PortGuard

USER MANUAL

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VoltGuard®

BASIC PURPOSE

PortGuard is an electric vehicle charging control unit communicating with electric vehicles in accordance with the CNS EN 61851-1 standard. This unit is installed in electric vehicle charging stations, usually for Mennekes Type 2 sockets. The PortGuard charging control unit is used for setting the required charging station parameters, indicating the charging station status and checking the service and additional devices to ensure safe charging of electric vehicles. When installed within the VoltGuard charging infrastructure system, the PortGuard charging control unit is used as the final action element of the electric vehicle charging system processing information transferred from the HomeGuard residual capacity meter through the serial line and dynamically setting the consumption parameters. It is capable of setting the charging current exactly according to the current available at the point of supply (at the distribution meter). The communication between the HomeGuard residual capacity meter and the PortGuard charging control unit can also be done by means of RS485 twisted pair bus, however, such a cable is usually not installed between the input of the power supply point and the charging station. In case the installation uses the ShiftGuard PLC modems, the charging stations can be placed anywhere after the distribution meter.

MAIN FEATURES

- Electric vehicle charging control in accordance with the CNS EN 61851-1 standard
- Power supply of 230V AC and for controlling the armature of the power contactor of the electric vehicle power supply line
- CC (Current Configuration) inputs for entering the maximum electric vehicle charging current evaluated throughout the charging process
- Evaluation of the type of the connected PP charging cable using point-to-point resistance (RPP)
- Switching relay contact outputs for activating the ventilation
- Switching relay contact outputs for signalling the error status
- Outputs for LED status indication
- Circuits for controlling the motor of the charging cable socket lock, monitoring its proper locking
- Automatic unlocking of the socket in case of 230V AC power failure
- DC power supply (12V / 0.85A) output terminals for other purposes
- Communication interface RS-485 (semi-duplex, 9600 Bd, 8N1)
- Dimensions designed for MODULBOX 5M

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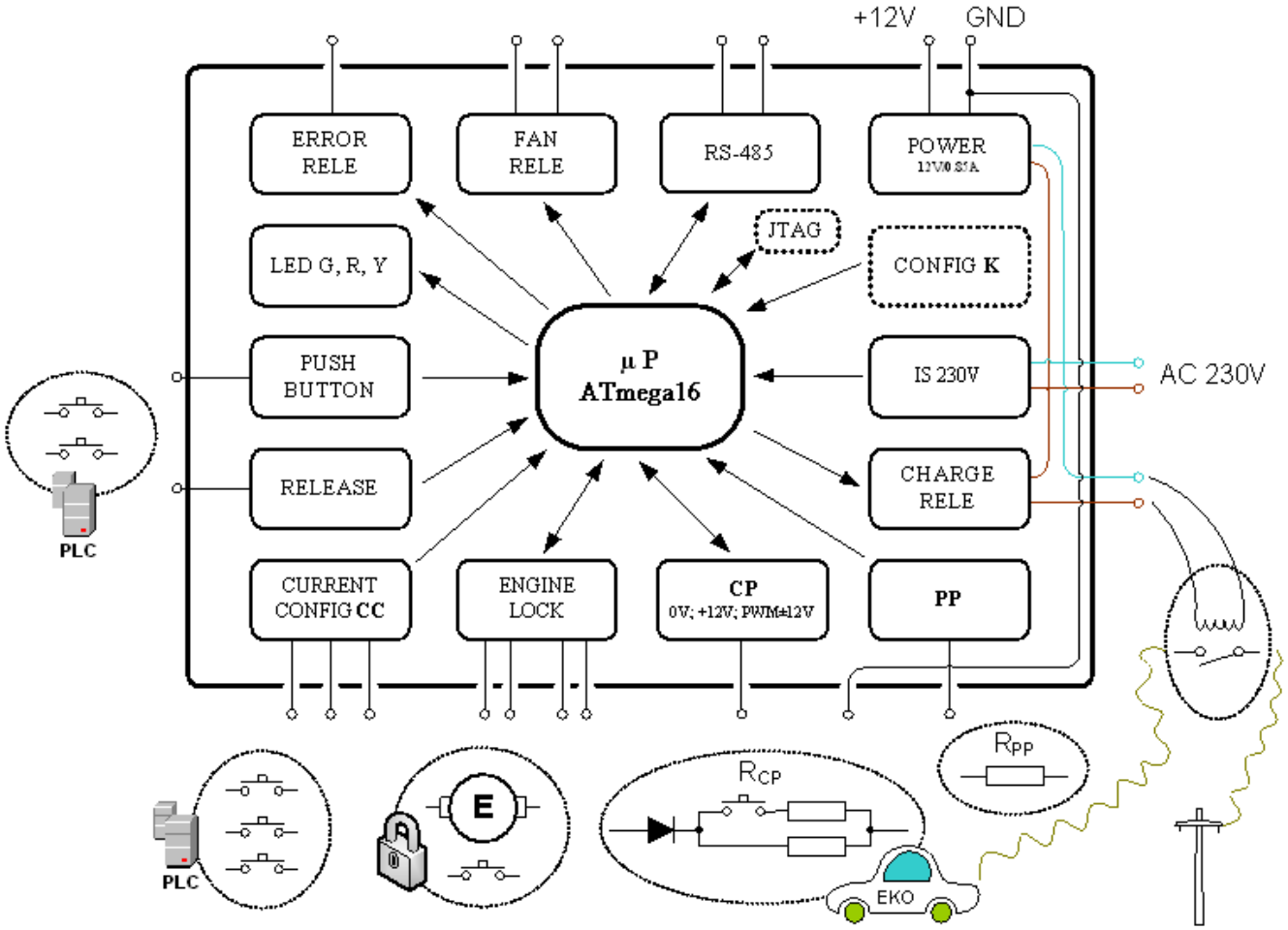
BLOCK DIAGRAM



DESCRIPTION

The PortGuard charging control unit is designed to communicate with the connected electric vehicle in accordance with the CNS EN 61851-1 standard. The communication is based on pulse-width modulation by changing the duty cycle of 1 kHz signal and its amplitude. Other devices are connected to PortGuard using its inputs and outputs.
The control unit contains an implemented status machine carrying out defined operations on the outputs according to input stimuli. Particular statuses and transitions of the status machine are described in the status diagram, see below.

CHARGING PROCESS

The input pin Terminal # 16-PB "PUSH BUTTON" controls locking/unlocking of the charging cable socket. The PB input voltage of (12-24) V activates the charging cable socket lock. The socket does not lock until the unit detects that a charging cable is connected to the socket (RPP resistor valid value) and the power supply of 230 V is available. The actual state of the socket lock is monitored by the input Terminal # 3. If locking fails, the unit attempts to lock the socket again with a period of 1 Hz. The PB input voltage of (0-3) V deactivates the charging cable socket lock. If unlocking fails, the unit attempts to unlock the socket again with a period of 1 Hz. The actual state of the socket is indicated by LED (blinking 2Hz – socket unlocked, blinking 5 Hz – socket locked). **By deactivating the socket lock the device goes into**

the "INIT" mode, unless it is the ERROR mode.
The input pin Terminal # 20-RE "RELEASE" allows charging of the electric vehicle or cancels the current charging process. **The RE input voltage of (0-3) V deactivates the charging process and the device goes into the "INIT" mode.** The RE input voltage of (12-24) V indicates that charging of the electric vehicle is allowed.

The ERROR mode (LED indicator OFF) is cancelled after deactivating the RELEASE input and the device goes into the "INIT" mode.

The device does not go out of "INIT" mode until the PUSH BUTTON input activates the charging cable socket lock, the socket is actually locked (evaluated by the input pin Terminal # 3) and the RELEASE input allows charging of the electric vehicle. POnce all the above conditions are met, the device goes into the "READ PP" mode.
If in the "READ PP" mode, the device evaluates the cable connection on the PP input and the cable type (which is then used for the PP current limit). Once the valid RPP resistor is recognized, the device goes into the "WAIT CP 9/6/3" mode.
If in the "WAIT CP 9/6/3" mode, the device activates +12V (no load) voltage on the output Terminal # 5-CP and on the same pin evaluates the voltage drop on the connected resistor on the side of the charged electric vehicle. In case the voltage drop on the pin Terminal # 5-CP is 9V, 6V or 3V, the device goes into the "WAIT CP 6/3" mode.
If in the "WAIT CP 9/6/3" mode (LED indicator blinks 2x), the device turns on a PWM signal of ±12V (no load) on the output Terminal # 5-CP with the duty cycle corresponding to magnitude of the charging current. In case the voltage drop on the pin Terminal # 5-CP is 6V or 3V, the device goes into the "WAIT 3 sec" mode. In case the voltage detected on the pin Terminal # 5-CP is 12V, the device goes into the "CHARGE DONE" mode.
If in the "CHARGE DONE" mode (LED indicator is off), the charging process is completed. In case the RE input voltage of (0-3) V is detected, the device goes into the "INIT" mode.
In case 230V AC power failure is detected, the device goes into the "INIT" mode. If K1 configuration jumper is installed, the charging socket is unlocked automatically using the residual power supply, independently on the PB (PUSH BUTTON) input voltage.

K3 configuration jumper "no lock mode" installed
This jumper informs the device about activating the mode without the charging cable socket lock. In this mode, the socket motor is deactivated and the input pin Terminal # 16 "PUSH BUTTON" does not affect the transitions between the device modes. The input Terminal # 3 does not affect the transitions either.

SETTING MAXIMUM CURRENT ON CP
The maximum current is defined by the duty cycle of the CP signal and can be set in three different ways: through a communication protocol; by setting the charging cable point-to-point resistance (RPP); and using the CC binary configuration inputs. All these inputs are equal and the set value is always the lowest value. The communication between PortGuard and the superior control system is expected to be done in real time and the value is to be repeated continuously. In case of failure longer than 10s, the value set by the communication protocol is no more taken into account and the maximum current is set according to the cable and the CC inputs.

Setting by communication protocol
The maximum current can be set through the communication protocol, see the chapter "Communication". The maximum current is 63/70A.

Setting by charging cable

Output PWM duty cycle ±12V, K4 configuration jumper not installed

The PWM duty cycle of the CP signal is calculated from the permissible current load of the charging cable.

RPP resistor	PP charging current
1.5 kΩ	13 A
680 Ω	20 A
220 Ω	32 A
100 Ω	63/70 A (according to K5 configuration jumper)

The table describes the relation between the RPP resistor and the permissible current load of the charging cable.

The RPP resistor is evaluated in the "READ PP" mode. During the charging process the value on this input is not evaluated providing a constant duty cycle throughout the charging process.

The duty cycle of the PWM output ±12V, K4 configuration jumper installed

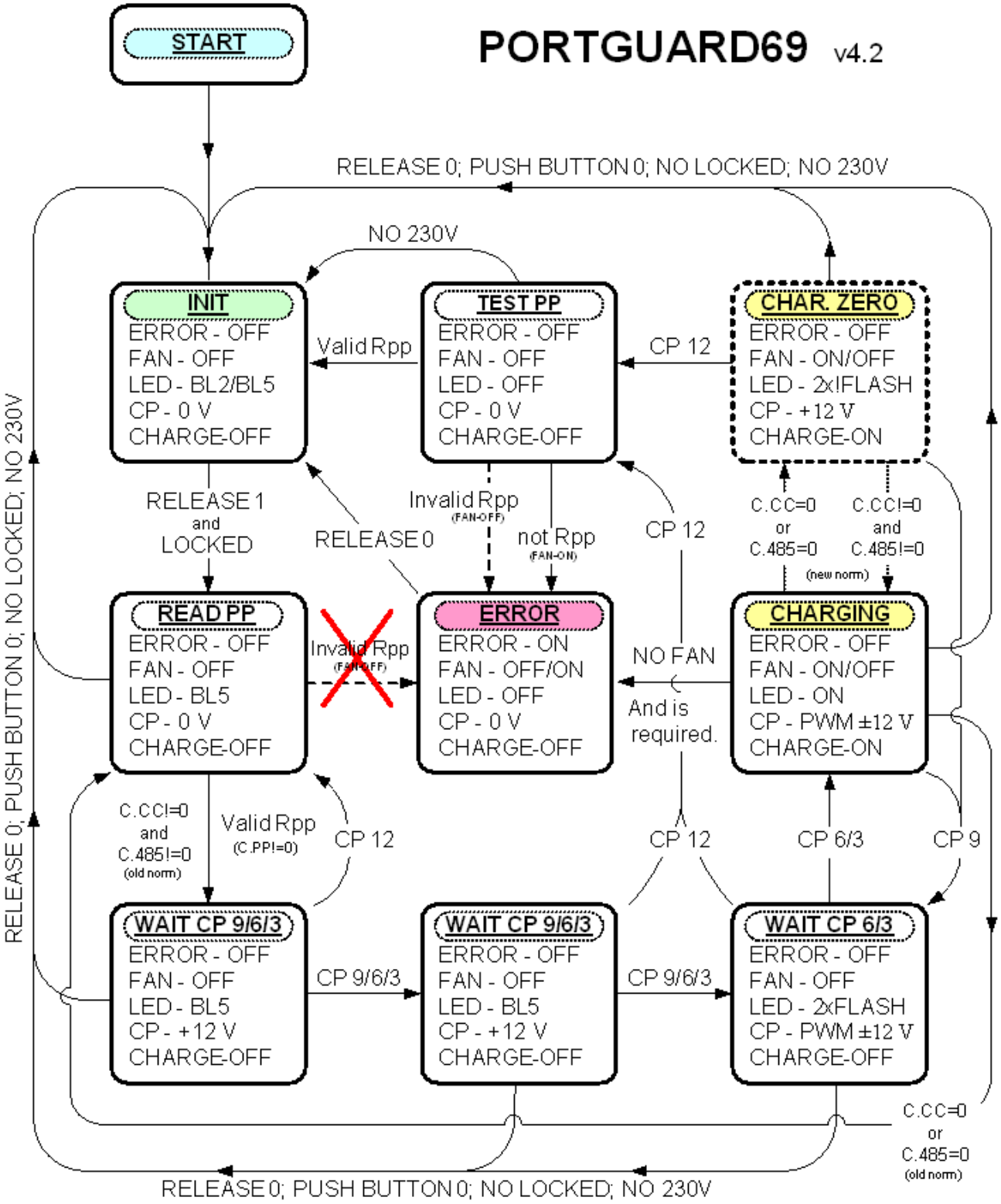
The PWM duty cycle of the CP signal is calculated from the lower value of the permissible current load of the charging cable (evaluated from the measured RPP value in the "READ PP" mode) and the configuration input Terminal # 17, # 18, # 19 – CC "CURRENT CONFIGURATION" (evaluated continuously in the "CHARGING" mode).

Setting by CC inputs

Three binary inputs (Terminal # 17, # 18, # 19) encode eight combinations. The set combination (0-7) is determined by conditional sum of three weights (input Terminal # 17/weight 1; input Terminal # 17/weight 2; input Terminal # 17/weight 4), similar to binary to decimal conversion. If the voltage detected on the particular input (Terminal # 17, # 18, # 19) is within (0-3) V, the weight of the particular input is not added to the total sum. If the voltage detected on the particular input (Terminal # 17, # 18, # 19) is within (12-24) V, the weight of the particular input is added to the total sum. The conditional sum of values (1; 2; 4) according to the input voltage (Terminal # 17, # 18, # 19) gives one of the combinations (0; 1; 2; 3; 4; 5; 6; 7).
The following table shows the relation between the charging current encoding and the input voltage (Terminal # 17, # 18, # 19) "CURRENT CONFIGURATION" (CC).

K2 jumper	Terminal#17(IN4) weight 1	Terminal#18(IN3) weight 2	Terminal#19(IN2) weight 4	Σ weights	CC maximum charging current
Not installed	(0-3) V	(0-3) V	(0-3) V	0	"WAIT"
Not installed	(12-24) V	(0-3) V	(0-3) V	1	6 A
Not installed	(0-3) V	(12-24) V	(0-3) V	2	10 A
Not installed	(12-24) V	(12-24) V	(0-3) V	3	13 A
Not installed	(0-3) V	(0-3) V	(12-24) V	4	16 A
Not installed	(12-24) V	(0-3) V	(12-24) V	5	20 A
Not installed	(0-3) V	(12-24) V	(12-24) V	6	25 A
Not installed	(12-24) V	(12-24) V	(12-24) V	7	32 A
Installed	(0-3) V	(0-3) V	(0-3) V	0	"WAIT"
Installed	(12-24) V	(0-3) V	(0-3) V	1	13 A
Installed	(0-3) V	(12-24) V	(0-3) V	2	20 A
Installed	(12-24) V	(12-24) V	(0-3) V	3	25 A
Installed	(0-3) V	(0-3) V	(12-24) V	4	32 A
Installed	(12-24) V	(0-3) V	(12-24) V	5	40 A
Installed	(0-3) V	(12-24) V	(12-24) V	6	50 A
Installed	(12-24) V	(12-24) V	(12-24) V	7	63 A

The table describes the relation between the K2 jumper, CC "CURRENT CONFIGURATION" inputs and the maximum charging current values.



RELEASE 0 – input voltage (0÷3 V)
RELEASE 1 – input voltage (12÷24 V)

PUSH BUTTON 0 – input voltage (0÷3 V)
PUSH BUTTON 1 – input voltage (12÷24 V)

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CONNECTORS AND INPUT/OUTPUT DESCRIPTION

Bottom part of 13-pin connector

Terminal # 1	Socket lock motor, input controlled by µP (0 V, +12 V/max 1.3A pulsating, NC.)	(black)
Terminal # 2	Socket lock motor, input controlled by µP (0 V, +12 V/max 1.3A pulsating, NC.)	(red)
Terminal # 3	Locked socket state switch, connected pull-up resistor, input active at (0-2) V	(white)
Terminal # 4	Locked socket state switch, pin grounded GND	(blue)
Terminal # 5	CP – input/output, microprocessor controlled output (0 V, +12 V, PWM ±12 V) (microprocessor evaluates the pin voltage)	
Terminal # 6	PP – input (µP determines the type of the connected charging cable according to the voltage on the pin)	
Terminal # 7	GND for pins (Terminal # 5, Terminal # 6, Terminal # 8)	
Terminal	Free	
Terminal # 9	Power contactor armature output (connects 230 V/max 5 A – L phase conductor, min. cable cross section 0.5mm^2)	
Terminal # 10	Power contactor armature output (connects 230 V/max 5 A – N central conductor, min. cable cross section 0.5mm^2)	
Terminal_N	230 V supply voltage input – N central conductor	
Terminal_M	230 V supply voltage input – L phase conductor	

Terminal # 1 - The socket lock motor: this pin is to be used for connecting the motor controlling the socket lock, the microprocessor can set the combination (0 V, +12V/1.3A pulsating, NC.). The pulse duration is controlled by the unit application logic; the output has no overcurrent protection.

Terminal # 2 - The socket lock motor: this pin is to be used for connecting the motor controlling the socket lock, the microprocessor can set the combination (0 V, +12V/1.3A pulsating, NC.). The pulse duration is controlled by the unit application logic; the output has no overcurrent protection.

Terminal # 3 - The locked socket state switch: this pin is used for connecting PULL-UP 2.2 kΩ resistor to 5V voltage and to the microprocessor input pin. The microprocessor evaluates the input voltage of (3-5) V as "the socket lock switch open". The microprocessor evaluates the input voltage of (0-2) V as "the socket lock switch closed".

Terminal # 4 - The locked socket state switch: this pin is used for delivering the signal GND for the socket lock switch.

Terminal # 5 - The CP input/output: on this pin, the microprocessor, using additional circuits, can set the voltage combination (-12 V, OPEN, +12 V, PWM defined duty cycle ±12 V) with the output impedance of 1k◦. This pin is also connected through the auxiliary divider to the microprocessor AD input for evaluating the actual voltage on this pin. The microprocessor evaluates the voltage drop on 1k◦ resistor and calculates retrospectively the load impedance on the side of the charged electric vehicle.

Terminal # 6 - The PP input: this input is used for evaluating the type of the connected charging cable, eventually for detecting if any cable is connected to the socket. The microprocessor, using the connected PULL-UP resistor (with a capacity of 1kΩ connected to 5V voltage and the AD converter input) evaluates the voltage drop on the AD converter input and the microprocessor recalculates it to the value of the resistor installed in the charging cable socket (according to the resistor evaluation, the maximum current load of the cable is: 13 A, 20 A, 32 A, 63/70 A).

Terminal # 7 - The signal GND for pins Terminal # 5, Terminal # 6.

Terminals - These terminals are free.

Terminal # 9

Terminal # 10 - The armature outputs: used for connecting the power contactor of the electric vehicle charging current line. When the RELE-CHARGE charging relay is activated, the pins Terminal # 9 and Terminal # 12 are connected. The maximum current load of the contacts is 5 A. The pin Terminal # 10 is connected to the pin Terminal_N and cannot be disconnected on the printed circuit board.

Terminal_N - Supply power of 230 V – N central conductor.

Terminal_M - Supply power of 230 V – L phase conductor.

Terminal_N and Terminal_M are the inputs with 230 V AC supply voltage used for supplying power to the internal power source and the armature coil in the power contactor of the electric vehicle charging current line.

The microprocessor, using the additional circuits, evaluates the availability of 230 V voltage. If the mains voltage failure is detected, the microprocessor interrupts the current charging process (with K1 configuration jumper installed the charging socket will also be automatically unlocked).

Upper part of 13-pin connector

Terminal # 22	Supply and signal GND for the pins Terminal # 16 - Terminal # 21
Terminal # 21	Supply terminal, voltage + 12 V (output 12 V/0.3 A or 12 V/1 A
Terminal # 20	Input IN1 (0-24) V – RE "RELEASE" electric vehicle charging prohibited/allowed
Terminal # 19	Input IN2 (0-24) V – CC.0 "CURRENT CONFIGURATION" – BCD-2.bit weight 4
Terminal # 18	Input IN3 (0-24) V – CC.1 "CURRENT CONFIGURATION" – BCD-1.bit weight 2
Terminal # 17	Input IN4 (0-24) V – CC.2 "CURRENT CONFIGURATION" – BCD-0.bit weight 1
Terminal # 16	Input IN5 (0-24) V – PB "PUSH BUTTON" opening/closing the socket lock
Terminal # 15	RS-485 (A)
Terminal # 14	RS-485 (B)
Terminal # 13	RELE-FAN.C1 (max 48V/1 A), when activated, it connects Terminal # 13 and Terminal # 12
Terminal # 12	RELE-FAN.C2 (max 48V/1 A),
Terminal # 11	RELE-ERROR.C1 (max 12V/0.1 A), when activated, it connects Terminal # 21 and Terminal # 11

Terminal # 22 - The supply and signal GND for the pins Terminal # 16 - Terminal # 21.

Terminal # 21 - The supply terminal with 12 V voltage.
In case the internal power source is installed, this terminal can be used as 12 V signal source for the inputs Terminal # 16 - Terminal # 21 and also to supply power to external applications requiring 12 V power voltage with 0.3 A maximum current. An increased consumption on this pin may cause the device error when activating the motor of the charging cable socket lock.
In case the internal power source is not installed, this terminal can used to supply power to the device. The external power source must be a stabilized source with a rated voltage of 12 V/1 A (a lower power source may not fully cover the device demands in all operating modes, a higher power source may damage the motor output control in case of short circuit in the charging cable socket lock motor).

Terminal # 20 - The RE "RELEASE" input IN1 (0-24) V; the input for allowing the charging mode. If the input voltage is (0-3) V, the device goes into or remains in the "INIT" mode. If the input voltage is (12-24) V, the device can go out of the "INIT" mode and continue in the active charging mode.

Terminal # 17, # 18, # 19 - The CC "CURRENT CONFIGURATION" inputs IN2; IN3; IN4 (0-24) V; these inputs are used to inform the device about the requirement for the electric vehicle maximum charging current.
Using the present charging current requirement, the device calculates the corresponding PWM duty cycle for the CP output by which it informs the electric vehicle about the maximum current value that the electric vehicle can use during the charging process. A detailed description can be found in the paragraph "CC Input Encoding".

Terminal # 16 - The PB "PUSH BUTTON" UN5 (0-24) V: the input for controlling the charging cable socket lock. The input voltage of (0-3) V sends a request for unlocking the socket; the input voltage of (12-24) V sends a request for locking the socket.

Terminal # 15 - The RS-485 serial interface, conductor A, semi-duplex configuration.

Terminal # 14 - The RS-485 serial interface, conductor B, semi-duplex configuration.

Terminal # 12, # 13 - The RELE-FAN contacts of the switching relay used to control the ventilation. The relay connects the contacts Terminal # 12 and Terminal # 13. The maximum load of the contacts is 48V/1 A.

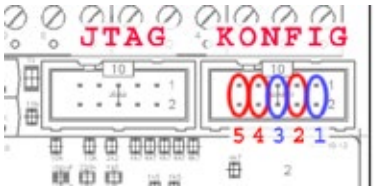
Terminal # 11 - The RELE-ERROR contacts of the switching relay used for ERROR mode indication: In case of the ERROR mode, the relay connects the contacts Terminal # 11 and Terminal # 21. The maximum load of the contacts is 12V/0.1 A.

LED INDICATON

The LED indicator on the PortGuard motherboard is described in the status diagram.

CONFIGURATION

The PortGuard configuration is carried out through the parameterization connector on the motherboard. Parameterization is usually done in the production plant; custom setting can only be done in special cases and by a trained person.



CON3 Connector (JTAG – installed inside the device)

The JTAG connector is used for programming the microprocessor firmware and debugging the code. The connector does not have to be installed in the final version.

CON4 Connector (KONFIG – installed inside the device)

The device configuration connector: As shown in the diagram above, the installed jumper enables the configuration of the device according to the following description:

K5 - ventilation:
- not installed – ventilation not available
- installed – ventilation available

K4 – do not use, a spare jumper for future use

K3 – lock deactivation:
- not installed – lock mode
- Installed – no lock mode

K2 – current range selection:
- not installed – current range: "WAIT", 6A, 10 A, 13A, 16A, 20A, 25A, 32A according to the input combination (Terminal # 17, # 18, # 19) "CURRENT CONFIGURATION" (CC)
- installed - current range: "WAIT", 13A, 20A, 25, 32A, 40A, 50A, 63A according to the input combination (Terminal # 17, # 18, # 19) "CURRENT CONFIGURATION" (CC)

K1 – power failure conduct:
- not installed – in case of power failure the lock remains unchanged as before the failure
- installed - in case of power failure the socket is automatically unlocked

COMMUNICATION

The setting of the RS485 serial channel is 9600, 8n1.
The device accepts the following communication packet on its input.

A. Short option – remaining circuit breaker capacity

STX	SOURCE	DEST	NUM OF SLAVES	CMD	DELKA	DATA	DATA	DATA	SUMA	ETX
0x02	'0' + Source	'0'	'0' + Domain DIP	'A'	3	'0'	'0'	'0'	SUMA	0x03

The variables are only the following fields:

- <STX> - Start of text – the start of the packet
- <SOURCE> - '0' character + address (usually the DIP switch value in the HomeGuard device)
- <DEST> - the address of the packet target device, for PortGuard usually '0'
- <NUM OF SLAVES> - the number of target devices which the packet is intended for. If more PortGuard modules are installed, the residual current value is adequately reduced.
- <CMD> - the command used for setting the station charging current, for PortGuard usually 'A'
- <DATA> - uses three characters, where '123' means free capacity 12.3 A.
- <SUMA> - the control packet sum – the result is one byte and it is calculated as XOR of all bytes over the SUMA byte including the STX byte

TYPE DESIGNATION AND ORDER CODE

PortGuard	PG	xx	yy.	zz
HW modification				
FW modification				
Internal setting				

For a specific order code depending on the device features, contact the supplier or directly the manufacturer.

INSTALLATION AND SOLVING OPERATIONAL PROBLEMS

DIN rail installation

The unit is mounted vertically onto the DIN rail in the switchboard. The device can be installed within the array of modular devices on the DIN rail like breakers and contactors. The device is designed to be installed in charging stations and must be inaccessible for average users.
The connection with the superior system (usually with the HomeGuard or ShiftGuard modules) is done through RS485 line. The line is connected using a usual twisted pair; a suitable cable is, for example, Lam Flexo Twin communication cable or Lam Flexo FTP. With a cable length of hundreds of meters, it is advisable to consider terminating the bus by a termination resistor, usually up to 1000 ohms. However, it is not necessary in most cases as the bus communication speed is very low.

VoltGuard®

TECHNICAL SPECIFICATIONS

Power supply

- Rated voltage: ..... 230 V AC
- Specified supply voltage range: ..... 0.9 – 1.1 Un
- Rated frequency: ..... 50 Hz
- Rated power input: ..... 5 W
- Internal power supply: ..... 12 DC/0.85 A

Functional properties

- CP output for station capacity information
- Connected cable type evaluation
- Internal configuration connector (ventilation available/unavailable, charging current control according to PP cable evaluation/PP cable evaluation and set CC input configuration)
- Switching relay output contacts for ventilation activation
- Switching relay output contacts for error mode indication
- LEI status indicator output
- Input/output for controlling the motor of the charging cable socket lock

Construction parameters

- Dimensions: ..... 71 x 91 x 71.5 mm (WxHxD)
- Weight: ..... 200 g
- Operating temperature: ..... between -30°C and +50°C
- Storage temperature: ..... between -40°C and +70°C
- Installation: ..... DIN rail
- IP Code IP20

Insulation parameters according to the CSN EN 60664-1/CSN EN 60664-3 standards

- Overvoltage category: III
- Pollution degree: 3
- Altitude: ..... <2000m

Communication

- Type: ..... RS485 twisted pair physical layer
- Communication line parameters: ..... 9600 baud, 8n1
- RS485 serial line power supply: ..... internal
- RS485 twisted pair replacement options: ..... Voltdrive ShiftGuard PLC modems
- Communication protocol: ..... VoltGuard system proprietary protocol, see product documentation

Type tests

- Protection class: 2
- Safety: ..... assessed according to the CSN EN 61010-1 standard

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SAFETY INSTRUCTIONS

The product is capable of safe operation. The manufacturer warns of the risk of possible danger resulting from incorrect handling or incorrect use of the product:

- The installation and maintenance must be carried out by a competent person with relevant electrical qualifications, who informs the operator about the conditions for safe operation.
- The product must not be used for other than its intended purpose.
- The product must not be modified compared to its standard design.
- The product must not be operated with other voltage, current or frequency than it was produce or professionally modified for.
- The product must be placed and secured, so that it is difficult to access or inaccessible for people without any electrical qualification, especially children.
- Before every re-commissioning, for example, after any reparation or maintenance, the protection and all safety measures must be completely restored to ensure safe operation.
- The product must not be used in conditions and environments that do not guarantee safe operation (for example, installed on a flammable surface, its cover made of flammable materials, insufficient protection against foreign body intrusion or water and other liquid ingress).

In case the user does not comply with any of the above instructions and if this noncompliance results in any defect, the manufacturer disclaims any liability for the defect.