values are organized into the following menus:

- **Parameters (PAR)**
- **Application Parameters (APP)**
- **Connections (CON)**
- **Internal Values (INT)**
- **Alarms (ALL)**
- **Digital Inputs (INP)**
- **Digital Outputs (OUT)**
- **Utility Commands (UTL)**
- **Fieldbus Commands (FLB)**
- **USB Port Commands (USB)**

Within each menu, variables are arranged in a progressive order, and only the relevant and currently used variables are displayed.

7.2.1 PARAMETERS (PAR)

These are defined parameters for variables that have specific settings, where their numerical value holds an absolute meaning (e.g., P63 = nominal motor frequency = 50 Hz) or a proportional value within a defined range (e.g., P61 = nominal motor current = 100% of the drive's nominal current). They are classified into:

- Free Parameters: These can be modified at any time (online) during operation.
- Reserved Parameters: These can only be modified offline, with access to the reserved parameters being protected by an access code (P60).
- BDF DIGITAL Reserved Parameters: These are visible after entering the BDF DIGITAL access code (P99) and can only be modified offline.

The specific characteristics of each parameter are identifiable by their code or identification, as described below.

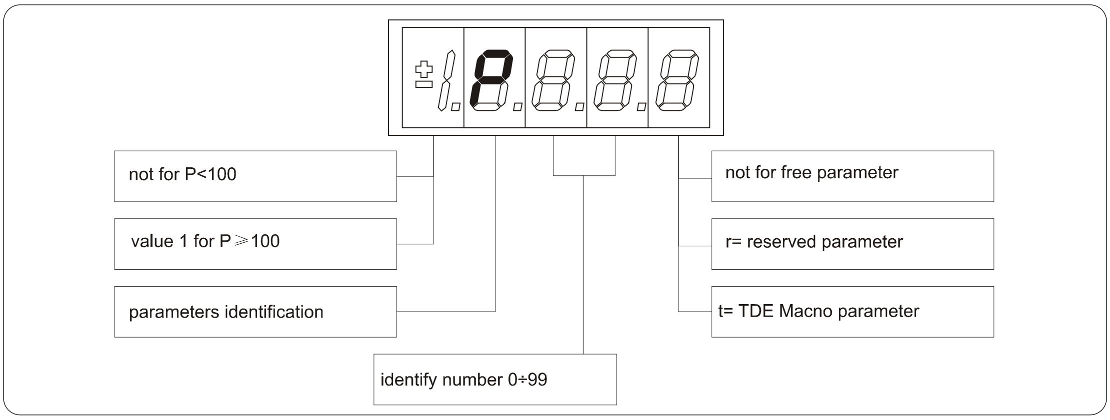


FIG. 2 (Parameters PAR)

For example: P60 r = parameter 60: reserved
1P00 t = parameter 100 BDF DIGITALreserved

7.2.2 APPLICATION PARAMETERS (APP)

For their definition refer to the description of the parameters. They are distinguished in free parameters, some modifiable always (Online), other only to converter not in run (offline), reserved, modifiable only offline and after access code to the reserved parameters (P60). The characteristics of each parameter are recognizable from the code of identification as below:

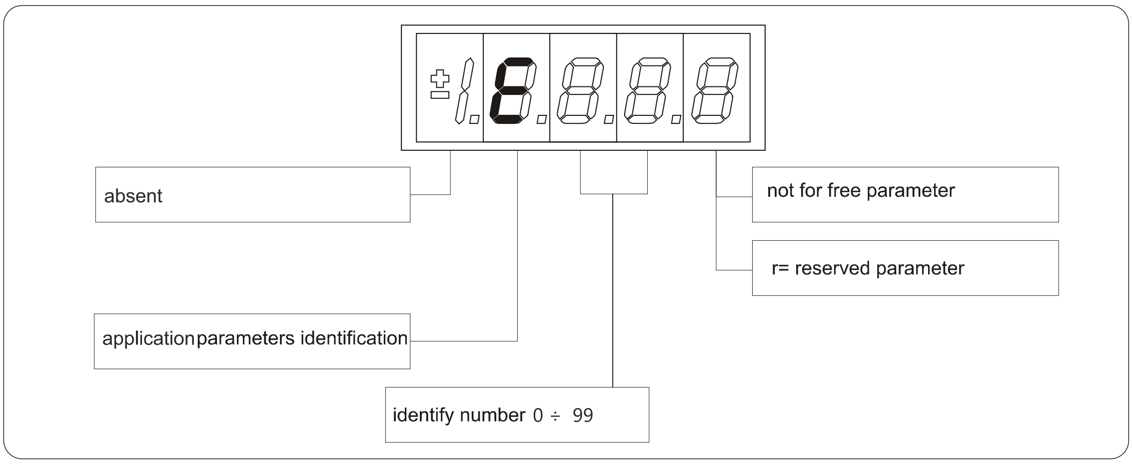


FIG. 3 (Application Parameters PAR)

For example: E03 r = application parameter 03: reserved

7.2.3 CONNECTIONS (CON)

They are certain connections that variables approach that are of numerical value comes connected to a function or a clear command {for example: rounded ramp insertion C27= 1; or no rounded ramp, C27= 0; or save parameters on EEPROM memory, C63= 1}. They are in **free** connections, some of the like modifiable always (Online), other with converter in stop (offline) and **reserved**, modifiable only offline and after access code to the reserved parameters (P60), or reserved for the BDF DIGITAL, visible after having written the access code BDF DIGITALparameters (P99) and modifiable only offline.

The characteristics of each connection are individually recognizable of **identification code** as under report.

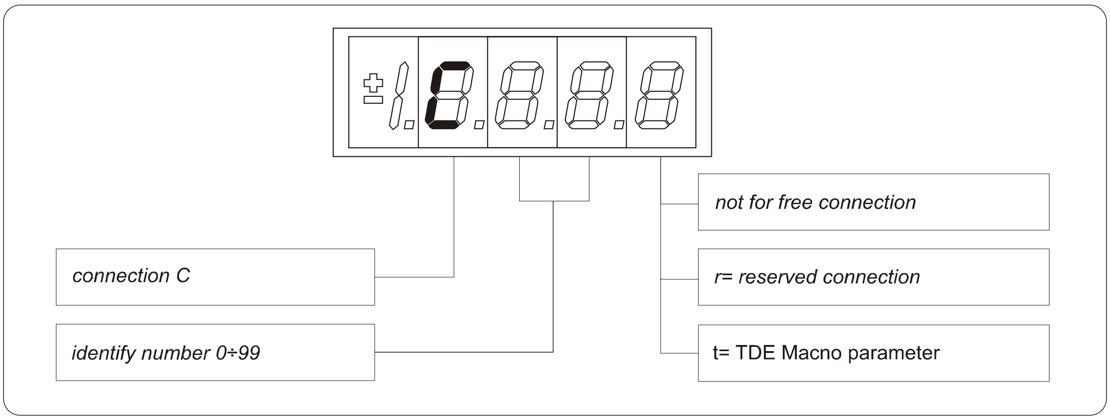


FIG. 4 (Connections CON)

7.2.4 INTERNAL VALUES (INT)

Overall functions of protection of the converter, of the motor or in the application whose status to active alarm or non active alarm it may be visualized in the display. The actived protection, stops the converter and does flash the display, excepted if it is disabled. With a single visualization is possible have all the indications with the following:

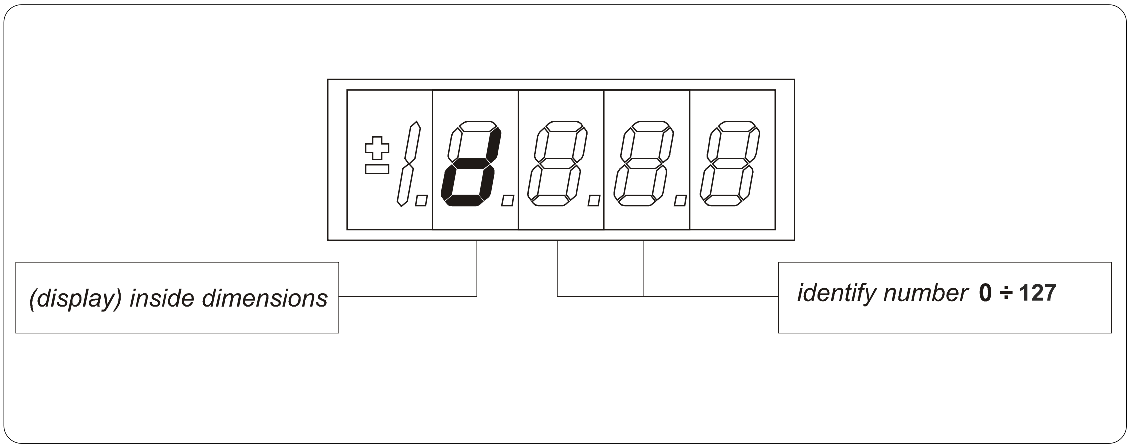


FIG. 5 (Internal Values INT)

7.2.5 ALARMS (ALL)

Overall functions of protection of the converter, of the motor or in the application whose status to **active alarm** or **non active alarm** it may be visualized in the display. The active protection, stops the converter and does flash the display, excepted if it is disabled. With a single visualization is possible have all the indications with the following:

For ex. **A03.L = power fault doesn't activate**

The alarms are all memorized and so they remain till that is not missing the cause of the alarm and have been resetted (input of resetting alarms activate) or (C30 = 1).

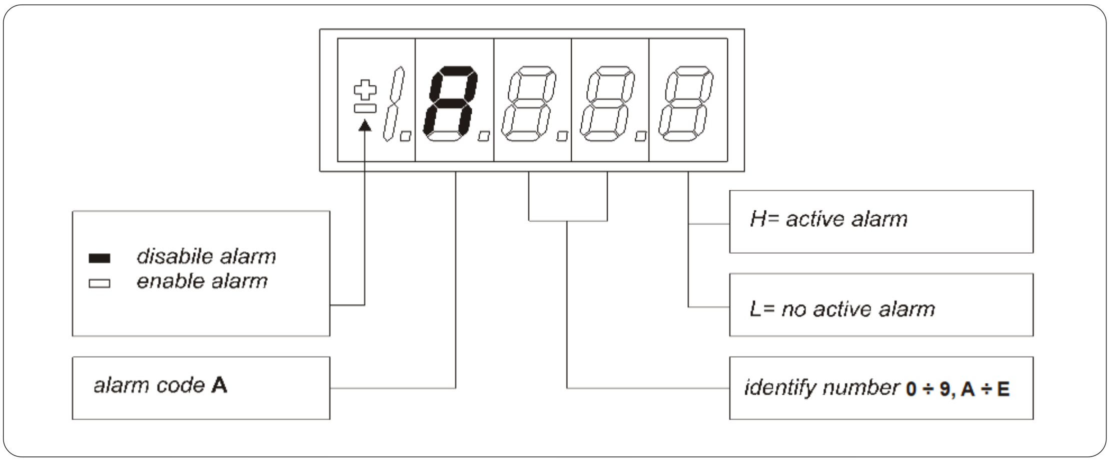


FIG. 6 (Alarms ALL)

7.2.6 LOGIC FUNCTIONS OF INPUT (INP)

The visualization between I00 and I31 is the status of the logical functions of sequence or protection that is assigned in the all digital input of the regulation. From I29 to I31 is the visualization of the status of the input from the power. Code of identification (input) logical input.

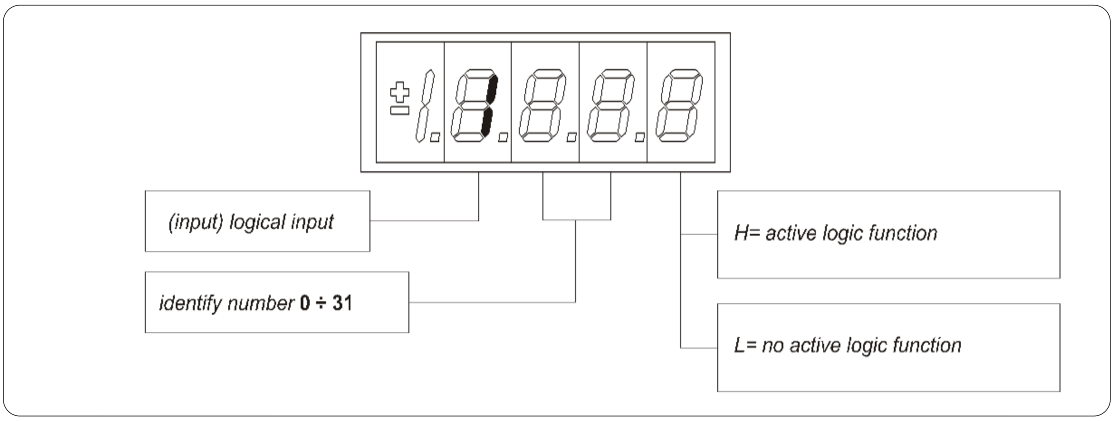


FIG. 7 (Logics functions of input INP)

7.2.7 LOGIC FUNCTIONS OF OUTPUT (OUT)

Visualization of the status, of the logical functions (for example: drive ready, converter in run) scheduled in the control, that may or may not be assigned of predicted digital output. Code of identification:

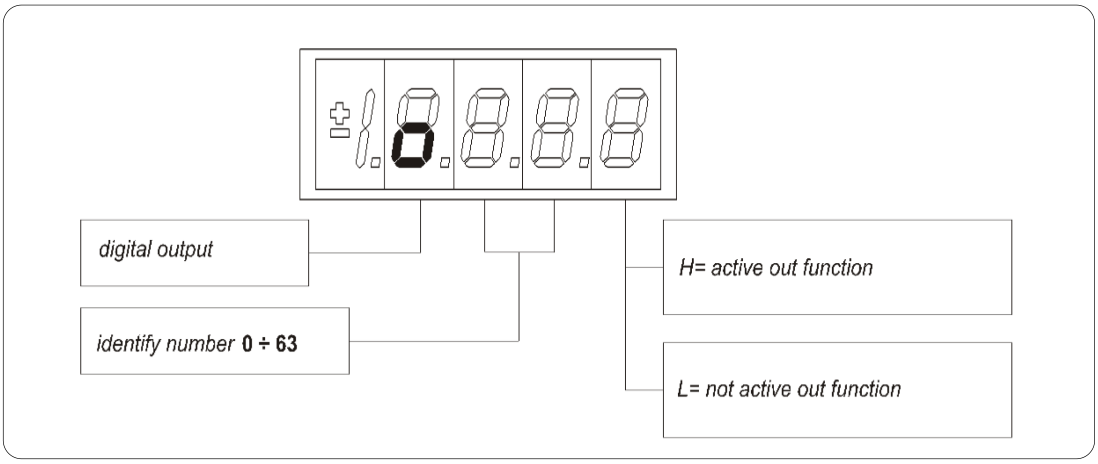


FIG. 8 (Logics functions of output OUT)

7.2.8 UTILITIES COMMANDS (UTL)

They are certain connections that variables approach that are of numerical value comes connected to a function or a clear command. They are only in **free** connections. The characteristics of each connection are individually recognizable of **identification code** as under report:

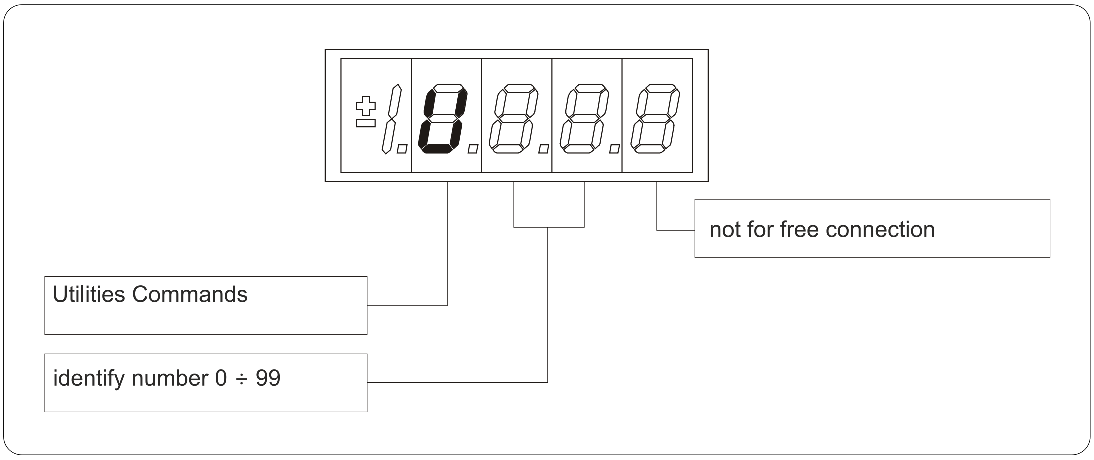


FIG. 9 (Utilities Commands UTL)

7.2.9 FIELDBUS PARAMETERS (FLB)

FLB menu refers to parameters related to Fieldbuses management that was previously accessible only by OPDExplorer as they weren't associated to any “standard” parameter, connection or extra parameter and so not accessible by keypad. Now they are grouped in this new menu, as lists in following tables, and so they can be viewed and changed (if not read-only) by keypad.

Notice that all parameters in FLB menu are not protected by any key nor by run status so they can be changed at any time. Code of identification:

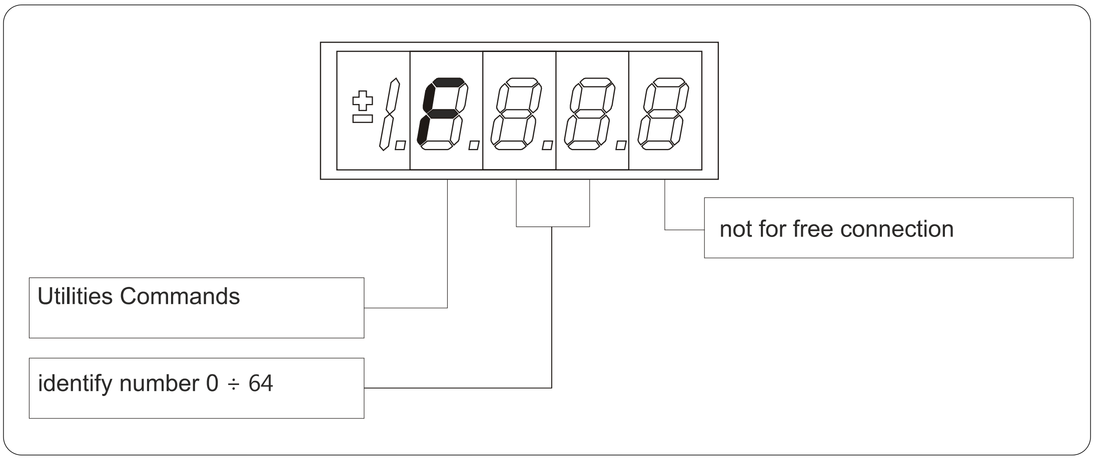


FIG. 10 (Fieldbus Parametrs FLB)

7.2.10 USB PORT COMMANDS (USB)

If the keypad interface to the drive is replaced with a USB port, a new **USB menu** is added, providing commands for data exchange with a USB pen drive. This new functionality allows for the saving of multiple parameter recipes, firmware, and application files on the same pen drive. For more detailed information, please refer to the specific manual available on our website: www.bdfdigital.it under **Product/Download/Manuals/Automation/OPDE family**. The code of identification for this feature is:

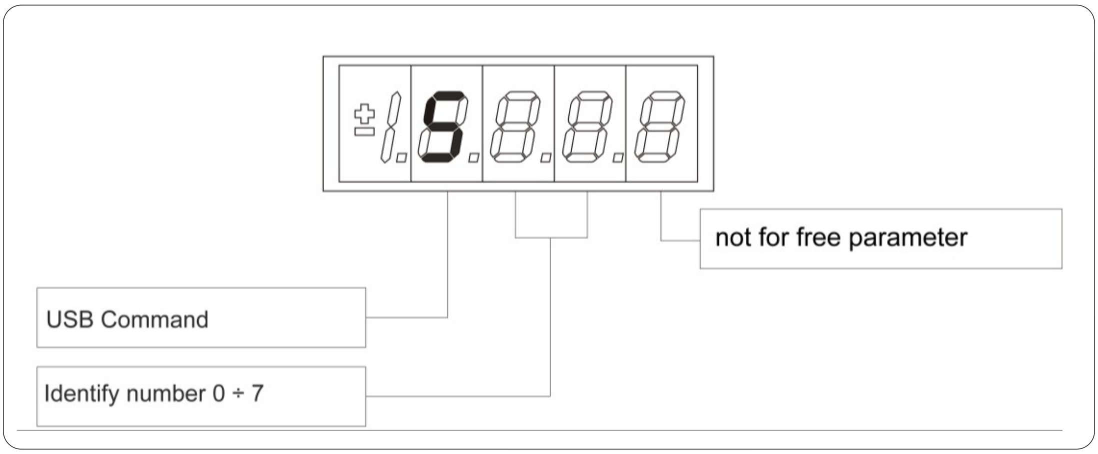


FIG. 11 (USB Commands)

7.3 IDLE STATE

It's the status that the display assumes right after the lighting or when none is programming (P112 seconds, 10 of default, after the last movement, except that is not is visualizing an internal variables, or an input, or a digital output). When the keypad is on idle state, if the converter isn't running, the status "**STOP**" is visualized; if the converter is running the internal values selected with C00 connection or the status "**run**" is visualized. If the converter finds the status alarm, for intervention of one or more protections, the written on the keypad start to flash and they come visualized all the active alarms (one by one).

7.4 MAIN MENU

Leaving from the status of rest pressing the "**S**" key the principal menu is gone into of circular type that contains the indication of the type of visualizable variables:

- **PAR** = Parameters
- **APP** = Application Parameters
- **CON** = Internal Connections
- **INT** = Internal values
- **ALL**= Alarm
- **INP** = Digital Input
- **OUT** = Digital Output
- **UTL** = Utilities commands
- **FLB** = Fieldbus Parameters
- **USB** = USB commands

To change from a list to another enough is necessary to use the "+" or "-" keys and the passage will happen in the order of figure. Once select the list you pass on the relative sub-menu pressing "**S**"; the reentry to the main menu from the following visualizations will be able future through the pressure of the key "**S**" simple or double in brief succession (less in a second), like showed after. The return to the status of rest comes instead automatically after 10 (P112) seconds of inactivity is from some sub-menu that goes by the main menu.

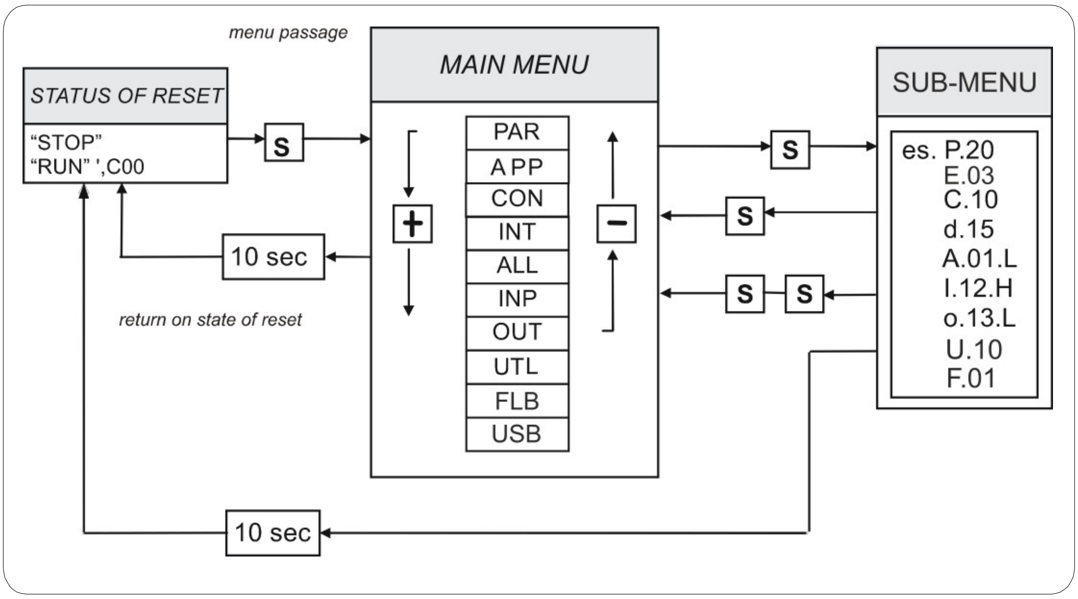


FIG. 12 (Main Menu)

7.4.1 SUB-MENU OF PARAMETERS, APPLICATION PARAMETERS AND CONNECTIONS MANAGEMENT

To navigate through the parameter, application, or connection menus, press "S" to enter the sub-menu list. Once inside, use the "+" or "–" keys to scroll through the parameters or connections, with the list being circular (i.e., it loops back to the beginning after reaching the end).
Each parameter or connection has an identifier:

- The letter "r" indicates the parameter is reserved.
- The letter "t" indicates it is reserved for BDF DIGITAL.
- The letter "n" indicates that the parameter or connection can only be modified when the converter is not in run (i.e., offline).

If a parameter or connection is reserved, you must enter the appropriate access code to modify it:

- "n" type parameters require the converter to be offline and access code P60.
- "r" type parameters require access code P99 to access the reserved BDF DIGITAL parameters.

Press the "S" key to view the value of the parameter or connection. Press it again to return to the list. If you press "S" twice in quick succession (less than 1 second), you'll return to the main menu. If no action is taken within 10 seconds, the system automatically returns to its resting state.
To modify the value of a parameter or connection:

1. Once the parameter is displayed, press both "+" and "–" keys. The first digit's decimal point will begin to flash, indicating that the value can now be modified.
2. Changes can only be made when the converter is offline, and if the parameter is of type "n", you must enter the correct access code (P60). For "r" parameters, access code P99 is required.

After making changes, press "S" again to save and return to the sub-menu list. If you wish to exit without saving changes, simply wait 10 seconds, or press "S" to revert to the original value. The system will automatically return to its resting state after 10 seconds of inactivity

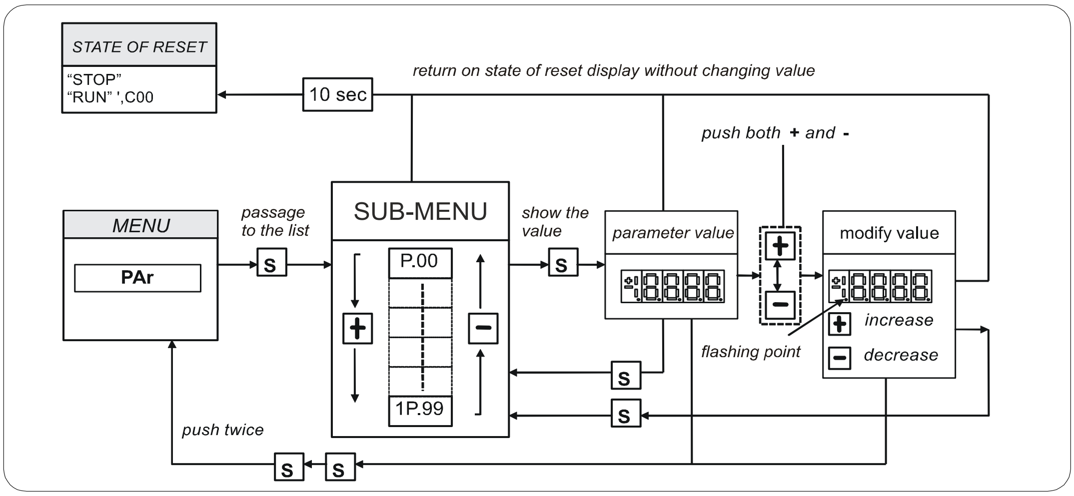


FIG. 13 (Submenu management parameters PAR)

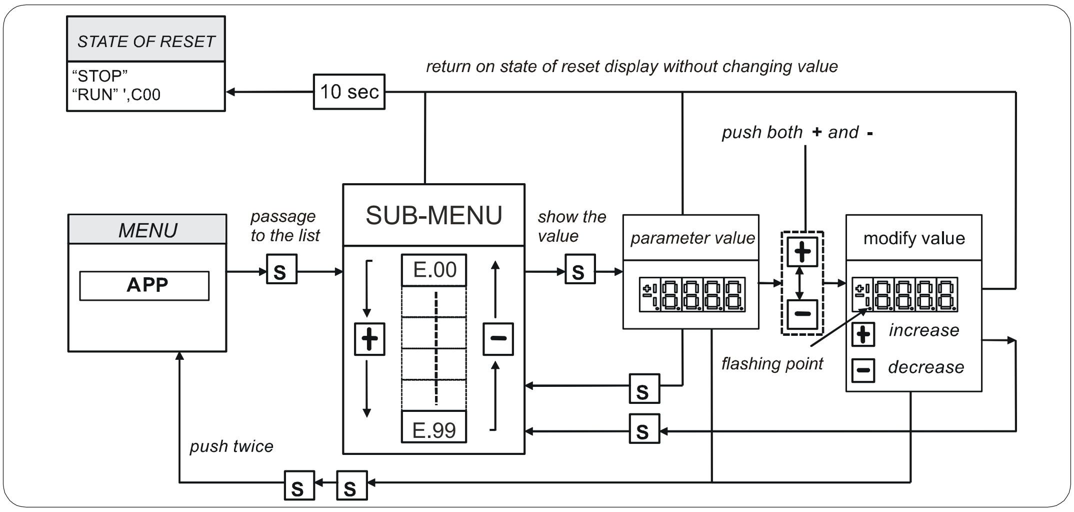


FIG. 14 (Submenu management application parameters APP)

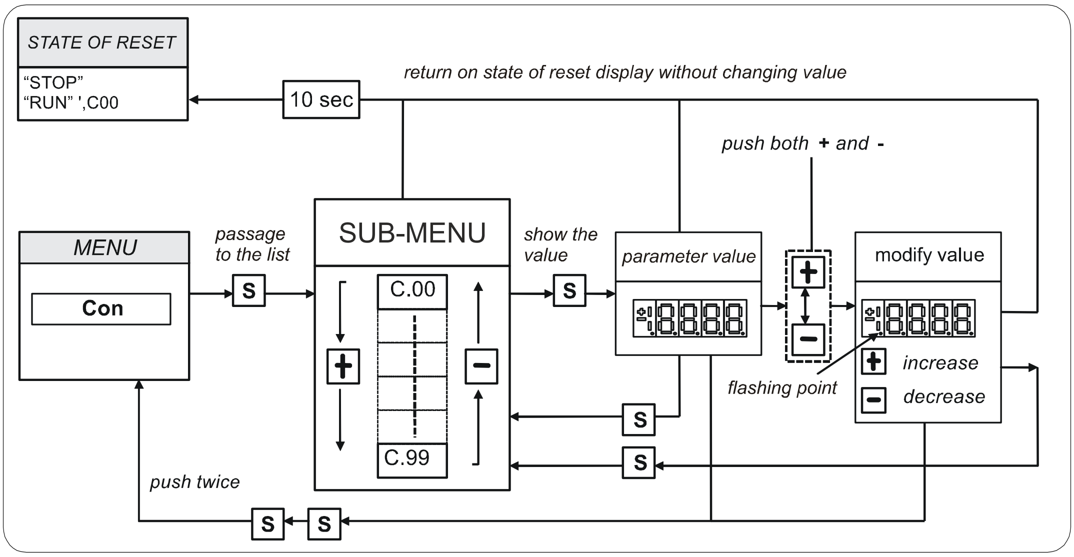


FIG. 15 (Submenu management connections CON)

7.4.2 VISUALIZATION OF THE INTERNAL VALUES (INT)

From "**INT**" you enter into the sub-menu list of internal values pressing "**S**". In the list you are moving with the keys "+" or "–" till that appearing address of dimensions wanted visualize "**dxx**"; pressing "**S**" disappears the address and appear the value of the dimension. From this status you go back to sub-menu list, repressing "**S**", and go again to the main menu repressing "**S**" twice in fast succession; from the menu and from the sub-menu. You return automatically to the status of rest after a time of 10 seconds.

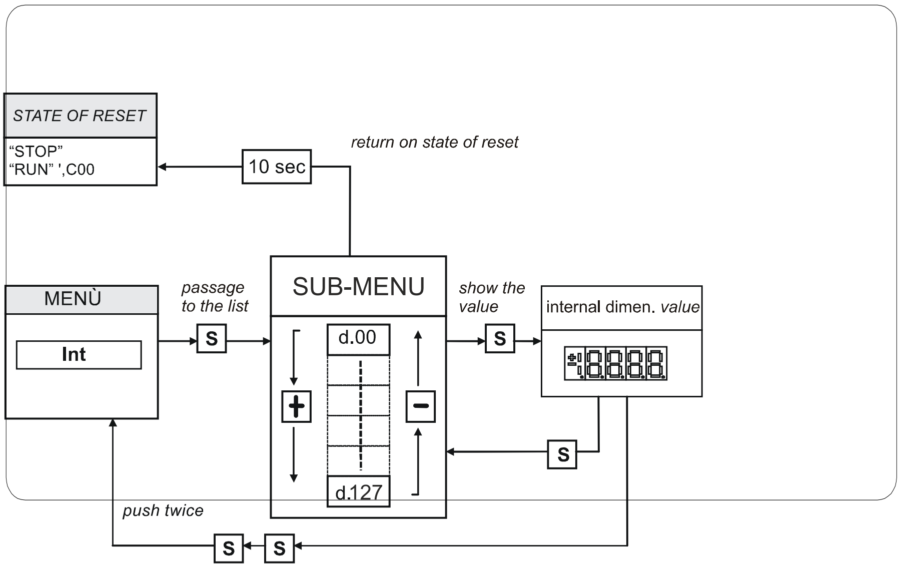


FIG. 16 (Visualization of the internal dimensions INT)

7.4.3 ALARMS (ALL)

From "**ALL**" you enter into of sub-menu list of the alarms pressing "**S**". From the corresponding submenu with the keys "+" and "–" move all addresses desired for the alarms; with this, in the box to the right, appears the status of the alarm "**H**" if active, "**L**" if don't. If the alarm has been disabled; in this case too with the active status doesn't appear any stop of the regulation, the address of the alarm is preceded by the sign "–".
To exclude the event of an alarm You must enter into the menu to modify both the keys "+" and "–" and when the flashing point appears of the first number You can enable or disable the alarm with the keys "+" or "–"; if the alarm is disabled appears the sign the "–" to the left of the writing "A.XX.Y".
From the status of modification returns to the list of sub-menu and You return operative the select made pressing "**S**", from the menu and from the submenu You turn automatically to the status of rest after a time closed to 10 seconds.

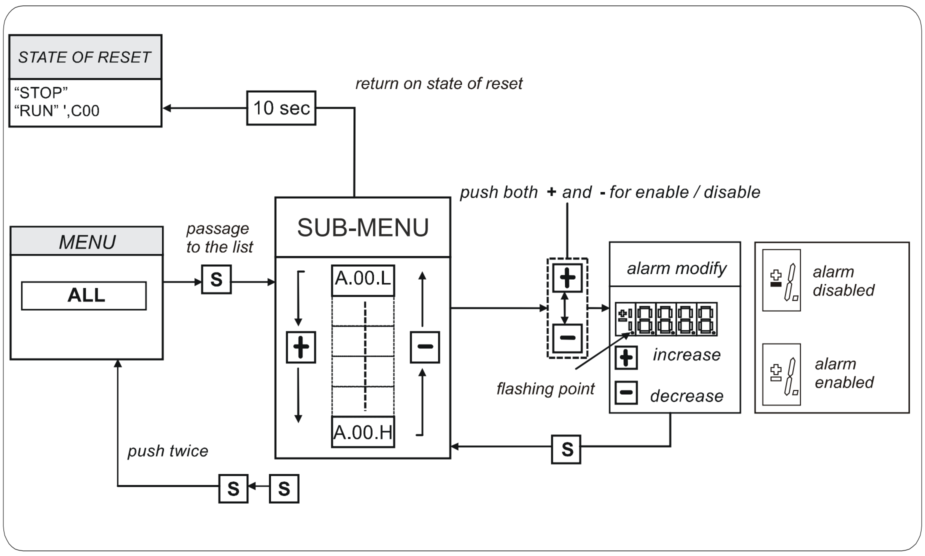


FIG. 17 (Alarms ALL)

7.4.4 VISUALIZATION OF THE INPUT AND OUTPUT (INP AND OUT)

From the "**INP**" or from the "**OUT**" you enter into corresponding list of sub-menu pressing "**S**". From the corresponding list of sub-menu with the keys "**+**" and "**–**" move to the address desired for the digital input (i) and the output (o); together to this, in the box, appear the status: "**H**" if activate, "**L**" if not active. From this status you returns to the main menu pressing "**S**".

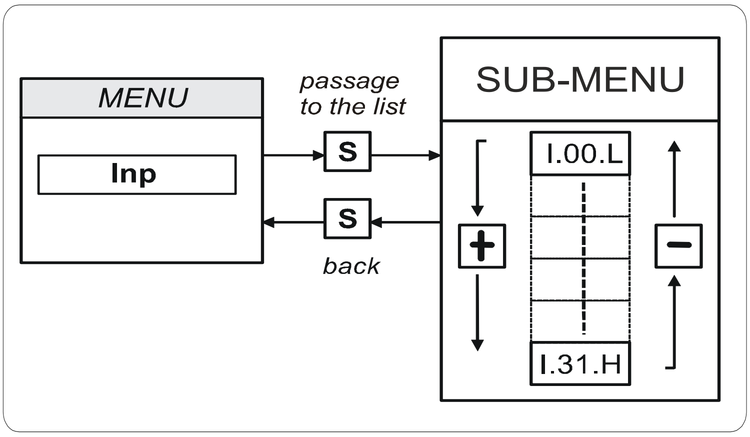


FIG. 18 (Digital input INP)

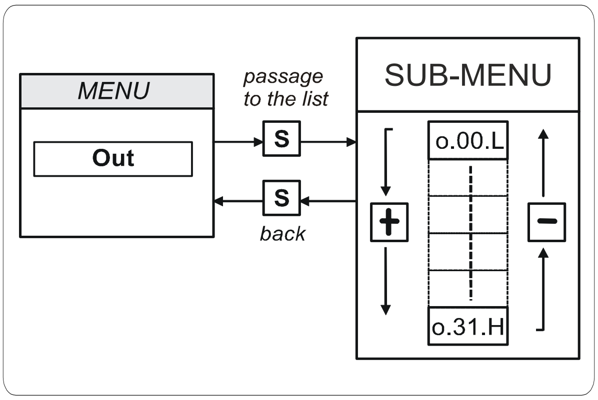


FIG. 19 (Digital output OUT)

7.4.5 SUB-MENU OF USB PORT MANAGEMENT

From "**USB**" you enter into corresponding list of sub-menu pressing "**S**". At the access will be available only "**S.00=0**" command, because USB port is normally disable and can't interact with a pen-drive. In order to enable USB port set **S.00=1**; now a pen-drive will be recognized and in the USB sub-menu all the command will be available (S.01÷S.07). S.00 will come back to 0 (USB port disable) if a pen-drive hasn't been connected within 30 seconds.

Once entered into the list is able look through the commands by pressing the keys "**+**" or "**–**" to move in increase or in decrement; even in this case the list is circular. If You press "**S**" key the value of the command is visualized; at this point repress "**S**" once You return to the sub-menu list, press twice "**S**" in fast succession (less 1 seconds), return to the main menu. The system returns automatically to the status of rest and after 10 seconds of have past inactivity. To modify the value of the parameter or of connection once entered into visualization it necessary press both keys "**+**" and "**–**"; in that moment it starts to flash the decimal point of the first figure to the left warning that from that moment the movement of the keys "**+**" and "**-**" modifies the value.

For more information look at the specific manual situated in our web site **www.bdfdigital.it** in Product/Download/Manuals/Automation/OPDE family.

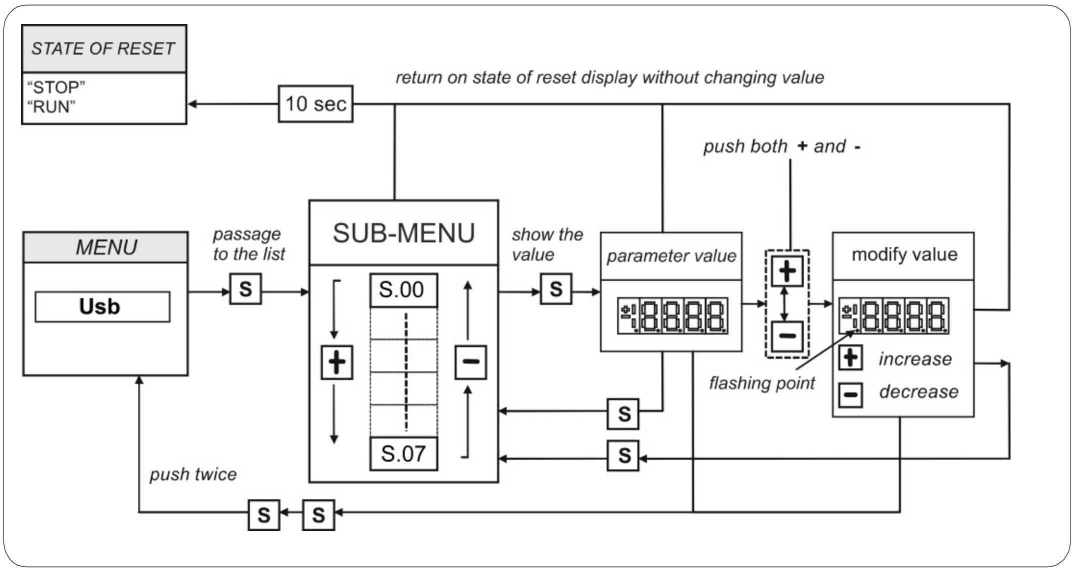


FIG. 20 (USB commands)

7.5 PROGRAMMING KEY

7.5.1 CLASSIC KEY

The programming key I2C device allows to back up **all the parameters** of a drive (both Core and Application parameters), in order to upload into others drives or the same if data have been compromises. The data are stored in a EPROM type memory, so **battery backup is not necessary**. In this device is possible to save **only one parameters recipe at a time**, so a second saving data leads an overwriting of previous parameters; the switch put on the key upper front side allows to protect the stored data against possible writing procedures.

FIG.21 (key)

Use method

Parameters transmission from drive to key:

- Insert the key into the suitable slot with the correct way (otherwise it's not read);
- Select the "**SAvE**" function with the buttons ▼ and ▲ located on the keyboard of the drive and push "●" as confirm.

FIG. 22

If the security switch is in " 🔒 " position the command is stopped and the warning "**Prot**" is displayed for 4s. Otherwise all the parameters is transferred and the "**runn**" notice is displayed, then the message "**donE**" will be shown for 2s as memorization confirm.

Parameters transmission from key to drive:

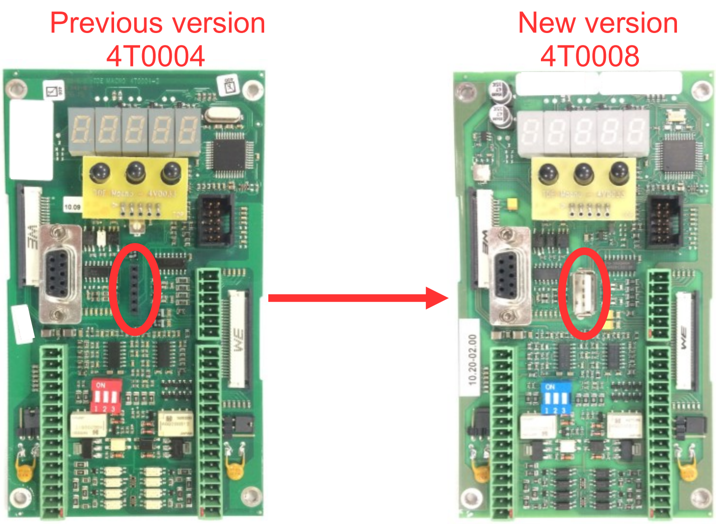
- Insert the key into the suitable slot with the correct way (otherwise it's not read);
- Open the reserved parameter key with **P60=95**;
- Select the "**LoAd**" function with the buttons ▼ and ▲ located on the keyboard of the drive and push "●" as confirm;
- Set **C63=1** to save the new parametrization permanently, switch off and switch on the regulation supply to make it operative.

FIG.23

During the data transfer the message "**runn**" is displayed, then the "**donE**" notice will be shown for 2s as memorization confirm.
If the programming key contains not compatible parameters with Core and Application firmware of the drive the warning "n.CPt" will be displayed for 4s; instead, if they are invalid the warning "Err" will be shown for 4s. Both this cases have as effect the load of the factory preset parameters.

7.5.2 USB KEY

The **274T0008** is the **new display/keypad + I/O board** for OPDE drives, that replaces previous 274T0004. As before, the display/keypad board of OPDE has its own micro-controller and firmware, that manages the operator interface and implements a ModBus master to communicate with the OPDE control board by a internal serial line.
The main difference to the previous boards is related to "parameters key" interface. The old boards support only the BDF DIGITAL, custom made, Parameters Key that was based on EEprom type non-volatile memory and I2C interface bus.
The new board supports **USB 2.0** flash drive that's based on Flash type non-volatile memory and USB interface bus.
When USB key is enabled, OPDE acts like an USB Host for **MSD** (Mass Storage Device).



Using a standard USB flash drive carries to some great advantages:

- they are manufactured by multiple suppliers nor only by BDF DIGITAL, so they are widely available, all over the world;
- they are cheap;
- they are based on consolidated, reliable memory storage technology and they use the USB (Universal Serial Bus) that's also a standard, well known interface, already present in every Personal Computer build in the last 20 years;
- they are familiar and commonly used by all people that already use a PC;
- they are available in a wide range of memory capacity, from few MBs to several GBs;
- they use standard data organizations ("File Systems" like FAT16 and FAT32) to store data in form of tree structured folders and data files;
- they allow to store into one pen-drive until to 10 parameter recipes, 10 core firmware and 10 application firmware;
- they allow to have a full back up of a drive (firmware + parameters);
- the USB port is available even if the internal connection with the drive control board is missing and also if the drive control board is in "**boot**" state due to a previously aborted/incomplete firmware download;
- they allow to have a direct connection to a PC without any specific interface converter; with a HUB USB it's also possible connect more than one drive in the same time (it's not possible connect more than one pen-drive).

A brand new menù "**USb**" (not available remotely via OPDExplorer) is provided to enable and manage all the functionalities related to the USB key interface. The USB menu is not available only during the upload/download of the core/application firmware started from another source (like OPDExplorer and RS485 serial interface).

7.5.2.1 SPECIFICATION

Following specifications are only related to the new USB interface, as all other are equal to the previous board.

Connector	USB Type-A receptacle
Power supply voltage	5 Vdc ± 5% (supplied only when USB interface is enabled)
Power supply current	limited to 390 mA ± 10%

Interface communications	USB 2.0-compliant, Low Speed (1.5 MBps) and Full Speed (12 MBps)
Supported profiles	MSD Host, CDC Device[1]
Supported file systems	FAT12, FAT16, FAT32

USB key functions	store parameters to key (up to 10 "slots") load parameters from key load only core parameters from key load only application parameters from key upload core and application firmware to key (up to 10 "slots") download core and application firmware from key download only core firmware from key

7.5.2.2 OPERATIONS

The USB bus is physically 1 to 1, where a "downstream" USB port of an apparatus is connected directly or through a cable to the "upstream" USB port of another apparatus; among other relevant differences, downstream port also carries power supply while upstream port can drain that power supply (or not if the apparatus is self-powered).
USB apparatus are distinct into "**Hosts**" (with downstream USB port) and "**Devices**" (with upstream USB port).
A single USB Host can be connected to multiple USB Devices using one or more USB Hubs, without a violation of the 1 to 1 rule, because the HUB USB has the main function to routing the messages flowing through his upstream port to the appropriate downstream port, allowing a star-like connected bus.
The USB interface implemented into OPDE is called **"Dual Role"** interface as it can act both like a Host or a Device:

- it's a **Host** when connected to a USB flash drive: its downstream port supplies power to the flash drive and sends commands to it in order to access to the data stored into the flash memory.
  The simplified Host implemented is **limited to management of just only 1 MSD Device**: USB Hub connection is not supported, so attach an USB flash drive directly.

Connection of USB Hosts or Devices other than MSD class was not fully tested and then can lead to unexpected results: please avoid them.

- it's a **Device** when connected to a PC: its upstream port receives commands from the PC in order to exchange communication data.
  As the downstream port from the PC also carries power supply, please **be sure that the OPDE USB Host interface is not enabled (S.00=0) prior to connect to PC**; if not, short circuits can happens between the 5V USB power supply of both interfaces resulting in damage of the USB port of the PC or the OPDE or both.
  As a Device, it can be connected to the downstream port of an USB Hub (one PC connected with more than one drive).

7.5.2.3 MENU USB

"**USb**" menu contains the commands related to the USB interface.

Name	Description	Min	Max	Default	Notes
S.00	enable USB Host interface	0	1	0[2]	when enabled, the 5V power supply is present on USB connector
S.01[1]	store core and application parameters to key slot #	0	10	0[3]	valid slot # are 1 up to 10 0 will abort the command
S.02[1]	load core and application parameters from key slot #	0	10	0[3]	valid slot # are 1 up to 10 0 will abort the command
S.03[1]	load only core parameters from key slot #	0	10	0[3]	valid slot # are 1 up to 10 0 will abort the command
S.04[1]	load only application parameters from key slot #	0	10	0[3]	valid slot # are 1 up to 10 0 will abort the command
S.05[1]	upload core and application firmware to key slot #	0	10	0[3]	valid slot # are 1 up to 10 0 will abort the command
S.06[1]	download core and application firmware from key slot #	0	10	0[3]	valid slot # are 1 up to 10 0 will abort the command
S.07[1]	download only core firmware from key slot #	0	10	0[3]	valid slot # are 1 up to 10 0 will abort the command

Notes: (1) command is available only when a compatible MSD device is connected to the USB Host interface.
(2) cammand value auto reverts to 0 if a compatible MSD device is missing for longer than 30 s.
(3) command value auto reverts to 0 after execution.

Remember that "**USb**" menù is not available remotely via OPDExplorer and during the upload/download of the core/application firmware started from another source (like OPDExplorer and RS485 serial interface).

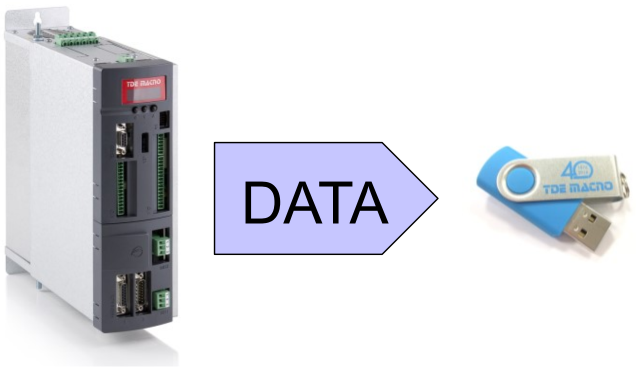
7.5.2.3.1 ENABLING USB HOST INTERFACE – CONNECTION OF A PEN-DRIVE

Before connecting a pen-drive in the menù is available only the command **S.00=0** (default).
Set **S.00=1** to enable the USB Host interface: the power supply is applied to the USB connector and then a pen-drive can be connected and recognized by the OPDE; if a MSD Device is not recognized within 30 seconds from the enabling or after removing another already recognized MSD Device, the command S.00 is automatically reverted to 0, disabling USB Host interface and switching off the power supply on USB connector. This is done for avoiding USB power supply to be present on USB connector when not necessary, preventing possible power supply short circuit in case of direct connection with a PC.
A connected Device is correctly recognized only if it's a MSD class device formatted using the File System **FAT 32** bit version (recommended choice). At the first connection of a pen-drive the OPDE create the path **\TDEMACNO\OPDE** that's used as **working directory**; this operation can last for several seconds during which the Operator Interface is freezed.

Only after all is ready the USB menu is populated with the other commands **S.01÷S.07** and they will be **disable when the pen-drive will be remove or will be set S.00=0**.
It's possible store until to 10 files for type (firmwares, applications, parameters) appointed by a number (slot #); chosing a different value for the commands S.01÷S.07 (value from 1 to 10) it's possible decide from what slot # take the file, saved into **\TDEMACNO\OPDE** directory, to complete the selected operation.
Setting the value 0 will abort the command.

7.5.2.3.2 STORE "CORE" AND "APP" PARAMETERS

Name	Description	Min	Max	Default	Notes
S.01(1)	store core and application parameters to key slot #	0	10	0(3)	valid slot # are 1 up to 10 0 will abort the command



OPDE parameters are divided into 2 sets: "core" parameters and "application" parameters; "core" parameter are those contained into PAR, CON and FLB menus, while "application" parameters are those into APP menu ("base" application parameters from E00 up to E99 and "extended" application parameters from E100 up to E599).

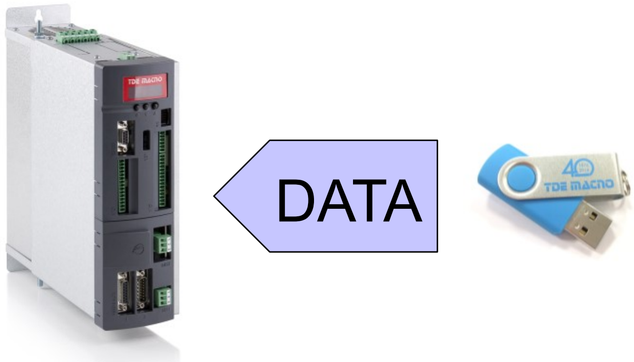
Command **S.01** stores **all the OPDE parameters** to the flash drive; the data are stored into the flash drive working directory in a file named **RCPxx_cc.cc_aa.aa_.MRA** where **xx** is the slot # number choosed by parameter S.01, **cc.cc** is the firmware "core" version and **aa.aa** is the firmware "app" version. The **MRA** file name extension identifies the custom file format (Modbus Register Ascii) used for storing the parameters recipe and the version of core and application firmware was added for better identification of the recipe when the file is accessed by a PC.
The user can further personalize the file name adding a comment before the final .MRA extension:
  example: RCP01_**E13358**.MRA.
<u>The only rule to respect is that the "RCPxx_" radix and the latest ".MRA" extension must be maintained in order to let the keypad correctly manage the file.</u>

Each slot # can contains only one file, so it's possible create until to 10 file of this kind: from **RCP01_cc.cc_aa.aa_.MRA** to **RCP10_cc.cc_aa.aa_.MRA**.

Warning: <u>if to store a recipe the slot # selected is already used by an other file, the last one will be overwrite and the data that this file contains will be lost.</u>

7.5.2.3.3 LOAD "CORE" AND "APP" PARAMETERS

Name	Description	Min	Max	Default	Notes
S.02(1)	load core and application parameters from key slot #	0	10	0(3)	valid slot # are 1 up to 10 0 will abort the command
S.03(1)	load only core parameters from key slot #	0	10	0(3)	valid slot # are 1 up to 10 0 will abort the command
S.04(1)	load only application parameters from key slot #	0	10	0(3)	valid slot # are 1 up to 10 0 will abort the command



Parameters recipe can be loaded from the flash drive into the OPDE by using commands **S.02÷S.04**: the value setted will choose the recipe slot # to load from (choosing slot "0" will result in no operation). The difference between the commands is related to the kind of parameters loaded: S.02 loads both core and application parameters, S.03 loads only core parameters while S.04 loads only application parametes.

Recommanded sequence of operation to load parameters:

- unlock suitable keys **P60=95** (access to reserved parameters) and/or **P99** (access to TDEMacno reserved parameters);
- load parameters recipe (core, application or both) by **S.02÷S.04**;
- save parameters to non volatile memory by **C63=1**;
- switch off 24V power supply of OPDE and wait till it turn off, then switch it on.

During the execution of these commands the display will show **«runn»** and if succesfully executed, the display will show **«donE»** for 10s (after the completion of command, the command value is automatically reverted to 0).

There are a variety of situations and problems that can happen and that prevent a correct execution of the command: in these cases the display will show a message (for 10s) that indicates the cause of failure:

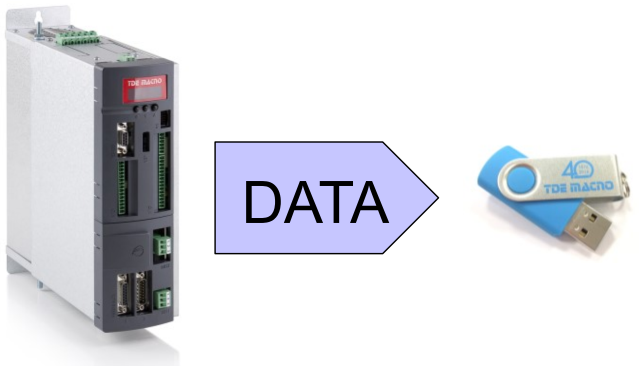
Error code	Description	Action
Prot	trying to store parameters recipe on flash drive that is write protected ("wp" file found in working directory)	use another flash drive / remove "wp" file from working directory
E.0.1.0	generic error during flash drive presence checking or write protection checking	retry / check the flash drive integrity / use another flash drive
E.3.3.3	OPD EXP control board modbus address not found	retry / retry after power cycle
E.5.4.1	communication error retrieving OPD EXP parameters map	retry
E.4.4.1	communication timeout retrieving OPD EXP parameters map	retry
E.1.5.0	error reading recipe file from flash drive (include file system errors, recipe file not found, recipe file format error)	retry / check the flash drive / check the recipe file

Error code	Description	Action
n.C.C	Not Compatible Core version between OPD EXP and recipe file to load	use a recipe file, created with a compatible core / change the firmware core to a compatile one
n.C.A	Not Compatible Application version between OPD EXP and recipe file to load	use a recipe file, created with a compatible application / change the firmware application to a compatile one
E.6.5.3	communication error setting OPD EXP parameters (C1-C8 reset)	retry
E.4.5.3	communication timeout setting OPD EXP parameters (C1-C8 reset)	retry
E.6.5.5	communication error setting OPD EXP parameters (PAR, CON, APP base)	retry
E.4.5.5	communication timeout setting OPD EXP parameters (PAR, CON, APP base)	retry
E.6.5.6	communication error setting OPD EXP parameters (FLB, APP extended)	retry
E.4.5.6	communication timeout setting OPD EXP parameters (FLB, APP extended)	retry
E.5.6.1	communication error retrieving OPD EXP parameters (PAR, CON, APP base)	retry
E.4.6.1	communication timeout retrieving OPD EXP parameters (PAR, CON, APP base)	retry
E.5.6.2	communication error retrieving OPD EXP parameters (FLB, APP extended)	retry
E.4.6.2	communication timeout retrieving OPD EXP parameters (FLB, APP extended)	retry
E.2.6.5	error writing recipe file to flash drive (file system errors, including errors in deleting existing recipes with same RCPxx_ radix)	retry / check the flash drive integrity / use another flash drive

Supervisor OPDExplorer allow to import/export **MRA** files into a pen-drive.
For example, after loaded a parameters recipe into a pen-drive, then connected the pen-drive to the PC, it's possible import the recipe in OPDExplorer ("**Parameters/Import from MRA file**") and print a file **.txt** ("**Parameters/Export to text file**") or save a **.TCN** file.
On the contrary starting from a **.TCN** file with the OPDExplorer is possible to export a **.MRA** file ("**Parameters/Export to MRA file**") **paying attention to save it with a valid name** into the working directory **\TDEMACNO\OPDE**.

7.5.2.3.4 STORE "CORE" AND "APP" FIRMWARE

Name	Description	Min	Max	Default	Notes
S.05[1]	upload core and application firmware to key slot #	0	10	0[3]	valid slot # are 1 up to 10 0 will abort the command



OPDE firmware is divided in 3 parts: the "bootloader", the "core" and the "application".
The bootloader is a part of firmware that's always present (and that can't be changed/updated by the user) into the internal flash memory of the OPDE control board: it allows the download and upload of the other 2 parts of firmware using a serial interface.
An new bootloader version was developed and released to strongly enhance performances: when used with 274T0008 the uploading and downloading execution time will be greatly reduced and also an additional data integrity check will be done on the downloaded firmwares.

Firmwares ("core" and "app" together) are stored into the flash drive working directory in 2 separated files named **CORExx_cc.cc_.LDR** and **APPxx_aa.aa_.LDR** where **xx** is the slot # number choosed by parameter **S.05**, **cc.cc** is the firmware "core" version and **aa.aa** is the firmware "app" version. The **LDR** file name extension identifies the hystorical file format (LoaDeR file) used by BDF DIGITALfor storing the firmware.
The user can further personalize the file name adding a comment before the final .LDR extension:
example: CORE01_12.22_**E13358**.LDR and APP01_00.26_**E13358**.LDR.
The only rule to respect is that the "COREx_" or "APPxx_" radix and the latest ".LDR" extension must be maintained in order to let the keypad correctly manage the file.

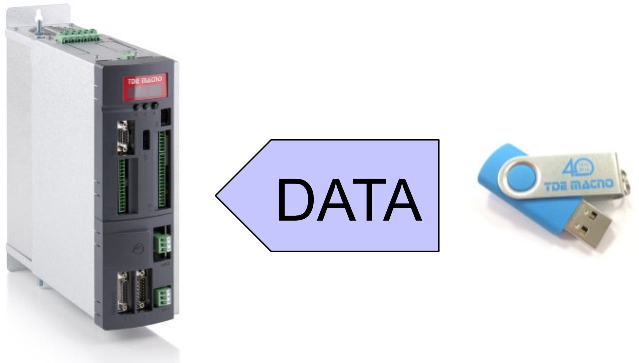
Each slot # can contains only one file, so it's possible create until to 10 file of this kind: from **CORE01_cc.cc_.LDR** to **CORE10_cc.cc_.LDR** and from **APP01_aa.aa_.LDR** to **APP10_aa.aa_.LDR**.

Warning: if to store a recipe the slot # selected is already used by an other file, the last one will be overwrite and the data that this file contains will be lost.

7.5.2.3.5 LOAD "CORE" AND "APP" FIRMWARE

Name	Description	Min	Max	Default	Notes
S.06(1)	download core and application firmware from key slot #	0	10	0(3)	valid slot # are 1 up to 10 0 will abort the command
S.07(1)	download only core firmware from key slot #	0	10	0(3)	valid slot # are 1 up to 10 0 will abort the command

Firmware can be downloaded from the flash drive into the OPDE by using commands **S.06** or **S.07**: the value setted will choose the firmware slot # to load from (choosing slot "0" will result in no operation). The difference between the commands is related to the kind of firmware downloaded: S.06 downloads both core and application firmware, S.07



downloads only core firmware.
Please notice that LogicLab compiles applications to be used with a specific version of core firmware (in order to grant the matching of internal variables and resources) so you can think that an application firmware executable is really bound to a specific version of core firmware. That's why we suggest to download both core and application in a single operation.

During the execution of these commands the display will initially show "**runn**" and then (as execution takes several seconds) a progression index like:

- "**uP.nn**" where **nn** goes from 00 up to 99 for upload;
- "**dL.nn**" where **nn** goes from 00 up to 99 for download.

If successfully executed, the display will show "**donE**" for 10s and after the completion of command, the command value is automatically reverted to 0.

There are a variety of situations and problems that can happen and that prevent a correct execution of the command: in these cases the display will show a message (for 10s) that indicates the cause of failure:

Error code	Description	Action
Prot	trying to upload firmware on flash drive that is write protected ("wp" file found in working directory)	use another flash drive / remove "wp" file from working directory
E.9.7.x	unable to activate OPD EXP boot mode	retry / retry after power cycle
E.5.7.x	communication error retrieving OPD EXP parameters during boot mode activation	retry / retry after power cycle
E.6.7.x	communication error setting OPD EXP parameters during boot mode activation	retry / retry after power cycle
E.4.7.x	communication timeout during boot mode activation	retry / retry after power cycle
E.2.8.2	error accessing or writing application firmware file to flash drive (file system errors, including errors in deleting existing files with same APPxx_ radix)	retry / check the flash drive integrity / use another flash drive

Error code	Description	Action
E.2.8.5	error accessing or writing core firmware file to flash drive (file system errors, including errors in deleting existing files with same COREXX_ radix)	retry / check the flash drive integrity / use another flash drive
E.C.8.0	OPD EXP refuses firmware uploading	
E.2.8.8	error writing firmware file to flash drive (file system errors)	retry / check the flash drive integrity / use another flash drive
E.5.8.x	communication error reading bootloader registers during firmware uploading	retry
E.6.8.x	communication error writing bootloader registers during firmware uploading	retry
E.4.8.x	communication timeout during firmware uploading	retry
E.7.9.1	error opening firmware file (file system errors)	retry / check the flash drive integrity / check firmware file / use another flash drive
E.7.9.2 **E.7.9.5**	error reading data block from firmware file (include file system errors, format errors)	retry / check the flash drive integrity / check firmware file / use another flash drive
E.7.9.3	firmware file format error: unsupported starting address	check firmware file
E.7.9.4	firmware file format error: no data at starting address	check firmware file
E.7.9.6	firmware file format error: data present at unsupported address	check firmware file
E.7.9.7	firmware file format error: CRC in file doesn't match	check firmware file
E.1.9.4	error opening application firmware file (file system errors, including file not found)	retry / check the flash drive integrity / check application firmware file / use another flash drive
E.1.9.6	error reading data block from application firmware file (include file system errors, format errors)	retry / check the flash drive integrity / check application firmware file / use another flash drive
E.1.9.9	error opening core firmware file (file system errors, including file not found)	retry / check the flash drive integrity / check core firmware file / use another flash drive
E.1.9.B	error reading data block from core firmware file (include file system errors, format errors)	retry / check the flash drive integrity / check core firmware file / use another flash drive
E.B.x.y	bootloader error register code xy (hex) during firmware downloading	retry
E.5.9.x	communication error reading bootloader registers during firmware downloading	retry
E.6.9.x	communication error writing bootloader registers during firmware downloading	retry
E.4.9.x	communication timeout during firmware downloading	retry
E.A.A.5	unable to exit OPD EXP boot mode	power cycle
E.5.A.x	communication error reading bootloader registers quitting boot mode	power cycle
E.6.A.x	communication error writing bootloader registers quitting boot mode	power cycle
E.4.A.x	communication timeout quitting boot mode	power cycle

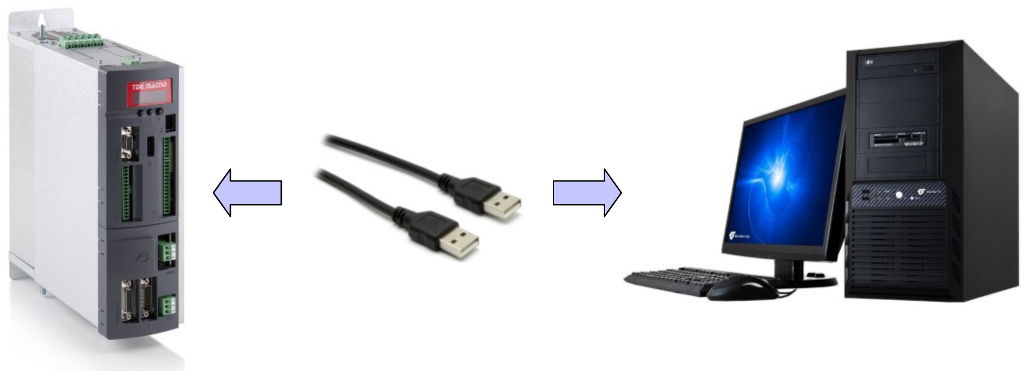
Warning:
Loading the firmware the control board of the OPDE is fully busy, so we suggest to power off the main voltage of the drive before these operations.

Warning: currently is not possible view what is saved into the slot # by the OPDE display, so, in order to avoid error, **we suggest to have a note of what and where has been saved into the pen-drive** or **verify it by the PC before these operations.**

7.5.2.4 CONNECTION TO PC

OPDE can be directly connected to a PC using an “A to A” type USB cable without any specific interface converter like OPDExplorer and RS485 serial interface. In this case the OPDE acts like an USB Device with **CDC** (Communication Device Class) profile, emulating an UART (Universal IM Receiver/Transmitter) that's seen as a virtual COM port on the PC.

Warning: <u>for safety, before doing the connection please check that the OPDE USB Host interface is disabled (**S.00=0**) because, if not, short circuits can happens between the 5V USB power supply of both interfaces resulting in damage of the USB port of the PC or the OPDE or both.</u>

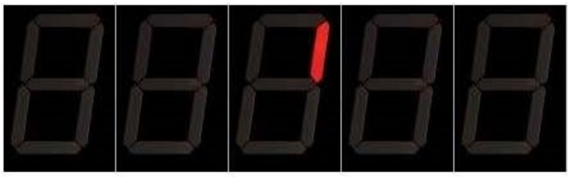


At the first connection the Operative System of the PC will ask for a driver that are powerd by BDF Digitalwith the .inf file (that's good for both 32 and 64bit Windows OSes) and that can be downloaded by the website www.bdfdigital.it a the voice **PRODUCTS/DOWNLOAD/UTILITY SW**, folder **DRIVER_USB_4T0008.zip**.
When driver has been installed the OPDE will be seen as a new COM port.

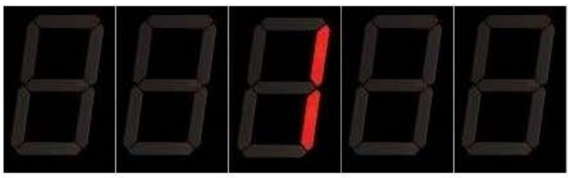
When a PC is directly connected to the OPDE, the Operator Interface is not working as the internal serial link is used exclusively for data communication with the PC.
For the same reason **speed is 38400 bps and Modbus address is 1** (regardless to settings in parameters P92 and P93) and can't be changed.

Here below are illustrated the only messages that the display can show:

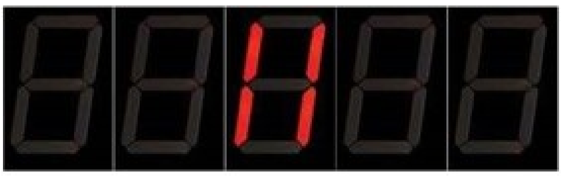
- OPDE connected to PC but driver not installed (led blinking)



- Driver installed and OPDE connected to PC (led blinking)



- During the data transfer the two led on the left blinking more slowly than the two on the right



8 LIST OF PARAMETERS

Name	Description	Min	Max	Default	UM	Scale
KP_AI1	P01 - Corrective factor for analog reference 1 (AUX1)	-400.0	400.0	100		10
OFFSET_AI1	P02 - Corrective offset for analog reference 1 (AUX1)	-100.0	100.0	0	%	163.84
KP_AI2	P03 - Corrective factor for analog reference 2 (AUX2)	-400.0	400.0	100		10
OFFSET_AI2	P04 - Corrective offset for analog reference 2 (AUX2)	-100.0	100.0	0	%	163.84
KP_AI3	P05 - Corrective factor for analog reference 3 (AUX3)	-400.0	400.0	100		10
OFFSET_AI3	P06 - Corrective offset for analog reference 3 (AUX3)	-100.0	100.0	0	%	163.84
DC_BUS_REF	P08 - DC Bus Voltage Reference	30.0	1200.0	650.0	V	10
GRID_ISL_V_REF	P10 - AC GRID_ISL Voltage Reference	15.0	780.0	230.0	V	10
SYNC_REG_KP	P11 - CanOpen SYNC loop regulator Proportional gain	0	200	5		1
SYNC_REG_TA	P12 - CanOpen SYNC loop regulator lead time constant	0	20000	400		1
KP_AI16	P13 - Corrective factor for 16 bit analog reference (AUX16)	-400	400	100	%	10
OFFSET_AI16	P14 - Corrective offset for 16 bit analog reference (AUX16)	-100	100	0	%	163.84
TF_LI6-7-8	P15 - I06,07,08 logical inputs digital filter	0.0	20.0	2.2	ms	10
BLK_START_TM	P21 - Black Start Time	0.01	199.99	1	s	100
FREQ_DROOP	P22 - % Frequency Droop	-100.0	100.0	2.0	%	81.92
VOLT_DROOP	P23 - % Voltage Droop	-100.0	100.0	5.0	%	81.92
DDROOP_GAIN	P24 - % Phase droop gain	-100.0	100.0	20.0	%	81.92
V_REG_KP	P31 - KpV voltage regulator proportional gain	0.1	400.0	6		10
V_REG_TI	P32 - TiV voltage regulator lead time constant	0.1	3000.0	30	ms	10
V_REG_TF	P33 - TfV voltage regulator filter time constant	0.0	25.0	0.4	ms	10
GRID_ISL_KP	P35 - KpV GRID_ISL V Prop Gain	0.01	40.0	0.10		100
GRID_ISL_TI	P36 - TiV GRID_ISL V lead time constant	0.1	3000.0	5.0	ms	10
GRID_ISL_TF	P37 - TfV GRID_ISL filter time constant	0.0	25.0	0.0	ms	10
PRC_DIS_REG_GRID_ISL	P38 - Cross Coupling multiplier for GRID_ISL V ac Control	0.0	200.0	80	%	10
MinVDcSStart	P39 - Min Volt DC for End Soft Start	60	95	80	% V_NOM	10
PRC_I_PEAK	P40 - Current limit	0.0	250.0	200	% I_NOM	40.96
VOLT_REG_FF_FILTER	P41 - Time constant for voltage regulator feed-forward calculation	0.0	500.0	4.5	ms	10
MAX_REGEN_I	P42 - Maximum regeneration current	0	400	200	% I_NOM	40.96
MAX_ABSORPT_I	P43 - Maximum absorption current	-400	0	-200	% I_NOM	40.96
TIMER_NO_BYPASS	P44 - Precharge debounce time - remain on bypass	50	1000	200	ms	1
TIMER_AGAIN_BYPASS	P45 - Precharge debounce time - reject bypass	50	1000	500	ms	1
MIN_V_GRID	P50 - Alarm level for minimum grid voltage	5.0	95.0	70.0	% V_NOM	10
MAX_V_GRID	P51 - Alarm level for maximum grid voltage	105.0	135.0	130.0	% V_NOM	10
K_V_GRID	P52 - Corrective Factor for AC Grid Voltage	25.0	200.0	100.0	%	10
K_V_GRID_EXT	P54 - Corrective Factor for AC Grid Voltage of external grid	25.0	200.0	100.0	%	10
GRID_CURRENT_OFFSET_U	P55 - Grid current sensor offset U	-100.0	100.0	0	%	327.67
GRID_CURRENT_OFFSET_W	P56 - Grid current sensor offset W	-100.0	100.0	0	%	327.67
PRC_AO1_10V	P57 - % value of 10V for analog output A	100.0	400.0	200	%	10
PRC_AO2_10V	P58 - % value of 10V for analog output B	100.0	400.0	200	%	10
VoltDroopFilt	P59 - Voltage Droop Filter Time const	0.0	200.0	6.0	ms	10
RES_PAR_KEY	P60 - Access Key to reserved parameters	0	65535	0		1
IN_LINE_REACT	P61 - Rated current of the Reactor	10.0	100.0	100	% I_NOM	327.67
V_NOM	P62 - Nominal Grid Voltage	30.0	1000.0	400	V	10
F_GRID_NOM	P63 - Rated grid frequency	5.0	100.0	50.0	Hz	1
VFilt	P64 - Filter Time Constant for V_GRID	0.0	30.0	0.0	ms	10
WaitAfeReady	P65 - Wait after Converter Ready	20	2000	1000	ms	1
DROOP_SIN	P66 - Droop sin (1=inductive 0=resistive)	0.00	1.00	1.00		100
FreqDroopFilt	P67 - Frequency Droop Filter Time const	0.0	200.0	6.0	ms	10
REF_ID	P68 - Reference Reactive Current	-80.0	80.0	0.0	% I_NOM	10
PRC_REAL_VRS	P69 - Voltage drop due to real resistor	0.0	25.0	0.1	% V_NOM	327.67
PRC_REAL_VLS	P70 - Voltage drop due to real inductance	0.0	50.0	3.0	% V_NOM	327.67
REACT_TF_THERM	P71 - Main reactor thermal time constant	30	2400	600	s	1
PRC_VIRTL_VRS	P72 - Voltage drop due to real+virtual resistor	-25.0	25.0	0.1	% V_NOM	327.67
PRC_VIRTL_VLS	P73 - Voltage drop due to real+virtual inductance	-50.0	50.0	3.0	% V_NOM	327.67
CAPAC_LINE_CURR	P74 - Capacitors Line Current	0.0	20.0	0.0	% I_NOM	327.67
PHASE_ANG	P75 - Grid Phase Shift	-180.0	180.0	0	°	10
PRC_DELTA_VLS	P77 - Voltage drop due to leakage inductance	5.0	100.0	10.0	% V_NOM	327.67
T_REACT	P78 - Main Reactor time constant Ts	0.0	50.0	50	ms	10
DDROOP_TF	P79 - Filter time constant for phase droop	0.0	100.0	50	ms	10
TR_ANGLE	P80 - Transformer phase shift (angle at grid side minus angle at AFE side)	-180.0	180.0	0	°	10
PLL_ERR_TF	P81 - TfPLLerr PLL error filter time constant	0.0	300.0	5.0	ms	10
GRID_F_TF	P82 - TfGridF Grid frequency filter time constant	0.0	30.0	0.0	ms	10
I_REG_KP	P83 - Kpc current regulator proportional gain	0.1	100.0	1.9		10
I_REG_TI	P84 - Tic current regulator lead time constant	0.0	1000.0	20	ms	10
I_REG_TF	P85 - Tfc current regulator (filter) time constant	0.0	25.0	0	ms	10
PLL_KP_STOP	P86 - KpPLL PLL regulator proportional gain at stop	0.1	10.0	1.0		10

PLL_TI_STOP	P87 - TiPLL PLL regulator lead time constant at stop	0.0	300.0	2.5	ms	10
PLL_KP_RUN	P88 - KpPLL PLL regulator proportional gain at run	0.1	10.0	1.0		10
PLL_TI_RUN	P89 - TiPLL PLL regulator lead time constant at run	0.0	300	250.0	ms	10
GRID_V_TF	P90 - TfGridV Grid voltage filter time constant	0.0	300	30.0	ms	10
LOAD_TEMP_MAX	P91 - Maximum reactor temperature (if read with PT100)	0.0	150.0	130	°C	10
MODBUS_ADDR	P92 - Serial identification number	0	255	1		1
MODBUS_BAUD	P93 - Serial baud rate			192	Kbit/s	1
LOAD_PRB_RES_THR	P95 - Reactor NTC or PTC resistance value for alarm	0	19999	1500	Ohm	1
PRC_REACT_DO_TEMP_THR	P96 - Reactor thermal logic output 14 cut-in threshold	0.0	200.0	100	% PRC_REACT_I_THERM	40.96
DCBUS_MIN_GRID_LOST	P97 - Minimum voltage level for forced grid off	100.0	1200.0	425	V	10
SW_PAR_KEY	P99 - Access key to TDE parameters	0	19999	0		1
FACTORY_PAR_KEY	P100 - Value of access key to reserved parameters	0	19999	95		1
F_PWM	P101 - PWM frequency	1000	25000	5000	Hz	1
PRC_DEAD_TIME_CMP	P102 - Dead time compensation	0.0	100.0	0	‰ PRC_V_MAX	32.76
PRC_I_MAX	P103 - Converter limit current	0.0	800.0	200	% I_NOM	40.96
T_RAD	P104 - Heat sink time constant	10.0	360.0	80	s	10
KP_DCBUS	P105 - Corrective factor for Bus voltage	80.0	200.0	100	%	10
DCBUS_MIN	P106 - Minimum DC Bus voltage	100.0	1200.0	400	V	10
DCBUS_MAX	P107 - Maximum DC Bus voltage	350.0	1200.0	760	V	10
OFFSET_AO1	P110 - Offset A/D 1	-100.0	100.0	0		327.67
OFFSET_AO2	P111 - Offset A/D 2	-100.0	100.0	0	%	327.67
DISP_WAIT_TIME	P112 - Wait time for display stand-by state	3	20	10	s	1
I_PEAK	P113 - Maximum converter current	0.0	3000.0	0	A	10
KP_LOAD_THERM_PRB	P115 - Multiplication factor for reactor PTC/NTC/PT100 analog reference value	0.00	200.00	100		163.84
T_JUNC	P116 - Junction time constant	0.1	10.0	3.5	s	10
KP_DRV_THERM_PRB	P117 - Multiplication factor for heat sink PTC/NTC analog reference value	0.00	200.00	100		163.84
TEMP_MAX	P118 - Max. temperature permitted by heat sink PTC/NTC	0.0	150.0	90	°C	10
CONV_START_TEMP_MAX	P119 - Max. temperature permitted by heat sink PTC/NTC for start-up	0.0	150.0	75	°C	10
RAD_DO_TEMP_THR	P120 - Heat sink temperature threshold for logic output o.15	0.0	150.0	80	°C	10
FAN_CTRL	P121 - FAN ctrl	0	3	1		1
MOD_INDEX_MAX	P122 - Max. modulation index	0.500	0.995	0.98		1000
PRC_I_ZERO_KP_COEFF	P124 - Corrective coeff. estimated Kp for zero current loop	0.1	200.0	50	%	40.96
PRC_I_ZERO_TI_COEFF	P125 - Corrective coeff. estimated Ti for zero current loop	0.1	200.0	10	%	40.96
PRC_I_REG_KP_COEFF	P126 - KpI Corrective coeff. estimated Kp for current loops	0.0	200.0	50	%	40.96
GRID_LEM_I_NOM	P128 - Full-scale RMS current for grid LEM (Active Filter option)	0.0	3000.0	0.0	A	10
RESYNC_AMPL_KP	P129 - Voltage regulator Kp for microgrid resync	0.01	80.0	1		100
RESYNC_AMPL_TI	P130 - Voltage regulator TiV lead time constant for microgrid resync	0.1	3000.0	300	ms	10
RESYNC_AMPL_TF	P131 - Voltage error regulator filter Tf time constant for microgrid resync	0.0	500.0	150	ms	10
RESYNC_FREQ_KP	P132 - Freq. regulator Kp for microgrid resync	0.01	80.0	0.1		100
RESYNC_FREQ_TI	P133 - Freq. regulator TiV lead time constant for microgrid resync	0.1	3000.0	300	ms	10
RESYNC_FREQ_TF	P134 - Freq. regulator filter Tf time constant for microgrid resync	0.0	500.0	50.0	ms	10
RESYNC_VOLT_THR	P135 - % Voltage threshold for microgrid resync	0.0	100.0	2.0	%	81.92
RESYNC_PHASE_THR	P136 - % Phase threshold for microgrid resync	0.0	100.0	0.5	%	81.92
RESYNC_VAL_TIME	P137 - Validation time for microgrid resync	20	2000	200	ms	1
KP_BOARD_THERM_PRB	P138 - Corrective factor for card thermal sensor	0.00	200.00	100	%	163.84
TRANSITION_ERR_TIME	P139 - Timeout for microgrid resync	0	15000	500	ms	1
SWAP_VOLT_THR	P140 - Voltage threshold for CSI to VSI swap function	0.0	100.0	10.0	%	163.84
SWAP_FREQ_THR	P141 - Frequency threshold for CSI to VSI swap function	0.0	100.0	5.0	%	163.84
CSIVSI_VOLT_MOD_FILTER	P142 - Time constant for voltage module reference filter for CSI to VSI transition	0.0	1000.0	200	ms	10
BLACK_START_INIT_TIME	P143 - Initial boost time for black-start	0.0	10000.0	0	ms	1
BLACK_START_INIT_VALUE	P144 - Initial boost value for black-start	0.0	100.0	0.0	%	163.84
LVFRT_T_MAX	P145 - LVFRT maximum duration	0.10	5.00	3.00	s	100
GRID_UNB_MAX	P146 - Maximum grid voltage unbalance for enabling run	0.1	100.0	10.0	% V_GRID_NOM	10
V_GRID_MAX_UNB	P147 - Maximum grid voltage with unbalanced grid for enabling run	0.0	200.0	115.0	% V_GRID_NOM	10
V_GRID_MIN_UNB	P148 - Minimum grid voltage with unbalanced grid for enabling run	0.0	200.0	80.0	% V_GRID_NOM	10
PRC_DEAD_TIME_CMP_XB	P151 - Xb = cubic coupling zone amplitude	0.0	50.0	12.0	% DRV_I_NOM	163.84
V_GRID_AMPL_COEFF_RESYNC	P152 - Line voltage amplitude coefficient (PLL for resync)	0.0	200.0	100	%	163.84
OFFSET_L1_RESYNC	P153 - Line voltage L1 offset (PLL for resync)	-16383	16383	0		1
OFFSET_L2_RESYNC	P154 - Line voltage L2 offset (PLL for resync)	-16383	16383	0		1
OVR_LOAD_T_ENV	P155 - Ambient temperature reference value during overload	0.0	150.0	40	°C	10
CHR_F_PWM	P156 - PWM frequency for converter definition	1000	16000	5000	Hz	1
DEAD_TIME_SW	P157 - Dead time duration	0.0	20.0	4	µs	10
PRC_I_DECOUP	P158 - Corrective coefficient for decoupling terms	0.0	200.0	0	%	40.96

ID_CANOPEN	P162 - CAN BUS node ID	1	127	1		1
ALL_ENAB	P163 - Alarm enable	-32768	32767	-1	Hex	1
V_GRID_AMPL_COEFF	P164 - Line voltage amplitude coefficient	0.0	200.0	100	%	163.84
OFFSET_L1	P165 - Line voltage L1 offset	-16383	16383	0		1
OFFSET_L2	P166 - Line voltage L2 offset	-16383	16383	0		1
CHR_V	P167 - Characterization voltage	200.0	690.0	400	V rms	10
PI_AC_TI	P181 - TiPlac PI_AC regulator lead time constant	0.0	1000.0	50.0	ms	10
DRV_K_ALTITUDE	P195 - Drive Derating with altitude	0	200	100	%	163.84
DEAD_TIME_SW_HW	P198 - Dead time hardware duration	0.0	20.0	0.0	µs	10
MIN_PULSE	P199 - Minimum command pulse duration	0.0	20.0	1.0	µs	10
CONTROL_SEL	C00 - Control Selection	0	13	0		1
DISPLAY_SEL	C14 - Display selection	0	127	0		1
EN_SLOT_SWAP	C19 - Enable sensor slot swap	0	1	0		1
SW_RUN_CMD	C21 - Run software enable	0	1	1		1
PWM_SYNCHRONIZATION	C23 - Pwm Synchronization	0	10	0		1
DC_BUS_FULL_SCALE	C24 - DC Voltage converter full scale	0	2	0	V	1
PWM_MOD_TYPE_SEL	C27 - PWM Modulation type selection	0	4	0		1
CONV_SW_EN	C29 - Converter software enable	0	1	1		1
ALL_RESET	C30 - Alarms reset	0	1	0		1
DIS_DCBUS_RIPPLE_ALL	C31 - Disable DC Bus Ripple Alarm	0	1	0		1
EN_LOAD_THERM_AL	C32 - Reactor thermal switch 'Block converter?'	0	1	1		1
REACT_THERM_CURV_SEL	C33 - Choice of reactor thermal curve	0	3	0		1
ALL_RST_ON_GRID	C35 - Automatic alarm reset when grid back on	0	1	0		1
EN_PW_SOFT_START	C37 - Enable soft start	0	1	1		1
BOARD_CONF	C40 - Control board mounting options	0	10	1		1
ALL_COUNT_RESET	C44 - Reset alarms counters	0	4	0		1
LOAD_THERM_PRB_SEL	C46 - Enable reactor thermal probe management (PT100/PTC/NTC)	0	5	0		1
CANOPEN_BAUD_SEL	C48 - CAN Baud rate	0	7	0		1
I_OVR_LOAD_SEL	C56 - Current overload	0	3	1		1
THERM_PRB_SEL	C57 - Enable heat sink heat probe management (PTC/NTC)	0	4	1		1
DIS_I_DECOUP	C59 - Disable dynamic decoupling + feedforward	0	1	0		1
PAR_ACT_BANK	C60 - Parameter bank active	0	1	0		1
DEF_PAR_RD	C61 - Default parameters Read	0	2	0		1
EEPROM_PAR_RD	C62 - Read parameters from EEPROM	0	2	0		1
EEPROM_PAR_WR	C63 - Save parameters in EEPROM	0	1	0		1
EN_FLDBUS	C64 - Enable fieldbus manage	0	7	0		1
EN_V_GRID_TUNING	C68 - Enable line voltage tuning	0	1	0		1
EN_HARMONICS_COMP	C69 - Enable Harmonics compensation	0	3	0		1
GRID_SEL	C70 - Grid type selection	0	1	0		1
LOAD_PRB_RES_THR_MUL	C71 - Reactor NTC or PTC resistance multiplication factor	0	1	0		1
EN_TLESS	C72 - Enable Transformerless	0	3	0		1
EN_R_GRID_TUNING	C73 - Enable Rgrid tuning	0	1	0		1
EN_LVFRT_MANAGE	C74 - Enable LVFRT manage	0	1	0		1
EN_NOT_LI	C79 - Enable negative logic for digital inputs	0	255	0		1
I_CTRL_SEL	C80 - Current control type selection	0	2	0		1
V_CTRL_SEL	C81 - Voltage control type (GRID-ISLAND)	0	1	0		1
SYNC_CARD_SEL	C82 - Type of Sync Card mounted	0	1	0		1
SWAP_ISL_EN	C83 - Swap to Island function Enable	0	1	0		1
DROOP_EN	C84 - Enable Droop Control	0	1	0		1
OVC_RESTART_SW	C85 - Enable Restart after OVC (SW-caption)	0	1	0		1
3PH_CTRL_EN	C86 - Enable control on V phase	0	2	0		1
DDROOP_SEL	C87 - Enable droop on instantaneous phase reference (Ddroop_f) + use 1st order filter on freq. droop	0	1	0		1
EN_MICROGRID_RESYNC	C88 - Microgrid resync. management enable	0	1	0		1
FREQ_BLACK_START	C90 - Enable frequency black-start	0	1	0		1
DRV_TH_MODEL	C94 - Drive Thermal Model	0	2	1		1
EN_AI1_4_20mA	C95 - Enable AI1 4-20mA	0	1	0		1
EN_AI2_4_20mA	C96 - Enable AI2 4-20mA	0	1	0		1
EN_AI3_4_20mA	C97 - Enable AI3 4-20mA	0	1	0		1
EN_BOOT	C98 - Enable boot mode	0	1	0		1
EN_PF_RES	C99 - Enable Power Fault reset	0	1	0		1
GRID_LEM_OFF_COMP_EN	U01 - Enable AT offset compensation for grid LEM (Active Filter)	0	1	0		1
MAPPING_CONFIG	U03 - Select the mapping configuration	0	32767	0	Hex	1
EN_I_VECTOR	U10 - Enable Current Vector for Power Part Test	0	1	0		1
I_VECTOR_FREQ	U11 - Current Vector frequency for Power Part Test	0	200	50	Hz	1
RX0_INDEX	Receive Object0 Index			0	Hex	1
RX0_SUB_INDEX	Receive Object0 Sub-Index			0	Hex	1
RX1_INDEX	Receive Object1 Index			0	Hex	1
RX1_SUB_INDEX	Receive Object1 Sub-Index			0	Hex	1
RX2_INDEX	Receive Object2 Index			0	Hex	1
RX2_SUB_INDEX	Receive Object2 Sub-Index			0	Hex	1
RX3_INDEX	Receive Object3 Index			0	Hex	1
RX3_SUB_INDEX	Receive Object3 Sub-Index			0	Hex	1
RX4_INDEX	Receive Object4 Index			0	Hex	1

RX4_SUB_INDEX	Receive Object4 Sub-Index			0	Hex	1
RX5_INDEX	Receive Object5 Index			0	Hex	1
RX5_SUB_INDEX	Receive Object5 Sub-Index			0	Hex	1
RX6_INDEX	Receive Object6 Index			0	Hex	1
RX6_SUB_INDEX	Receive Object6 Sub-Index			0	Hex	1
RX7_INDEX	Receive Object7 Index			0	Hex	1
RX7_SUB_INDEX	Receive Object7 Sub-Index			0	Hex	1
RX8_INDEX	Receive Object8 Index			0	Hex	1
RX8_SUB_INDEX	Receive Object8 Sub-Index			0	Hex	1
RX9_INDEX	Receive Object9 Index			0	Hex	1
RX9_SUB_INDEX	Receive Object9 Sub-Index			0	Hex	1
TX0_INDEX	Transmit Object0 Index			0	Hex	1
TX0_SUB_INDEX	Transmit Object0 Sub-Index			0	Hex	1
TX1_INDEX	Transmit Object1 Index			0	Hex	1
TX1_SUB_INDEX	Transmit Object1 Sub-Index			0	Hex	1
TX2_INDEX	Transmit Object2 Index			0	Hex	1
TX2_SUB_INDEX	Transmit Object2 Sub-Index			0	Hex	1
TX3_INDEX	Transmit Object3 Index			0	Hex	1
TX3_SUB_INDEX	Transmit Object3 Sub-Index			0	Hex	1
TX4_INDEX	Transmit Object4 Index			0	Hex	1
TX4_SUB_INDEX	Transmit Object4 Sub-Index			0	Hex	1
TX5_INDEX	Transmit Object5 Index			0	Hex	1
TX5_SUB_INDEX	Transmit Object5 Sub-Index			0	Hex	1
TX6_INDEX	Transmit Object6 Index			0	Hex	1
TX6_SUB_INDEX	Transmit Object6 Sub-Index			0	Hex	1
TX7_INDEX	Transmit Object7 Index			0	Hex	1
TX7_SUB_INDEX	Transmit Object7 Sub-Index			0	Hex	1
TX8_INDEX	Transmit Object8 Index			0	Hex	1
TX8_SUB_INDEX	Transmit Object8 Sub-Index			0	Hex	1
TX9_INDEX	Transmit Object9 Index			0	Hex	1
TX9_SUB_INDEX	Transmit Object9 Sub-Index			0	Hex	1
NODE_SLAVE_ADDR	Slave address			0		1
NODE_BAUD_RATE	Node baud rate	0	255	0		1
DATA_CONSISTENCE	Data consistence			0		1
EN_ACYCLIC_DATA	Enable acyclic data			0		1
EN_BIG_ENDIAN	Most significant bytes in multi-byte data types			0		1
PDP_SETUP_DATA	Old Profibus DP setup data			0		1
PRC_RX_WORD0	Process Data Read word 0			0	Hex	1
PRC_RX_WORD1	Process Data Read word 1			0	Hex	1
PRC_RX_WORD2	Process Data Read word 2			0	Hex	1
PRC_RX_WORD3	Process Data Read word 3			0	Hex	1
PRC_RX_WORD4	Process Data Read word 4			0	Hex	1
PRC_RX_WORD5	Process Data Read word 5			0	Hex	1
PRC_RX_WORD6	Process Data Read word 6			0	Hex	1
PRC_RX_WORD7	Process Data Read word 7			0	Hex	1
PRC_RX_WORD8	Process Data Read word 8			0	Hex	1
PRC_RX_WORD9	Process Data Read word 9			0	Hex	1
IP_ADDR_00	Anybus IP Address 00	0	255	0		1
IP_ADDR_01	Anybus IP Address 01	0	255	0		1
IP_ADDR_02	Anybus IP Address 02	0	255	0		1
IP_ADDR_03	Anybus IP Address 03	0	255	0		1
SUBNET_MASK_00	Anybus Subnet Mask 00	0	255	0		1
SUBNET_MASK_01	Anybus Subnet Mask 01	0	255	0		1
SUBNET_MASK_02	Anybus Subnet Mask 02	0	255	0		1
SUBNET_MASK_03	Anybus Subnet Mask 03	0	255	0		1
GATEWAY_00	Anybus Gateway 00	0	255	0		1
GATEWAY_01	Anybus Gateway 01	0	255	0		1
GATEWAY_02	Anybus Gateway 02	0	255	0		1
GATEWAY_03	Anybus Gateway 03	0	255	0		1
DHCP	Anybus DHCP	0	1	0		1
ESC_REG_ADDR	Select ESC register address	0	65535	65535	Hex	1
TLESS_DER_F_TD	P312 - Tless frequency derivative time constant	0.1	3000.0	200.0	ms	10
TLESS_DER_F_TF	P313 - Tless frequency derivative filter time constant	0	3000.0	10.0	ms	10
TLESS_DER_F_THR	P314 - Tless frequency derivative threshold	0.0	100.0	10.0	%	10
TLESS_DER_I_TD	P315 - Tless current derivative time constant	0.1	3000.0	20.0	ms	10
TLESS_DER_I_TF	P316 - Tless current derivative filter time constant	0	3000.0	10.0	ms	10
TLESS_DER_I_THR	P317 - Tless current derivative threshold	0.0	100.0	10.0	%	10
TLESS_IDC_NOM	P318 - Tless Idc rated current	0.001	32.767	0	A	1000
TLESS_IDC_THRa	P319 - Tless Idc threshold a	0.1	100.0	0.5	% I_CONV_NOM	10
TLESS_IDC_THRb	P320 - Tless Idc threshold b	0.1	100.0	1.0	A	10
TLESS_LPF2_DMP	P321 - Tless LPF2a and LPF2b damping factor	0.01	1.00	0.90		100
TLESS_LPF2a_TF	P322 - Tless LPF2a filter time constant	0.1	3000.0	200.0	ms	10
TLESS_LPF2b_TF	P323 - Tless LPF2b filter time constant	0.1	3000.0	25.0	ms	10
TLESS_NOTCH_DMP	P324 - Tless Notch filter damping factor	0.0	100.0	0.0	%	10
TLESS_NOTCH_F0	P325 - Tless Notch Filter natural frequency	0.0	100.0	50.0	Hz	10
TLESS_NOTCH_FB	P326 - Tless Notch Filter bandwidth	0.0	100.0	25.0	Hz	10
TLESS_OFF_MAX	P327 - Tless maximum voltage offset	0.1	5.0	2.0	% V_CONV_NOM	10

TLESS_REG_KP	P328 - Kp Tless regulator gain	0.01	100.00	3.5		100
TLESS_REG_MAX	P329 - Tless regulator maximum output	0	400	200	%	1
TLESS_REG_TF	P330 - Tf Tless regulator filter time constant	0.0	3000.0	0.0	ms	10
TLESS_REG_TI	P331 - Ti Tless regulator lead time constant	0.1	3000.0	50	ms	10
TLESS_U_KP	P332 - Tless U amplitude compensation	0.0	200.0	100.0	%	10
TLESS_W_KP	P333 - Tless W amplitude compensation	0.0	200.0	100.0	%	10
KT	P334 - Multiplier	1.0	100.0	1.0	p.u.	10
PRC_DELTA_VRG	P335 - Voltage drop due to total resistor toward the grid	0.01	100.00	10.0	%	100
EN_PWM_VAR	P339 - Enable fPwm variation	0	3	0		1
FPWMSWEEP_INJ_F	P340 - frequency of fPwm sweep (percentage of fPwm)	0	16000	100	Hz	1
FPWMSWEEP_INJ_A	P341 - Amplitude of fPwm sweep (percentage of fPwm)	0	30	10	%	1
I_NOM	P53 - Rated Converter current	0.0	400	0	A	10
K_V_GRID_TDE	Factory corrective Factor for AC Grid Voltage	25.0	200.00	100.0	%	10
OFFSET_AO1_TDE	Factory corrective offset for A/D 1	-100.0	100.0	0	%	327.67
OFFSET_AO2_TDE	Factory corrective offset for A/D 2	-100.0	100.0	0	%	327.67
V_GRID_AMPL_COEFF _TDE	Factory corrective factor for Line voltage amplitude coefficient	0.0	200.0	100.0	%	163.84
OFFSET_L1_TDE	Factory corrective offset for line voltage L1	-16383	16383	0		1
OFFSET_L2_TDE	Factory corrective offset for line voltage L2	-16383	16383	0		1
OFFSET_AI1_TDE	Factory corrective offset for analog reference 1 (AI1)	-100.0	100.0	0	%	163.84
OFFSET_AI2_TDE	Factory corrective offset for analog reference 2 (AI2)	-100.0	100.0	0	%	163.84
OFFSET_AI3_TDE	Factory corrective offset for analog reference 3 (AI3)	-100.0	100.0	0	%	163.84
KP_DCBUS_TDE	Factory corrective factor for Bus voltage	0.0	200.0	100	%	10
KP_LOAD_THERM_PR B_TDE	Factory multiplication factor for motor PTC/NTC/KTY84 analog reference value	0.00	200.00	100		163.84
KP_CONV_THERM_PR B_TDE	Factory multiplication factor for radiator PTC/NTC analog reference value	0.00	200.00	100		163.84
FW_REV	D00 - Software version			0		256
ACTV_POW	D01 - Active power delivered			0	kW	16
CONTROL_SEL	D02 - Control Selected			0	0:AFE Std 1:FFE 2:MGrid	1
GRID_SEQUENCE	D03 - Positive/negative L1, L2, L3 - sequence			0	1:Positive 0:Negative	1
GRID_F	D04 - Measured grid frequency			0	Hz	16
V_BUS_NORM	D05 - V bus Norm	0	500	0	% VBUS_NOM	163.84
DRV_I_CONN_TH_MO DEL	D06 - Drive inner connection limit			0	% DRV_I_CONN _MAX	163.84
PRC_IQ_REF	D07 - Request of active current Iq rif	-100	100	0	% I_NOM	40.96
PRC_ID_REF	D08 - Request of reactive current Id rif	-100	100	0	% I_NOM	40.96
GRID_STATUS	D09 - GRID_ISL_status			0		1
MICROGRID_TRANS_S TS	D10 - Microgrid Transition State Machine Status			0		1
REACT_I	D11 - Current module			0	A rms	16
GRID_SEL	D14 - Grid type			0		1
PRC_IQ	D15 - Active current Iq	-100	100	0	% I_NOM	40.96
PRC_ID	D16 - Reactive current Id	-100	100	0	% I_NOM	40.96
PRC_V	D18 - Reference voltage module	-100	100	0	% V_NOM	40.96
MOD_INDEX	D19 - Modulation index	-100	100	0		40.96
PRC_VQ_REF	D20 - Vq rif	-100	100	0	% V_NOM	40.96
GRID_V	D21 - Grid AC Voltage			0	V rms	1
PRC_VD_REF	D22 - Vd rif	-100	100	0	% V_NOM	40.96
GRID_LEM_I	D23 - Current module on external sensors (Active filter)			0	A rms	16
DC_BUS	D24 - Bus voltage			0	V	16
RAD_TEMP	D25 - Heat sink temperature reading			0	°C	16
LOAD_TEMP	D26 - Reactor temperature			0	°C	16
PRC_REACT_I_THERM	D28 - Reactor thermal current	-100	100	0	% soglia All	40.96
PRC_I_MAX	D29 - Current limit	-100	100	0	% I_NOM	40.96
MAIN_GRID_F	D30 - Measured main grid frequency			0	Hz	16
MAIN_GRID_V	D31 - Main grid AC Voltage			0	V rms	1
PRC_APP_I_MAX	D32 - Maximum current limit by application	-400	400	0	% I_NOM	40.96
VBUS_REF_NORM	D33 - DC Voltage Reference (Norm)	0	100	0	% DC_BUS_NO M	163.84
REG_CARD_TEMP	D40 - Regulation card temperature			0	°C	16
LOAD_PRB_RES	D41 - Thermal probe resistance			0	kOhm	16
AI1	D42 - Analog Input AI1	-100	100	0	%	40.96
AI2	D43 - Analog Input AI2	-100	100	0	%	40.96
AI3	D44 - Analog Input AI3	-100	100	0	%	40.96
IGBT_J_TEMP	D45 - IGBT junction temperature			0	°C	16
IGBT_J_TEMP_MARGI N	D46 - IGBT junction temperature margin with its limit			0	°C	16
PRC_APP_I_MIN	D48 - Minimum current limit by application	-400	400	0	% I_NOM	40.96
WORK_HOURS	D49 - Work Hours			0	hours	1
SERIAL_NUMBER	D59 - Converter Serial Number			0		1
FLD_CARD	D60 - Fieldbus Card			0		1
PLC_REV	D61 - Application Revision			0		163.84
HW_SENSOR2	D62 - Sensor2 presence			0		1
HW_SENSOR1	D63 - Sensor1 presence			0		1
MAP_ERROR_CODE	Mapping Error Code			0		1
MAP_ERROR_OBJ	Mapping Error Object			0	Hex	1
FLDB_ERROR_CODE	Fieldbus error code			0		1
FLDB_STATE	Fieldbus state			0		1
PRC_TX_WORD0	Process Data Write word 0			0	Hex	1

PRC_TX_WORD1	Process Data Write word 1			0	Hex	1
PRC_TX_WORD2	Process Data Write word 2			0	Hex	1
PRC_TX_WORD3	Process Data Write word 3			0	Hex	1
PRC_TX_WORD4	Process Data Write word 4			0	Hex	1
PRC_TX_WORD5	Process Data Write word 5			0	Hex	1
PRC_TX_WORD6	Process Data Write word 6			0	Hex	1
PRC_TX_WORD7	Process Data Write word 7			0	Hex	1
PRC_TX_WORD8	Process Data Write word 8			0	Hex	1
PRC_TX_WORD9	Process Data Write word 9			0	Hex	1
DISPLAY_FW_REV	Display Firmware revision			0		1
AI16	16 bit Analog input (optional)	-100	100	0	%	40.96
ANYBUS_EN	Anybus module enabled			0		1
FLDBUS_STATE	Anybus/Profinet module state			0		1
SW_RESET_CNT	Software reset occurs			0		1
BO_CAN_MOD	Bus-off status. If 1 the CAN module is in bus-off status			0		1
REC_CAN_MOD	CAN Receive Error Counter			0		1
TEC_CAN_MOD	CAN Transmit Error Counter			0		1
STATE_SM	Actual states of the State Machine			0		1
CYCLE_TIME	CAN Open: Cycle period in us (Obj 0x1006) - EtherCAT: Sync0 Cycle time in ns			0		1
PDO_MAPPING	PDO mapping - the value is configured with C91			0	Hex	1
EN_PDO	COE: PDO enabled			0	Bin	1
EN_SM_ASSIGN	COE: Sync Manager PDO assigned			0	Bin	1
ESC_DL_STATUS	ESC Data Link Status			0	Bin	1
RD_ESC_REGISTER0	Read ESC registers 0			0	Hex	1
RD_ESC_REGISTER1	Read ESC registers 1			0	Hex	1
I_LOOP_BAND	Current loop bandwidth			0	Hz	1
SYNC_DELAY	Delay from SYNC reception to routine execution			0	us	1
PWM_SYNC_OFFSET	PWM offset for SYNC delay control			0	pulses	1
PWM_COUNTER	ISR counter			0.0		1
V_ISR	Voltage routine duration			0	us	64
I_ISR	Current routine duration			0	us	64
APP_FAST_ISR	Application fast task duration			0	us	64
APP_AVBLE_FAST_ISR	Application fast task available time			0	us	64
DRV_F_PWM_MAX	Max PWM frequency available			0	Hz	1
BOOTLOADER_REV	Bootloader revision					1
PN_LED_STATUS	Profinet Led Status					1
TLESS_IDC_U	D400 - Tless Idc U current	0	32.767	0	A	1000
TLESS_IDC_W	D401 - Tless Idc W current	0	32.767	0	A	1000

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