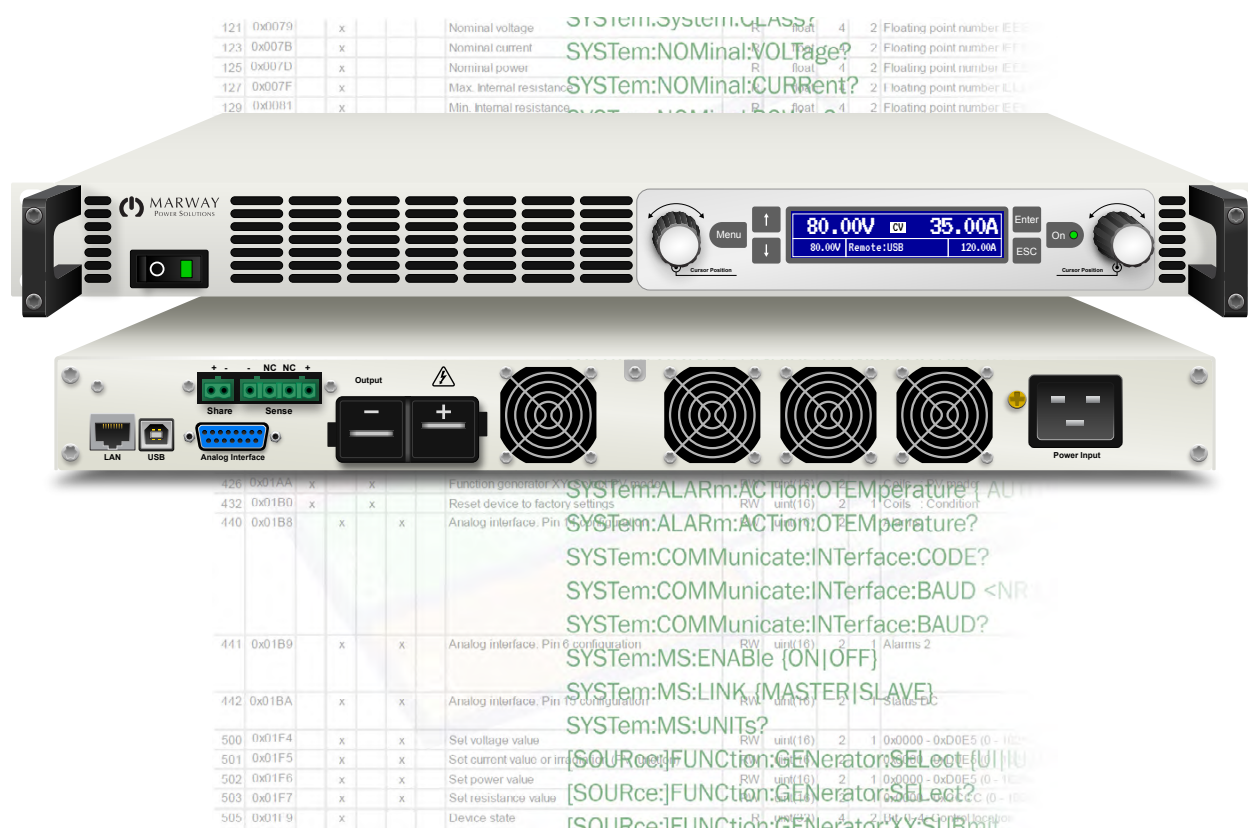




mPower™ DC Power Supplies 300 Series

Operating Guide and Programming Reference



Oct 2022 : P/N 501046-300-OP-A

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<http://www.marway.com/docs>

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1 General

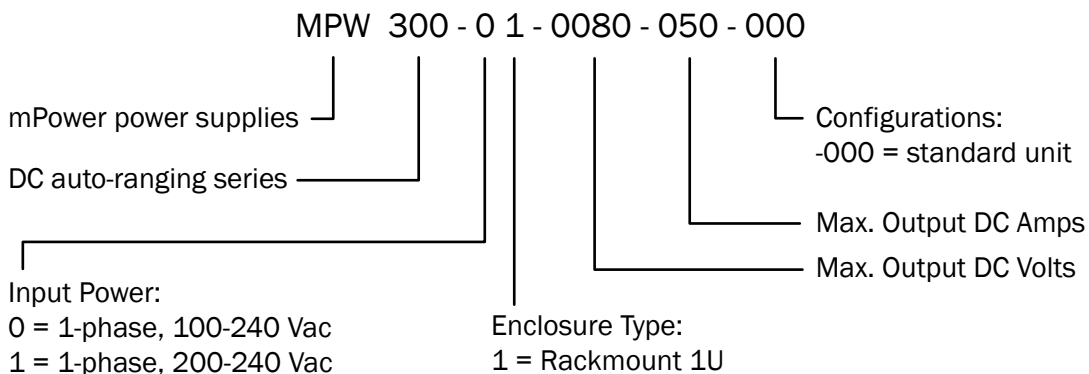
1.1 Documentation Symbols

Warning and safety notices as well as general notices in this document are shown in a box with a symbol as follows:

	Symbol for a life threatening danger
	Symbol for general safety notices (instructions and damage protection bans) or important information for operation
	Symbol for general notices

1.2 Product Key

Decoding of the product description on the label, using an example:



1.3 Intended Product Usage

The equipment is intended to be used as a general purpose power supply only as a variable voltage and current source.

1.4 Safety Notices

Mortal danger - Hazardous voltage



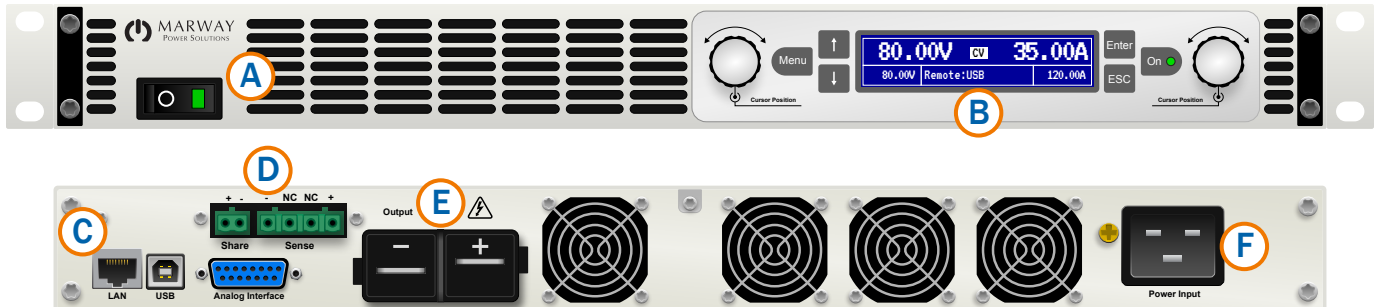
- This is electrical equipment with some parts operating with dangerous voltage. All exposed components which can have live voltage must be covered.
- All work on connections must be carried out under zero voltage (output disconnect), and may only be performed by qualified and informed persons. Improper actions can cause fatal injury as well as serious material damage.
- Never touch cables or connectors directly after unplugging from mains supply as the danger of electric shock remains. Verify there is zero voltage with a handheld meter.
- Never touch the contacts on DC output terminal directly after switching off the DC output, because there still can dangerous voltage present, sinking more or less slowly depending on the load. There also can be dangerous potential between negative DC output to GND or positive DC output to GND due to charged capacitors. Verify there is zero voltage with a handheld meter.
- Always follow 5 safety rules when working with electric devices:
 - Disconnect completely.
 - Secure against reconnection.
 - Verify that the system has zero voltage.
 - Carry out earthing and short-circuiting.
 - Provide protection from adjacent live parts.



- The equipment must only be used as intended.
- The equipment is only approved for use within the connection limits stated on the product label.
- Do not insert any object, particularly metallic, through the ventilator slots
- Avoid any use of liquids near the equipment. Protect the unit from wet, damp and condensation.
- Do not connect loads, particularly low resistance, to power supplies under power; sparking may occur which can cause burns as well as damage to the equipment and to the user.
- ESD regulations must be applied when plugging interface cards or modules into the relative slot
- Interface cards or modules may only be attached or removed after the unit is switched off. It's not necessary to open the unit.
- Do not connect external power sources with reversed polarity to DC input or outputs. The equipment will be damaged.
- Avoid where possible connecting external power sources to the DC output, and never those that can generate a higher voltage than the nominal voltage of the unit.
- Always configure the various protecting features against overvoltage etc. for sensitive loads to what the target application requires.

2 Installation

2.1 Physical Overviews



A - Power switch

B - Control panel

C - Control interfaces (LAN, USB, Analog)

D - Share bus and Sense bus connectors

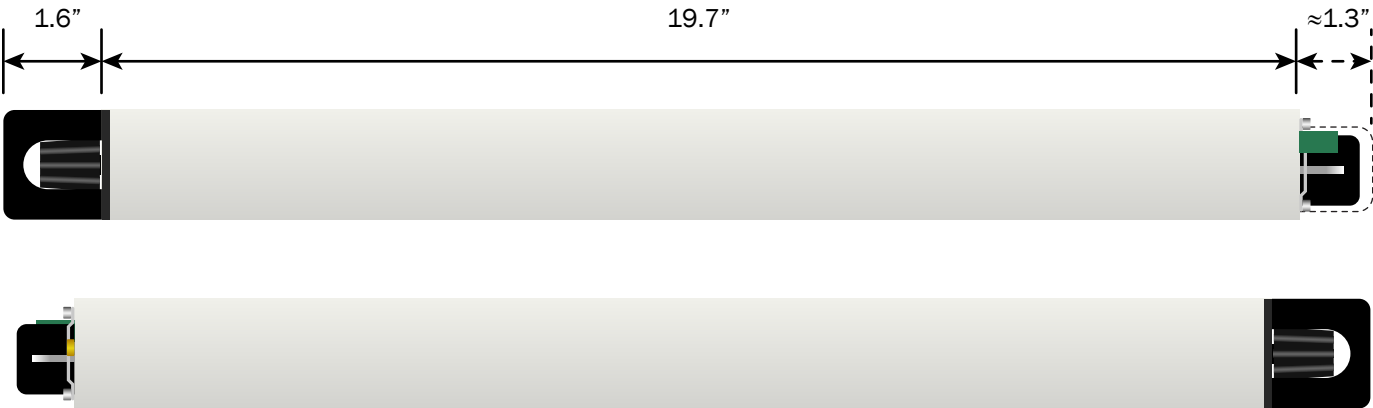
E - DC output

F - AC input connector



The brass screw next to the AC connector is a central grounding point for internal use. Do not unscrew to connect external GND potential here. The device is grounded via the AC cable.

1U sides shown without DC terminal cover. Note that DC outlet dimensions do not include cable bend radius.



1U top shown without DC terminal cover.



2.2 Unpacking and Visual Check

After every transport, with or without packaging, or before commissioning, the equipment should be visually inspected for damage. An obviously damaged unit (e.g. loose parts inside, damage outside) must under no circumstances be put into service.

2.3 Transport and Storage

2.3.1 Transport



- The handles on the front side of the unit are not for carrying!
- Because of its weight, transport by hand should be avoided where possible. If unavoidable then only the housing should be held and not on the exterior parts (handles, DC output terminal, rotary knobs).
- Do not transport when switched on or connected!
- When relocating the equipment use of the original packing is recommended
- The unit should always be carried and mounted horizontally
- Use suitable safety clothing, especially safety shoes, when carrying the equipment, as due to its weight, a fall can have serious consequences.

2.3.2 Packaging

It's recommended to keep the complete transport packaging for the lifetime of the power supply for relocation or return to the manufacturer for repair.

2.3.3 Storage

In case of long term storage of the equipment, it is recommended to use the original packaging or similar. Storage must be in dry rooms, if possible in sealed packaging, to avoid corrosion through humidity—especially to internal components.

2.4 Installation Preparation

2.4.1 Safety considerations before installation

Review safety notes in section [1.4. Safety Notices](#)



- When using a 19" rack, rails suitable for the width of the housing and the weight of the unit are to be used. Rails are to be provided by the end user suitable for the rack. (see [10. Model Specifications Appendix](#))
- Before connecting to the mains ensure that the connection is as shown on the product label. Over-voltage on the AC supply can cause equipment damage.

2.4.2 Mounting the unit

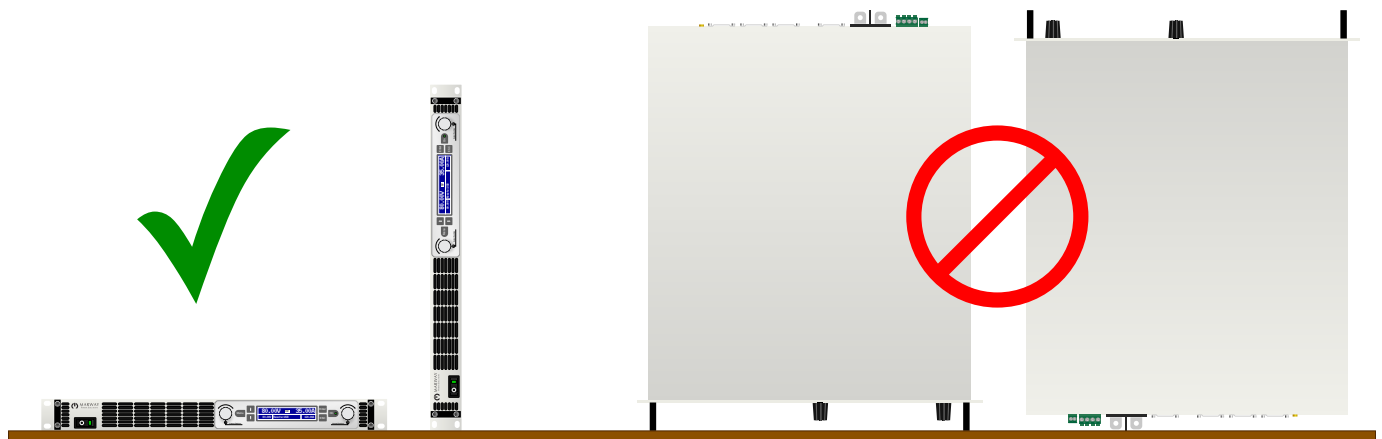


- Select the location for the equipment so that the connection to the load is as short as possible.
- Leave sufficient space behind the equipment, minimum 30 cm (1 ft), for ventilation.
- The unit is not stackable.
- Do not put anything with a total weight of more than 1 kg (2.5 lb) on top of the unit.

With all models, mounting brackets are included to mount the unit in a 19" rack. A rackmount installation will usually mount the power supply on suitable weight-rated rails (not included), and installed in 19" racks or cabinets. The depth of the power supply and rack, and its weight must be taken into account when selecting rails. The handles on the front are for sliding in and out of the cabinet. Slots on the mounting brackets of the front panel are for securing the unit to the rack's vertical rails to prevent inadvertent movement on the slides.

If the unit will be used in a table top setting, the brackets may be removed, and self-adhesive feet attached to the bottom of the unit.

Acceptable and unacceptable installation positions relative to a table surface.



2.5 Power Connections

2.5.1 AC input connections

Mains connection for an mPower 300 series system is done via the included mains cord. In case a different AC wiring is required, make sure that the other cable has a minimum cross section of 1.5 mm² (AWG 12).

Dimensioning of the DC wiring to the load/consumer has to reflect the following:



- The cable cross section should always be specified for at least the maximum input current of the unit.
- Continuous operation at the approved limit generates heat which must be removed, as well as voltage loss which depends on cable length and heating. To compensate for these the cable cross section should be increased and the cable length reduced.



- The unit can be connected to any wall socket or power distribution, as long as it features a safety contact (GND) and is capable for 16 A.
- When connecting the unit to a power distribution unit, along with other electric devices, it is important to consider the total power consumption of all devices on the outlet, so that the maximum current (power ÷ minimum voltage) does not exceed the definition for the wall socket, the multi-socket outlet and/or main distribution
- Before plugging in the input plug ensure that the unit is switched off by its mains switch.

The unit is delivered with a 3 wire mains cord (L, N, GND). If the unit is going to be connected to a standard 2-phase or 3-phase supply, following phases are required:

Nominal power	Phases	Supply type
1.5 kW / 3 kW	L1 or L2 or L3, N, GND	At least wall socket 16 A

The default input values of all models in this series are: 230 V, 16 A, 50 Hz. It is internally fused with 16 A. The 16 A input definition is due to the AC input current depending on the higher intake at low AC voltage (for minimum input voltage see technical specs). Connection to DC loads

2.5.2 DC output connections



- In the case of a unit with a high nominal current and hence a thick and heavy DC connection cable it is necessary to take account of the weight of the cable and the strain imposed on the DC connection. Especially when mounted in a 19" cabinet or similar, where the cable hangs on the DC output, a strain reliever should be used.
- Connection to and operation with transformerless DC-AC inverters (for example solar inverters) is restricted, because the inverter can shift the potential of negative output (DC-) against GND (ground), which is generally limited to max. ±400 V DC.

The DC load output is on the rear side of the unit and is **not** protected by a fuse. The cross section of the connection cable is determined by the current consumption, cable length and ambient temperature.

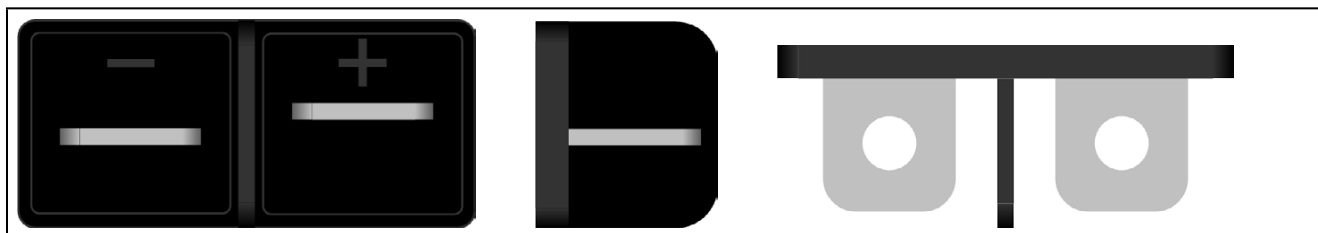
For cables up to 1.5 m (5 ft) and average ambient temperature up to 50 °C (122 °F), we recommend:

up to 10 A: 0.75 mm ² (AWG 18)	up to 40 A: 6 mm ² (AWG 8)
up to 15 A: 1.5 mm ² (AWG 14)	up to 60 A: 16 mm ² (AWG 4)
up to 30 A: 4 mm ² (AWG 10)	up to 100 A: 25 mm ² (AWG 2)

per lead (multi-conductor, insulated, openly suspended). Single cables of, for example, 70 mm² may be replaced by e.g. 2x 35 mm² etc. If the cables are long then the cross section must be increased to avoid voltage loss and overheating.

2.5.2.1 DC terminals

The diagrams below show an overview of the DC terminals from a plan, side, and top view. Both terminals have a 6mm hole in a nickel plated copper bar. It is recommended that connection of load cables always utilizes flexible cables with ring lugs.



2.5.2.2 Cable lead and plastic cover

A plastic cover for contact protection is included for the DC terminal. It should always be installed.



The connection angle and the required bending radius for the DC cable must be taken into account when planning the depth of the complete unit, especially when installing in a 19" cabinet or similar.

2.5.3 Grounding of the DC output

Grounding one of the DC output poles is allowed. Doing so can result in a potential shift of the grounded pole against GND. Because of insulation, there is a max. allowed potential shift of the DC output poles, which also depends on the unit model. See [10. Model Specifications Appendix](#).



The brass screw next to the AC connector is a central grounding point for internal use. Do not unscrew to connect external GND potential here! The unit is grounded via the AC cable.

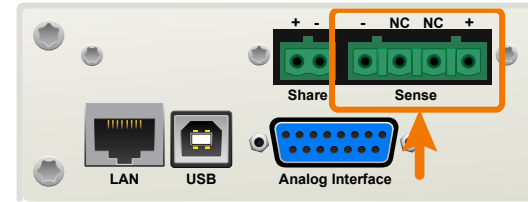
2.6 Remote Sensing Connection

Use the Sense connection when it is important that the adjusted output voltage is held constant at the load terminals rather than at the power supply's DC output terminals.

This Sense input is effective only in constant voltage operation (CV), and is recognized automatically by the system when installed.

In order to ensure safe insulation of high voltage models (500 V or higher), use only the two outer pins of the 4-pole terminal. The inner two poles, marked with NC (no connect), must remain unconnected.

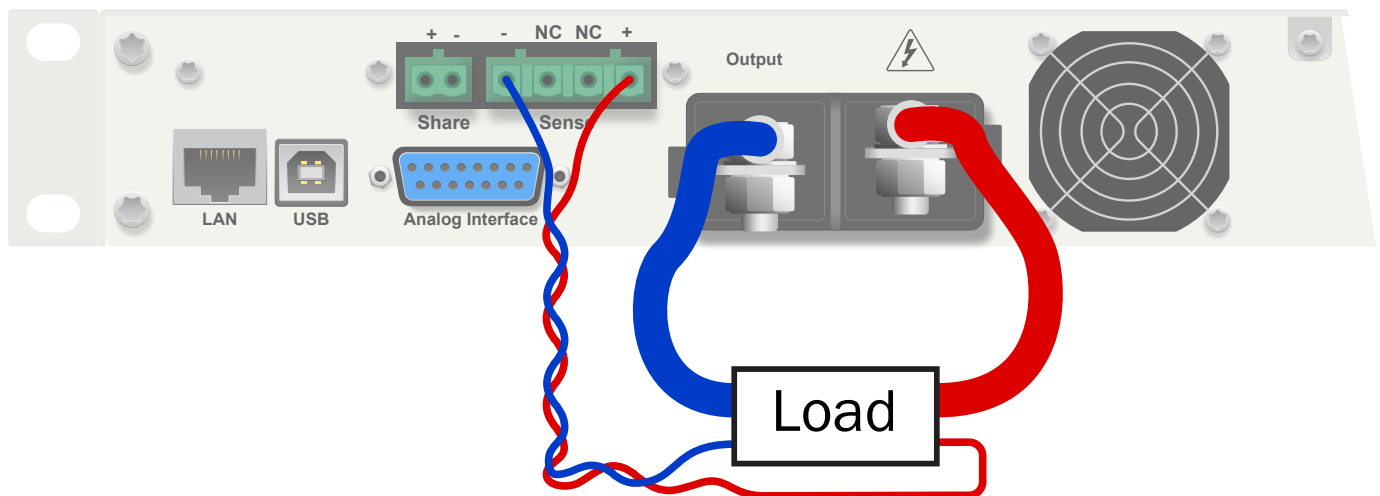
In the technical specifications (see section [10. Model Specifications Appendix](#)) the level of maximum possible compensation is given. If that is insufficient, the DC output cable cross section must be increased.



Both terminals “NC” of the Sense connector must not be wired!



- Remote sensing is only effective during constant voltage operation (CV) and for other regulation modes the sense input should be disconnected, if possible, because connecting it generally increases the oscillation tendency
- The cross section of the sense cables is noncritical. However, it should be increased with increasing cable length. Recommendation: for cables up to 5 m (16 ft) use at least 0.5 mm² (18ga).
- Sense cables should be twisted and laid close to the DC cables to damp oscillation. If necessary, an additional capacitor should be installed at the load/consumer to eliminate oscillation
- The Sense inputs must be connected with correct polarity to the load with Sense+ to DC+ of the load etc., otherwise both systems may be damaged.

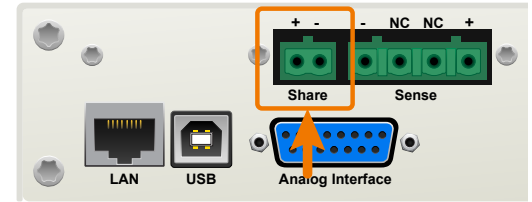


2.7 Share Bus Connection

The 2-pole terminal block named Share on the back of the unit is provided for connection to equally named connections on other mPower power supplies to achieve a balanced load current distribution during parallel connection. When multiple units (up to 10 total) are combined in parallel operation, the Share bus connectors must be wired together (+ to + and – to – across all units).

Further information about this mode of operation can be found in section 4.12. [Parallel Operation in Share Bus Mode](#).

For the connection of the share bus the following must be paid attention to:



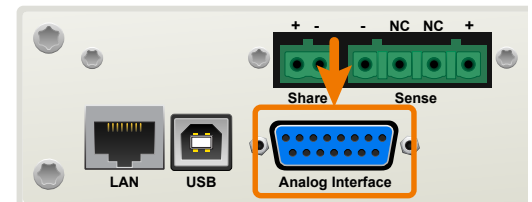
- Connection is only permitted between identical model units and between a max. of 10 units.
- The Share bus is referenced to DC minus output and thus affected by potential shifts. The potential of the DC minus has to be considered when connecting the Share bus to other units.
- When not using one or several units of a system configured with Share bus, because less power is required for an application, it is recommended to disconnect the unpowered units from the Share bus, because they may have a negative impact on the control signal on the bus due to their impedance. Disconnection can be done by simply unplugging them from the bus or using double pole switches.

2.8 Analog Interface Connection

The 15-pin, Sub-D socket on the back of the unit is provided for remote control via analog and discrete signals. To connect this to an external controller (PC, PLC, or other), a standard mating plug is necessary (not included in shipment).

The input voltage range of the set values, the output voltage range of the monitor values, and the reference voltage level can be switched in the Settings menu of the system as 0-5 V or 0-10 V, in each case for 0-100%.

See section 4.8.4. [Analog connector wiring](#) for pinout and other operation details.



- The analog interface is galvanically isolated from the unit internally. If not absolutely necessary, you should never not connect any ground of the analog interface (AGND) to the DC minus output as this will cancel the galvanic isolation.
- It is generally advisable to switch the unit completely off before connecting or disconnecting this connector, but at least switch off the DC output.

2.9 USB Port Connection

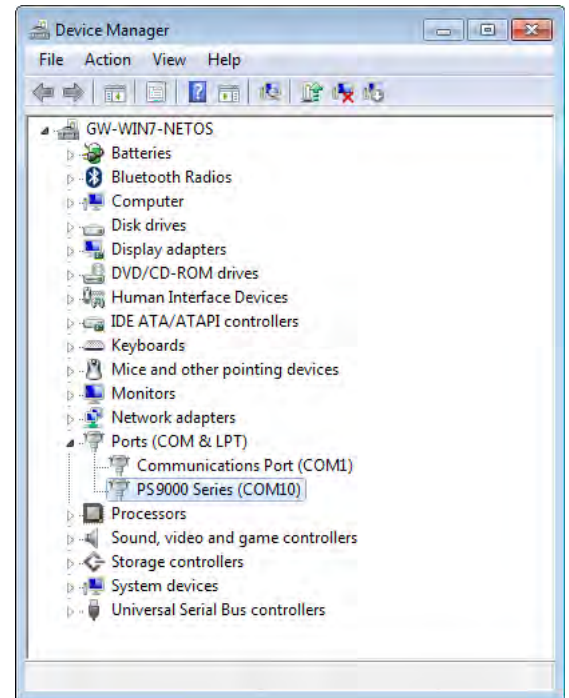
2.9.1 Driver installation (Windows)

On the initial connection with a PC, the operating system will identify the unit as new hardware, and will try to install a driver. The required driver is for a Communications Device Class (CDC) device, and is usually integrated in current operating systems such as Windows 7 or 10. However, it is strongly recommended to install and use the mPower USB Driver (available from our web site) to gain maximum compatibility between the computer and power supply.

2.9.1.1 Discovering COM Port in Windows

Once the driver is installed, and one or more power supplies are connected by USB to a PC, you will need to determine which COM port is used for which power supply. It is easier to do this if you attach one power supply at a time, so it is easier to find which COM port is the newest.

Attach a power supply, and turn on the AC power (it does not need any DC output connections). In Windows, navigate to Control Panels > Device Manager, and look for Ports in the list, and expand it. You will find one or more entries for PS 9000 Series — this is the name of the driver for the mPower DC 300. Next to those names you will see **(COMnn)** where nn will be a single or double-digit number. That is the COM port number. As you add one unit at a time, it should be apparant which COM has been added (and therefore which unit it connects to).



2.9.2 Non-Windows Drivers

We do not have drivers or installation instructions for other operating systems. Whether native drivers on other operating systems are sufficient to engage in remote control has not been tested. It is possible 3rd party commercial suppliers can help. Search the Internet for suppliers using the keywords “cdc driver windows” or “cdc driver linux” or “cdc driver macos”.

3 Features Overview

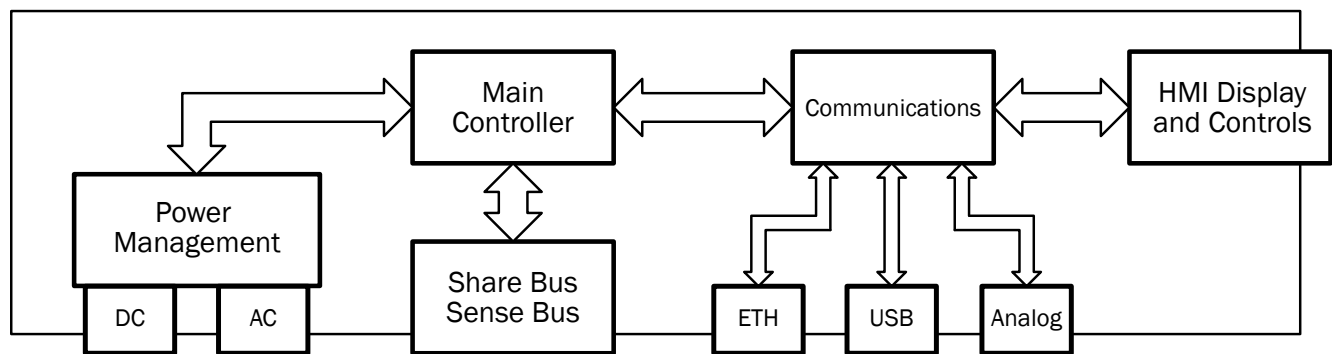
3.1 General Description

The mPower DC power supplies are especially suited to test and industrial applications due to their accuracy, programmability, wide selection of power ranges, and each unit's autoranging power delivery.

Configuration and control is possible using the built-in control panel and through various remote control methods. For remote control using a computer or PLC, the system includes both a USB port and an Ethernet port, as well as an analog interface. All interfaces are galvanically isolated up to 1500 Vdc.

In addition, these systems can be combined in parallel to achieve greater power and current capacity. Up to 10 identical units would be configured identically for set values, alarms, etc. The built-in Share Bus manages the current load sharing.

The block diagram illustrates the main functions inside the power supply, and their relationships.



3.2 Operation Features

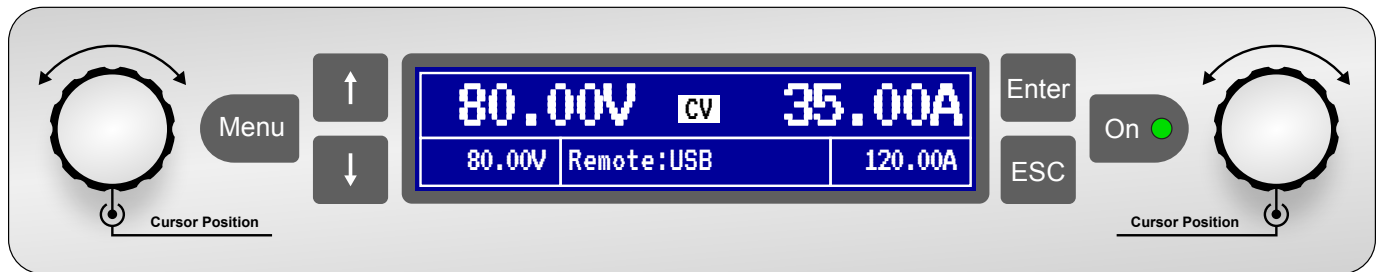
The mPower 300 is a versatile entry into programmable DC power supplies.

- Operates in constant voltage, constant current, or constant power mode.
- Autoranging power output enables the system to deliver 100% power over a wide range of voltage and current.
- Parallel output connectivity of up to 10 units to create a total power output of up to 30 kW.
- Output Share Bus which automates the regulation of current loading among parallel-connected units.
- Output Voltage Sense Bus which monitors voltage at the load, instead of the output terminals, to compensate for minor losses in output cables.
- Programmable mode, set values, alarms, and more using Modbus and SCPI protocols.
- USB for remote control through Windows®, LabView®, and your own custom scripts.
- Ethernet for remote control using your own custom scripting.
- Analog Interface for remote control and monitoring of key operational parameters of the system using a PLC or your own custom control circuitry.
- Graphical display user interface with multiple buttons, and two rotary controls (which speed up data entry) allows for complete configuration, control, and monitoring without a PC.
- Safety features including user interface lockout and discharge circuitry. Built-in alerts for over voltage, current, power, and temperature.

3.3 Control Elements

3.3.1 The control panel

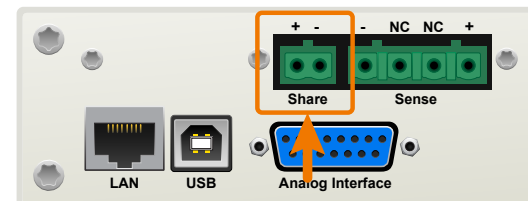
The control panel consists of a display, two rotary knobs with a push function, and six pushbuttons. All of the unit's configuration and control capabilities can be managed from this control panel.



3.3.2 Share bus connector

Up to 10 identical mPower 300 models may be connected in parallel to achieve higher total power and current capacity.

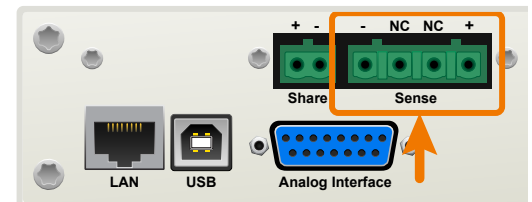
See section 2.7. [Share Bus Connection](#) for connection details, and section 4.12. [Parallel Operation in Share Bus Mode](#) for operation details.



3.3.3 Sense connector

In constant voltage operation (CV) where it is important that the adjusted output voltage is held constant at the load terminals rather than at the power supply's DC output terminals, the Sense connection can be used. This works in CV mode only, and should be disconnected for other modes of operation.

See section 2.6. [Remote Sensing Connection](#) for connection details.

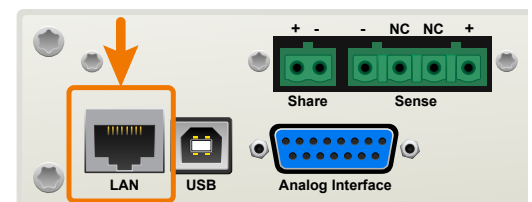


3.3.4 Ethernet port

The Ethernet port provides two interfaces for remote control and monitoring.

First, a simple website is accessible in a standard browser which provides a configuration page for network parameters, as well as an input field for SCPI commands. This interface primarily serves to help with command testing purposes. It's not intended to be a general purpose dashboard or control panel.

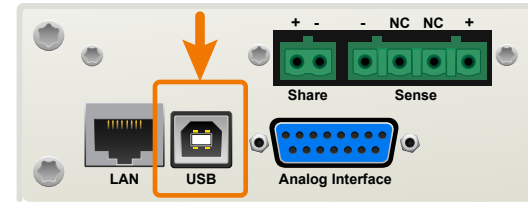
Second, TCP/IP access on a configurable port provides communication with the system for control using Modbus and SCPI based protocols through most of the common programming languages.



3.3.5 USB port

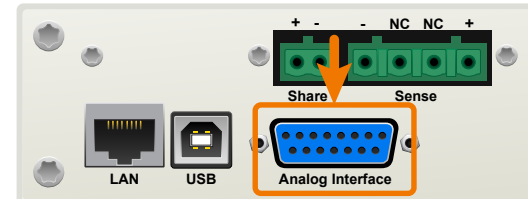
The USB-B port on the back of the power supply is provided for connection to a PC for control communication and for firmware updates. A Windows device driver installs as a virtual COM port. The driver is available from our web site.

Using the USB port, the system can be controlled by commands from either SCPI or Modbus RTU protocol. The system will automatically detect the type of message.



3.3.6 Analog interface

This 15-pin, Sub-D socket on the back of the unit is provided for remote control via analog and discrete signals. Voltage, current, and power mode targets can be adjusted, and power measurements can be monitored. A few condition flags are available, and the DC output can be switched on and off.



4 Operation



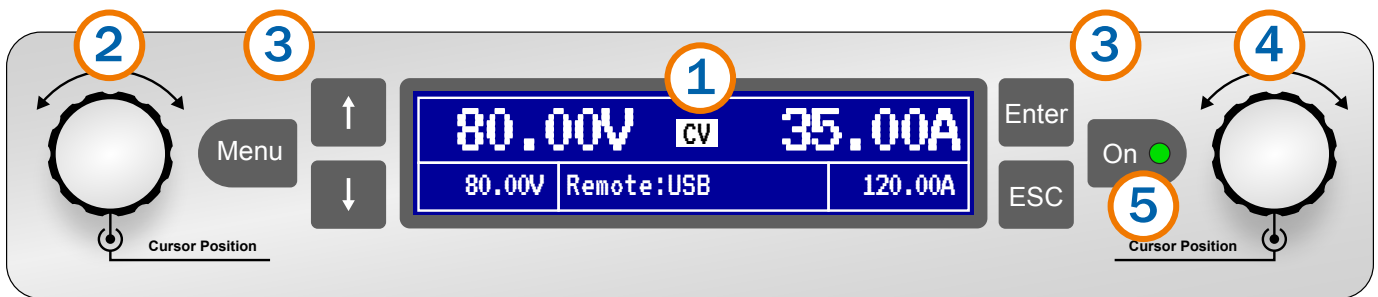
- To help ensure safety when operating the unit, it is essential that persons who operate the unit are fully trained and acquainted in the required safety measures to be taken when working with dangerous electrical voltages.
- For models which can generate a voltage which is dangerous by contact, or is connected to such models, the included DC terminal cover, or an equivalent, must always be used.
- Whenever the load and DC output are being re-configured, the unit should be disconnected from the AC mains, and not rely only on the DC output being switched off.



- Operation of a power supply without any load or a very small load ($<0.5\%$ of I_{Nom}) is not considered as a normal operation mode.
- Technical specifications cannot be guaranteed when running a power supply without a load.
- It is recommended to run a power supply always with at least 10% voltage and current load.







4.1 The Control Panel

The control panel consists of a display, two rotary knobs with a push function, and six pushbuttons.



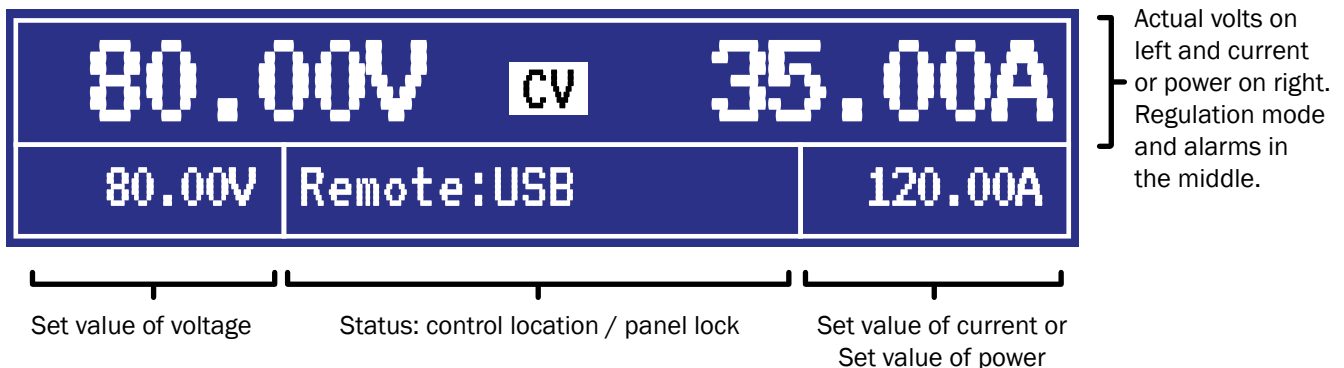
Overview of control panel elements

(1)	Display Used for indication of set values, menus, conditions, measured values and status.
(2)	Left rotary knob, with pushbutton function Turn: adjusts various set values which are related to the DC output voltage. Push: selects the decimal position of a value to be changed (cursor)

(3)	Buttons	
		Activates the setup menu for various unit settings (see 4.2.2. Configuration in the setup menu)
		Navigates through menus, submenus and parameters (direction: up / left) or changes view mode
		Navigates through menus, submenus and parameters (direction: down / right) or changes view mode
		Submits altered parameters or set values in submenus, as well enters submenus. Can also be used to acknowledge alarms.
		Cancels changes of parameters in the setup menu or leaves submenus
(4)	Right rotary knob, with pushbutton function Turn: adjusts various set values which are related to the DC output current, the DC output power. Also adjusts parameters in the setup menu. Push: selects the decimal position of a value to be changed (cursor)	
(5)	On/Off button for DC output  Used to toggle the DC output between on and off, also used to acknowledge alarms. The LED indicates the state of the DC output, no matter if the unit is manually controlled or remotely (LED on = output on).	

4.1.1 Display

The graphic display is divided into six areas. In normal operation, the upper section is used to show actual values, and the lower section is used to display status information and set values.



Actual values area (upper section)

In normal operation, the DC output values (large numbers) of voltage and current of power are displayed, depending on the selected view mode. The display format of values depends on the power range of the model as discussed in 4.1.4. Resolution of the displayed values.

The regulation mode CV, CC or CP (see 4.3. Operating Modes) is displayed in the center. Alarms will also be displayed using abbreviations (OT, OVP, OCP, PF, OPP).

Set values area (lower section, left and right)

The set values of voltage and current (U/I mode) or voltage and power (U/P mode) are displayed here, and are adjustable with the left and right rotary knobs when operating the system manually. While doing so, the digit to adjust can be selected by pushing the corresponding rotary knob which moves the cursor. The left rotary knob is always assigned to the

DC output voltage and related parameters like OVP or U-max, whereas the right rotary knob is assigned to either the DC output current (and related parameters), or to the DC output power. In remote control condition, whether analog or digital, the set values given from remote are displayed here.

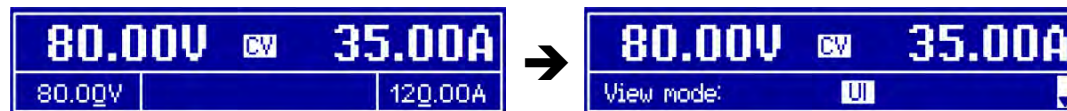
The values are increased by clockwise turning and decreased by anti-clockwise turning. Values will be limited by configurations of maximum value or an adjustment limit (see 4.5.3. Adjustment limits).

General display and settings ranges:

Display	Unit	Range	Description
Actual voltage	V	0-125% U_{Nom}	Actual values of DC output voltage
Set value voltage	V	0-102% U_{Nom}	Set value for limiting the DC output voltage
Actual current	A	0.2-125% I_{Nom}	Actual value of DC output current
Set value current	A	0-102% I_{Nom}	Set value for limiting the DC output current
Actual power	W	0-125% P_{Nom}	Actual value of output power, $P = U * I$
Set value power	W	0-102% P_{Nom}	Set value for limiting DC output power
Adjustment limits	A, V, W	0-102% Nominal val.	U-max, I-min etc., related to the physical units
Protection settings	A, V, W	0-110% Nominal val.	OVP, OCP etc., related to the physical units

Status area (lower half, middle)

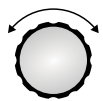
This area shows the control location mode (see 4.6.2. Control locations) or another status (see table below). When the **Menu** pushbutton is activated while the output is on, the lower section of the display changes to what is called the Quick Menu (see 4.5.6. The quick menu).



Normally, this middle area displays various status texts:

Display	Description
Locked	The HMI is locked
Remote	The system is under remote control from:
Analog	the built-in analog interface
USB	the built-in USB port or a plug in interface module
Ethernet	the built-in Ethernet/LAN port
Local	The system has been locked by the user explicitly against remote control

4.1.2 Rotary knobs



As long as the system is in manual operation, the two rotary knobs are used to adjust set values, as well as setting the parameters in the settings menu. For a detailed description of the individual functions see section 4.5. Manual Operation.

4.1.3 Pushbutton function of the rotary controls

The rotary controls include a push function. When adjusting values, pushing the rotary dial moves the cursor in sequence through the significant digits of the value like this:



4.1.4 Resolution of the displayed values

In the display, set values can be adjusted in fixed increments. The number of decimal places depends on the unit ratings. The values have 4 or 5 digits, while actual and set values related to the same physical unit always have the same number of digits.

Adjustment resolution and number of digits of set values in the display:

Voltage, OVP, U-min, U-max			Current, OCP, I-min, I-max			Power, OPP, P-max		
Nominal	Digits	Increment	Nominal	Digits	Increment	Nominal	Digits	Increment
80 V	4	0.01 V	6 A	4	0.001 A	1500 W	4	1 W
200 V	5	0.01 V	10 A / 12 A	5	0.001 A	3000 W	4	1 W
360 V / 500 V	4	0.1 V	15 A / 20 A	5	0.001 A			
750 V	4	0.1 V	25 A	5	0.001 A			
			30 A / 50 A	4	0.01 A			
			100 A	5	0.01 A			



In manual operation, every set value can be set in the increments given above. Be aware however, that the actual output values set by the system will lie within percentage tolerances as shown in the specification tables. These will influence the actual values used during operation.

4.2 System Configuration

4.2.1 Initial network setup

The system is delivered with default network parameters. The Ethernet/LAN port is immediately ready for use after the initial commission using these default parameters:

- IP: 192.168.0.2
- Subnet mask: 255.255.255.0
- Gateway: 192.168.0.1
- Port: 5025
- DHCP: off

In order to configure the network parameter to your needs, you have three options: the setup menu through the display, the system's web interface, or the EA Power Control software, which is available as a download. To use the setup menu, start with [4.2.2. Configuration in the setup menu](#). Then see [4.2.2.7. Menu "Communication"](#).

For the configuration via the system's web interface or EA Power Control, the unit must be connected to a network or directly to a PC which can access the default IP address of 192.168.0.2.

► Initial network setup using the system website

1. If the system display is in any kind of menu, exit the menu to the main display.
2. Open the system website in a browser by entering the default IP (<http://192.168.0.2>)
3. After the website has loaded, check the status field item **Access**. It should display the status **free**. If it shows something else, the system is either in remote control (**rem**) or blocked from remote control (**local**). If it shows **local**, first remove the block. Refer to section [4.6.2. Control locations](#) to do that.
4. If **Access** displays **rem**, skip to step 5. Otherwise enter the command **syst:lock on** into the **SCPI command** field and send with return key. Check if item **Access** in status field changes to **rem-eth** (remote Ethernet).
5. Switch to page **CONFIGURATION** (upper left corner) and set up the network parameters as well as the port.
6. Wait a few seconds to try the new IP. If a DNS name is being used, the system must be restarted.

4.2.2 Configuration in the setup menu

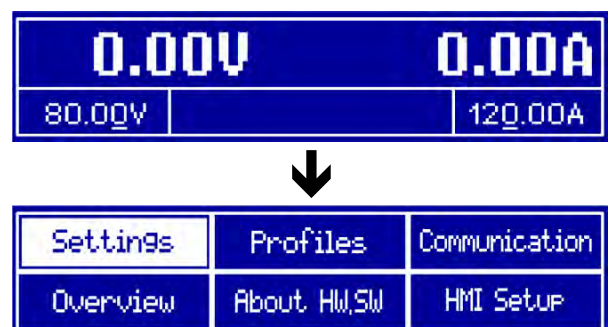
The built-in setup menu serves to configure user adjustable settings not typically changed for a power run.

Push **Menu** when the DC output is switched off. This will reveal the main menu titles. A hierarchical layout shown in the next section.

Menu navigation is done with the **↓**, **↑** and **Enter** buttons.

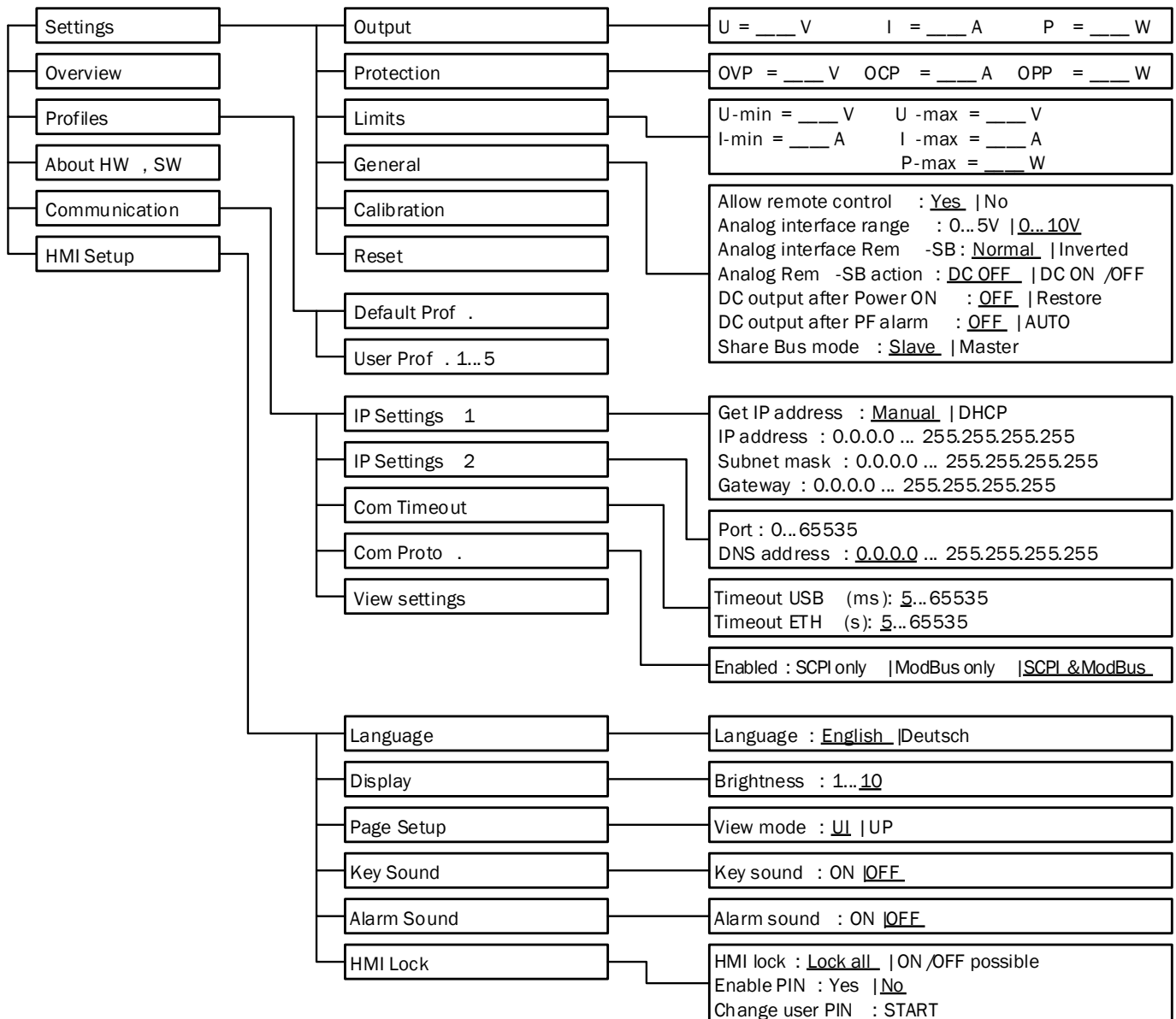
Parameters (values, settings) are set using the rotary knobs. The assignments of the rotary knobs, if multiple values can be set in a particular menu, is always the same: parameters on the left side use the left knob, parameters on the right side use the right knob.

Note that if the DC output is active when **Menu** is pushed, the "quick menu" and some status information will be shown instead.



4.2.2.1 Menu Hierarchy Overview

The menu structure is shown schematically on the next page. Some setting parameters are self-explanatory, others are not. The latter will be explained on the pages following. Underlined parameters show the default value after delivery or reset.



4.2.2.2 Menu “Settings”

Element	P.	Description
Allow remote control	1	Selection “NO” means that the unit cannot be remotely controlled over any of the digital or analog interfaces. If remote control is not allowed, the status will be shown as “Local” in the status area on the main display.
Analog interface range	2	Selects the voltage range for the analog inputs, actual output values and the reference voltage output of the analog interface on the rear. 0–5 V = 0-5 V correspond to 0–100% set /actual values, reference is 5 V 0–10 V = 0-10 V correspond to 0–100% set /actual values, reference is 10 V
Analog interface Rem-SB	3	Determines with “normal” (default), that the function and levels of input Rem-SB are as described in 4.8.5. Analog interface specification . With selection “inverted”, the described function is logically inverted. Also see 4.8.6. DC Output On/Off using REM-SB .
Analog Rem-SB action	4	Since Firmware 2.03, the input REM-SB of the analog interface can be used to control the DC output of the unit even without remote control via analog interface being activated. This setting determines the type of action: DC OFF = Toggling the pin only switches the DC output off DC ON/OFF = If the DC output has been switched on before, toggling the pin can switch the output off and on again
DC output after power ON	5	Determines the condition of the DC output after power-up. OFF = DC output is always off after switching on the unit. Restore = DC output condition will be restored to the condition prior to switch off.
DC output after PF alarm	6	Determines how the DC output shall react after a power fail (PF) alarm has occurred: OFF = DC output will be switched off and remain until user action AUTO = DC output will switch on again after the PF alarm cause is gone and if it was switched on before the alarm occurred
Share Bus mode	7	Default setting: Slave For parallel operation of multiple units, where using the Share bus connection is recommended. In parallel operation, any unit could be master.

4.2.2.3 Menu “Calibrate Device”

From within this menu, a calibration and readjustment procedure for output voltage and current, separate procedures for set value and actual value, can be started. For further details refer to [8.3. Calibration \(readjustment\)](#).

Element	Description
Voltage	Starts the semi-automatic calibration procedure for output voltage U
Sense volt.	Starts the semi-automatic calibration procedure for remote sensing input „Sense“
Current	Starts the semi-automatic calibration procedure for output current I
Cal. date	Here you can enter the date of the most recent calibration (year, month, day)
Save & exit	This menu item saves and leaves the setup menu to main display

4.2.2.4 Menu “Reset Device”

Entering this menu item will prompt for acknowledgement to reset the entire system to default settings and set values. Selecting **No** will cancel the reset procedure, while selecting **Yes**, submitted by **Enter**, will instantly reset the system.

4.2.2.5 Menu “Profiles”

See [4.1.1. Loading and Saving a User Profile](#).

4.2.2.6 Menus “Overview” and “About HW, SW...”

This menu pages display an overview of the set values (U, I, P), related protection settings (OVP, OCP, OPP), limits settings and an alarm history (counter) of alarms that might have occurred since the last time the unit was switched on. Furthermore, you can find information about the unit (model, serial number, firmware versions etc.).

4.2.2.7 Menu “Communication”

Here settings for the Ethernet port (on rear side of unit) are made. The USB port there doesn't require any settings.

When delivered or after a complete reset, the Ethernet port has following default settings assigned:

- DHCP: off
- IP: 192.168.0.2
- Subnet mask: 255.255.255.0
- Gateway: 192.168.0.1
- Port: 5025
- DNS: 0.0.0.0
- Host name: Client
- Domain: Workgroup

Those settings can be changed anytime at will, in the setup menu or via the system website, which you can open from the current IP or host name (also see [4.2.1. Initial network setup](#)).

Submenu “IP Settings 1”

Element	Description
Get IP address	Manual (default): uses the default (after delivery or reset) or the last set network parameters. Those parameters are not overwritten by selection DHCP and remain when switching back from DHCP to Manual DHCP : after switching to DHCP and submitting the change with button Enter , the unit will instantly try to get network parameters (IP, subnet mask, gateway, DNS) assigned from a DHCP server. If the attempt fails, the unit will use the settings from Manual again. In this case, the overview in screen View settings will indicate the DHCP status as DHCP (failed) , otherwise as DHCP (active)
IP address	Only available with setting Get IP address = Manual . Default value: 192.168.0.2 Permanent manual setting of the unit's IP address in standard IP format
Subnet mask	Only available with setting Get IP address = Manual . Default value: 255.255.255.0 Permanent manual setting of the subnet mask in standard IP format
Gateway	Only available with setting Get IP address = Manual . Default value: 192.168.0.1 Permanent manual setting of the gateway address in standard IP format

Submenu “IP Settings 2”

Element	Description
Port	Default value: 5025 Adjust the socket port here, which belongs to the IP address and serves for TCP/P access when controlling the unit remotely via Ethernet
DNS address	Default value: 0.0.0.0 Permanent manual setting of the network address of a domain name server (short: DNS) which has to be present in order to translate the host name to the unit's IP, so the unit could alternatively access by the host name

Submenu “Com Proto” (communication protocols)

Element	Description
Enabled	Default value: SCPI&Modbus Enables or disables SCPI or Modbus RTU communication protocols for the unit. The change is immediately effective after submitting it with ENTER button. Only one of both can be disabled.

Submenu “Com Timeout” (communication timeout)

Element	Description
Timeout USB (ms)	Default value: 5 Communication timeout in milliseconds. Defines the max. time between two subsequent bytes or blocks of a transferred message. For more information about the timeout refer to the external programming documentation <i>Programming Guide</i> .
Timeout ETH (s)	Default value: 5 Adjustable time, after which the unit will automatically disconnect the socket connection, if there was no communication during that period

4.2.2.8 Menu “HMI Setup”

These settings refer exclusively to the control panel (HMI) and the display. The table lists all available settings for the HMI, no matter in which submenu they can be found.

Element	Description
Language	Selection of the display language between “Deutsch” and “English”
Brightness	The brightness, i.e. background illumination of the display can be adjusted here. Range is 1–10, default is 10.
View mode	The display mode of actual and set values can be switched here. Refer to 4.5.4. Display modes for actual and set values for details
Key Sound	Activates or deactivates sounds when pushing a button on the HMI. It can usefully signal that the action has been accepted.
Alarm Sound	Activates or deactivates the additional acoustic signal of an alarm. See also 4.9. Alarms and Monitoring .
HMI Lock	Activates the HMI lock. See 4.10. Control Panel Lock for details

4.3 Operating Modes

The power supply is internally controlled by different control or regulation circuits, which bring voltage, current and power to the adjusted values and hold them constant, if possible. These circuits provide different operating modes. Each operating mode has its own characteristics which is explained briefly below.

4.3.1 Voltage regulation

Voltage regulation is also called constant voltage operation (CV).

The DC output voltage of a power supply is held constant on the adjusted value — unless the output current or the output power (according to $P = U_{OUT} * I_{OUT}$) reaches the adjusted current or power limit. In both cases, the system will automatically change to constant current or constant power operation, whichever occurs first. The output voltage can then no longer be held constant, and will sink to a value resulting from Ohm's law.

While the DC output is switched on, and constant voltage mode is active, the **CV mode active** condition will be indicated on the display by the abbreviation CV, on the analog interface on the CV pin, and as a status value readable via digital interface.

4.3.2 Current regulation

Current regulation is also known as current limitation or constant current mode (CC).

The DC output current is held constant by the power supply once the output current to the load reaches the adjusted limit. The current flowing from the power supply is determined by the output voltage and the load's true resistance. As long as the output current is lower than the adjusted current limit, the system will be either in constant voltage or constant power mode. If, however, the power consumption reaches the set maximum power value, the system will switch automatically to power limiting, and sets the output current according to $I_{MAX} = P_{SET} / U_{IN}$, even if the maximum current value is higher. The current set value, as determined by the user, is always an upper limit only.

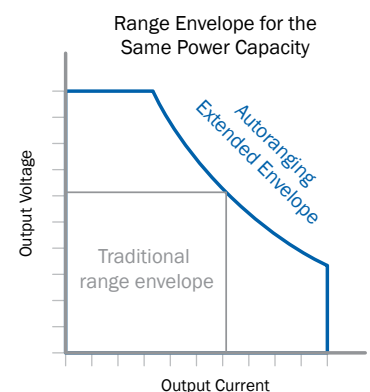
While the DC output is switched on and constant current mode is active, then the condition **CC mode active** will be indicated on the display by the abbreviation CC and this message will be passed as a signal to the analog interface, as well stored as status which can also be read via digital interface.

4.3.3 Power regulation

Power regulation, also known as power limiting or constant power (CP), keeps the DC output power of a power supply constant if the current flowing to the load in relation to the output voltage and the resistance of load reaches the adjusted value according to $P = U * I$ $P = U^2 / R$. The power limiting then regulates the output current according to $I = \sqrt{P / R}$, where R is the load's resistance.

Power limiting operates according to the autorange principle such that at lower output voltages, higher current flows and vice versa in order to maintain constant power within the range of the unit.

While the DC output is enabled, and constant power mode is active, the condition **CP mode active** will be shown on the graphic display by the abbreviation CP, and can also be read as a status message via digital interface.





By default, the system would only show the output power supplied via its own DC terminal. That value includes all dissipation loss over the cables. If you want to read the true power consumption of your load, you can connect the remote sense input with correct polarity to the load's DC connection points, so the system can measure the voltage on the load and thus display the power consumed by the load. In this situation, the system supplies more power than indicated, because then the dissipation loss is not accounted for. This can cause the system to be in power limitation even when the actual power didn't yet reach the adjusted limit.

4.3.3.1 Power derating

The mPower 300 series offer an extended AC supply voltage range, but are optimized for the use at 230 Vac, $\pm 10\%$. Below a certain supply voltage, all models will automatically start to derate (i.e. reduce the maximum available output power). The derating happens on the AC input side, and thus the system won't indicate the derating as a "CP" condition.

Depending on the rated power of the particular model, the derating starts at different supply voltages:

- 300-01 1.5 kW models
 - Above approximately 150 Vac, maximum output power is available.
 - Below approximately 150 Vac, maximum power is reduced to 1000 W.
 - Below approximately 90 Vac, DC output is shut off.
- 300-11 3 kW models
 - Above approximately 207 Vac, maximum output power is available.
 - Below approximately 207 Vac, maximum power is reduced to 2500 W.
 - Below approximately 180 Vac, DC output is shut off.

4.4 Alarm Conditions



This section only gives an overview about hardware alarms. What to do in case your system indicates an alarm condition is described in section [4.9. Alarms and Monitoring](#).

As a basic principle, all alarm conditions are signaled visually (text + message in the display), audibly (if activated), and as a readable status via the digital interface. With any alarm occurring, the DC output of the unit is switched off. In addition, the alarms OT and OVP are reported as signals on the analog interface.

4.4.1 Available alarm signals

The equipment offers various signals for alarm conditions, however, not necessarily for all potentially dangerous situations. The signals may be visual (on the display as text) acoustic (piezo buzzer) or electronic (pin/status output of an analog interface). All alarms will cause the system to permanently or temporarily switch off the DC output.

The meaning of the signals is as follows:

Signal OT (OverTemperature)	Overheating of the unit DC output will be switched off temporarily Non-critical
Signal OVP (OverVoltage)	Overvoltage shutdown of the DC output due to high voltage entering the unit or generated by the unit itself due to a defect or because the adjusted OVP threshold was lower than the actual output voltage Critical! The unit and/or the load could be damaged
Signal OCP (OverCurrent)	Shutdown of the DC output due to excess of the preset limit Non-critical, protects the load from excessive current consumption
Signal OPP (OverPower)	Shutdown of the DC output due to excess of the preset limit Non-critical, protects the load from excessive power consumption
Signal PF (Power Fail)	DC output shutdown due to AC undervoltage or defect of the AC input circuit Critical on overvoltage! AC input circuit could be damaged

4.4.2 Power fail

Power Fail (PF) indicates an alarm condition which may have various causes:

- AC input voltage too high (mains overvoltage) or too low (mains undervoltage, mains failure)
- Defect in the input circuit (PFC)



Switching off the unit by the mains switch can not be distinguished from a mains blackout and thus the unit will signal a PF alarm every time the unit is switched off. This can be ignored.

4.4.3 Overtemperature

An overtemperature alarm (OT) can occur if an excess temperature inside the unit causes to switch off the DC output.

Internal overtemperature and subsequent temporary shutdown is usually caused by insufficient cooling (excess ambient temperature, fans and air inlets polluted). The fans will still cool down the unit until it can automatically switch on again to continue operation.

4.4.4 Overvoltage

An overvoltage alarm (OVP) will switch off the DC output and can occur if

- the power supply itself, as a voltage source, generates an output voltage higher than set for the overvoltage alarm threshold (OVP, 0–110% U_{Nom}) or the connected load somehow returns voltage higher than set for the overvoltage alarm threshold.
- the OV threshold has been adjusted too close above the output voltage. If the unit is in CC mode and if it then experiences a negative load step, it will make the voltage rise quickly, resulting in a voltage overshoot for a short moment which can already trigger the OVP.

This function serves to warn the user of the power supply audibly or visually that the system probably has generated an excessive voltage which could damage the connected load application.



The system is not fitted with protection from external overvoltage. Overvoltage can damage parts inside!

4.4.5 Overcurrent

An overcurrent alarm (OCP) will switch off the DC output and can occur if the output current in the DC output reaches the adjusted OCP limit.

This function serves to protect the connected load application so that this is not overloaded and possibly damaged due to an excessive current.

4.4.6 Overpower

An overpower alarm (OPP) will switch off the DC output and can occur if the product of the output voltage and output current in the DC output reaches the adjusted OPP limit.

This function serves to protect the connected load application so that this is not overloaded and possibly damaged due to an excessive power consumption.

4.5 Manual Operation

4.5.1 Switching the unit on

The unit should, as far as possible, always be switched on using the main power switch on the front left of the unit. Alternatively this can take place using an external cutout (contactor, circuit breaker, etc of suitable current capacity) which interrupts the AC power feed.

After switching on, the display will show a logo for a few seconds, plus some information like model, firmware version(s), and serial number, and will then be ready for use.

In setup (see section 4.2.2. Configuration in the setup menu) in the second level menu **General** is an option **DC output after power ON** in which the user can determine the condition of the DC output after power-up. Factory setting here is **OFF**, meaning that the DC output on power-up is always switched off. Selection **Restore** means that the last condition of the DC output will be restored, either on or off. All set values are always saved and restored.



For the time of the start phase the analog interface can signal undefined statuses on the output pins such as OT or OVP. Those signals must be ignored until the unit has finished booting and is ready to work.

4.5.2 Switching the unit off

Upon switching the whole unit off, the last output condition, and the most recent set values are saved. A “PF” alarm (power failure) will be reported on the display, but can be ignored.

The DC output is immediately switched off. After a short while fans will shut down, and after another few seconds the unit will be completely powered off.

4.5.3 Adjustment limits

By default, all set values (U, I, P) are freely adjustable from 0 to 102% of the rated value.

This may be problematic in some cases, especially for protection of applications against overcurrent. Therefore upper and lower limits for current and voltage can be set which limit the range of the adjustable set values. For power, only an upper value limit can be set.

These limits apply to every method of setting a value. This also includes remote control via analog or digital interface. In remote control, the global range of 0–100% (digital) 0–5 V / 0–10 V remains, only narrowed by the limits defined here.

An example: you would define the limits for a model with 80 V, 120 A and 3 kW as depicted in the screen above, with U-min = 10V and U-max = 75 V. In analog remote control, the active control voltage range for mode 0–10 V results as 1.25 V–9.375 V. As soon as the system is switched to analog remote control, it would put out minimum 10V, even there is nothing connected to voltage control input VSEL.

Values beyond the limits given by digital commands are not accepted (and will return an error when using SCPI). Excess values given from analog control voltages are ignored.



► How to configure the adjustment limits

1. Switch off the DC output and push button **Menu** to call the setup menu.
2. Push button **Enter** to call submenu **Settings**. In the submenu navigate to **Limits** and push **Enter** again.
3. In the screen you can now adjust the settings I-min, I-max, U-min, U-max and P-max with the rotary knobs. Switching between values for current and power is done with the arrow buttons **↑** and **↓**.
4. Accept the settings with **Enter** or discard them with **ESC**.



The adjustment limits are coupled to the set values. This means that the upper limit (-max) may not be set lower than the corresponding set value. For example, if you wish to set the limit for the current set value I-max to 90 A while the currently adjusted set value is 100 A, then the set value must first have to be reduced to 90 A or less. This logic applies when adjusting I-min as well.

4.5.4 Display modes for actual and set values

In general, the display panel shows the actual output voltage and the related set value in the left half of the display, and the actual output current and related set value in the right half. In order to have the power set value in direct access, the display mode can be switched.



The default display mode **UI** shows voltage and current.

The set value of power is accessible in the setup menu or when switching to a different view mode with the arrow buttons **↑** or **↓**.



Alternatively, mode **UP** show voltage and power.

The set value of current is then only accessible in the setup menu or when switching to a different view mode with the **↑** or **↓** buttons.

► How to change the display mode in the menu

1. Switch off the DC output and push button **Menu** to call the setup menu.
2. In the menu, navigate to **HMI Setup** and push **Enter**. In the submenu, navigate to **Page Setup** and push **Enter** again.
3. Select the desired display mode (see above) with the right rotary knob.
4. Accept the settings with **Enter** or discard them with **ESC**.

► How to change the display mode directly

During normal display (as shown in the figures above), push any of the arrow buttons **↑** **↓** to switch between the view modes.

Depending on your setting, the main display will change after leaving the setup menu and the right rotary knob is then either assigned to set value of current or power

4.5.5 Manual adjustment of set values

Adjusting set values of voltage, current and power is a key feature of a power supply and hence the two rotary knobs on the front of the unit are usually assigned to two of the three values, in manual operation. Default assignment is voltage and current.

During manual operation, these set values can only be adjusted with the **rotary knobs**.





Adjusting a value is immediately submitted, no matter if the output is switched on or off.



When adjusting the set values, upper or lower limits may come into effect. See section [4.5.3. Adjustment limits](#). Once a limit is reached, the display will show a note like “Limit: U-max” etc. for ≈2 seconds.

► How to adjust values U, I or P with the rotary knobs




1. First check whether the value to be changed is assigned to one of the rotary knobs already. The assignment can be changed by selecting a different view mode. See [4.5.4. Display modes for actual and set values](#).
2. With mode UI selected and as long as the main display is active, turn the left knob to adjust output voltage and the right knob to adjust the output current. In mode UP, turn the right knob to adjust the output power, as long as the power set value with unit W (Watts) is displayed. The arrow buttons   can be used to toggle between current and power set value.
3. Any set values can be adjusted with the adjustment limits. For switching the digit to adjust, push the rotary knob that you are currently using to adjust the value. Every push moves the cursor under the digit in clockwise order:



4.5.6 The quick menu

The quick menu is an alternative menu for quick access to offline features while the DC output is online. It is accessible with the **Menu** button and looks like the lower half of this display:



Navigation in the menu is also done with arrow buttons  /  and .

You can select the between view mode and the HMI lock, each with three button pushes.



If you activate the display from within the quick menu, the additional PIN lock might become active, depending on your settings.



4.5.7 Switching the DC output on or off

The DC output of the unit can be manually or remotely switched on and off. This can be restricted in manual operation by the control panel being locked.



Switching the DC output on during manual operation or digital remote control can be disabled by pin REM-SB of the built-in analog interface. For more information refer to [4.8.6. DC Output On/Off using REM-SB](#).

► How to manually switch the DC output on or off

1. As long as the control panel (HMI) is not fully locked press the button . Otherwise you are asked to disable the HMI lock first.
2. This button toggles between on and off, as long as a change is not restricted by an alarm or the system is locked in “remote”. The current condition is displayed with the LED in the button  (LED on = output on).

► How to remotely switch the DC output on or off via the analog interface

See section [4.8.6. DC Output On/Off using REM-SB](#).

► How to remotely switch the DC output on or off via the digital interface

See the external documentation *Programming Guide* if you are using custom software, or refer to the external documentation of LabView VIs or other software, if available, provided by the manufacturer.

4.6 Manual vs Remote Control

4.6.1 One remote interface in control

Remote control is possible through any of the built-in interface ports: USB, Ethernet/LAN or analog.

It is important to note that only one interface can be in control at any one time. This means that if, for example, an attempt were to be made to switch to remote control using the USB interface while analog remote control is active, the system would report an error at the USB interface. In the opposite direction a switch-over via pin Remote would be ignored.

However, regardless of which interface is being used for control, all interfaces can be used to monitor status and actual data values at any time.

4.6.2 Control locations

Since the power supply can be controlled from the onboard controls, and from a variety of remote control interfaces, we have the concept of control location—that is, the location, or source, of where control is being managed. The power supply software concerns itself with this concept by managing whether control is allowed from the local controls only, from remote controls only, or from either location.

Models with a digital display will show the control location.

Location as displayed on the system	Description
(no label)	If there is no specific control location indicated, the system is available for remote access, and all interfaces for remote control are enabled.
Remote Analog, Remote USB, etc.	Remote control is active.
Local	Remote control is blocked, the system can only be controlled manually from the unit's built-in controls.

All mPower DC 3 series offer a configuration setting **Allow remote control** to enable or disable remote control of the system.

Changing this setting to indicate **Local** results in remote control being blocked. Activating this block would be useful for safety purposes — a user can temporarily disable remote control in order to safely access the system to change some wiring, or just change a setting, without unexpected interference from a remote command.

Activating condition **Local** causes the following:

- If remote control is active through a digital interface, then remote control is immediately terminated and must be reactivated at the PC once **Local** is no longer active.
- If remote control is active through the analog interface, then remote operation is interrupted temporarily until remote control is allowed again. This is because pin **Remote** would continue to signal “remote control = on” unless it was otherwise disabled. If the level of pin **Remote** is changed during the **Local** phase, then remote operation would not be reinstated.

4.7 Remote Control with USB or Ethernet

4.7.1 General

The system supports built-in digital interfaces of USB and Ethernet. The USB interface requires no setup on the power supply itself. The Ethernet interface typically requires network setup, but can also be used with its default parameters right from the start if the computer is able to connect to the preset LAN settings.

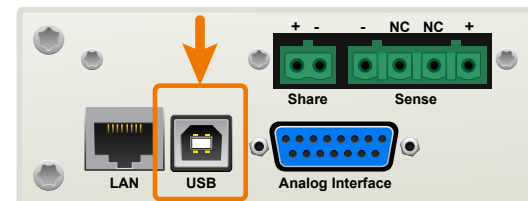
Using a digital interface, primarily the set values (voltage, current, power) and system conditions can be set and monitored. Furthermore, various other functions are supported as described in the programming documentation.

When changing to remote control, the existing set values (whether created in remote or local modes) will be used.

4.7.2 Remote control with USB

The USB-B port on the back of the power supply is provided for connection to a PC for control communication and for firmware updates. A Windows device driver installs as a virtual COM port. The driver is available from our web site. See [2.9.1. Driver installation \(Windows\)](#).

Using the USB port, the system can be controlled using commands with Modbus RTU or SCPI protocols. The system will automatically detect the type of message, so there's no need to pre-configure which protocol will be used.



4.7.3 Remote control with Ethernet

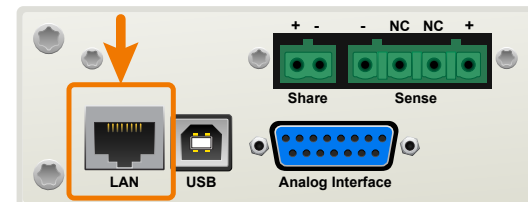
The Ethernet port provides two interfaces for remote control and monitoring.

First, a simple website is accessible in a standard browser which provides a configuration page for network parameters, as well as an input field for SCPI commands.

Second, TCP/IP access on a configurable port (typically 5025) provides communication with the system for control using Modbus and SCPI based protocols through most of the common programming languages.

Using the Ethernet port, the system can be controlled using commands with Modbus RTU or SCPI protocols. The system will automatically detect the type of message, so there's no need to pre-configure which protocol will be used.

The network setup can be done manually using the on-board control panel or by DHCP. The transmission speed is set to **Auto negotiation** (using 10MBit/s or 100MBit/s). Duplex mode is always full duplex. For the network port setup refer to [4.2.1. Initial network setup](#).



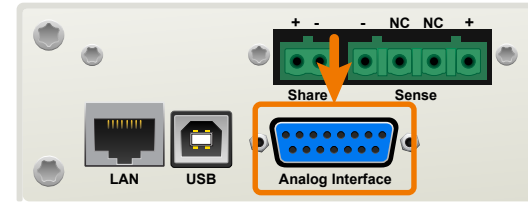
4.7.4 Programming

Programming details for the interfaces, the communication protocols, commands, etc. are detailed starting in section [5. Programming Introduction](#).

4.8 Remote control with the analog interface

This 15-pin, Sub-D socket on the back of the unit is provided for remote control via analog and discrete signals. Voltage, current, and power mode targets can be adjusted, and power measurements can be monitored. A few condition flags are available, and the DC output can be switched on and off.

Be aware that when remote control is in operation, no specific port has priority over the others. If more than one interface (USB, Ethernet, analog) is connected, commands can come from any of them at any time. Therefore, only one interface should be used at any one time for control. However, monitoring is always available on any port at any time.



4.8.1 General

The built-in, galvanically isolated (up to 1500 V DC), 15-pole analog interface is located on the rear side of the unit and offers the following functions:

- Remote control of current, voltage and power
- Remote status monitoring (CC/CP, CV)
- Remote alarm monitoring (OT, OVP, PF)
- Remote monitoring of actual values
- Remote on/off switching of the DC output

Setting the three set values via the analog interface always takes place concurrently. This means that for example the voltage can not be set through the analog interface, and current and power set by the rotary knobs, or vice versa.

The OVP set value and other supervision (events) and alarm thresholds cannot be set via the analog interface, and therefore must be adjusted on the control panel before the analog interface is put in operation. Analog set values can be fed in by an external voltage or generated by the reference voltage on pin 3. As soon as remote control via the analog interface is activated, the values shown as set values on the display will be those provided by the interface.

The analog interface can be operated in the common voltage ranges 0–5 V and 0–10 V. In each case, they represent 0–100% of the nominal value (the nominal rating of the power supply). The selection of the voltage range can be done in the system setup. See section [4.2.2. Configuration in the setup menu](#). The reference voltage sent out from pin 3 (VREF) will be adapted accordingly and is then:

- **0–5 V:** Reference voltage = 5 V, 0–5 V set values (VSEL, CSEL, PSEL) correspond to 0–100% nominal values, 0–100% actual values correspond to 0–5 V at the actual value outputs (CMON, VMON).
- **0–10 V:** .Reference voltage = 10 V, 0–10 V set values (VSEL, CSEL, PSEL) correspond to 0–100% nominal values, 0–100% actual values correspond to 0–10 V at the actual value outputs (CMON, VMON).

Input of excess set values (e.g. >5 V in selected 5 V range or >10 V in the 10 V range) are clipped by setting the set value at 100%.

Before you begin, please read these important notes for use of the interface:

- Analog remote control of the system must be activated by switching pin “REMOTE” (5) first. Only exception is pin REM-SB, which can be used independently.
- Make sure that the hardware that will control the analog interface cannot supply voltage to the pins higher than specified (i.e. the 5 or 10 V limit).
- Set value inputs, such as VSEL, CSEL and PSEL, must not be left unconnected (i.e. floating).
- It is always required to provide all three set values at once. In case any of the set values is not used for adjustment, it can be tied to a known level you prefer or routed to pin VREF, so it gives 100%.

4.8.2 Resolution and sample rate

The analog interface is internally sampled and processed by a digital microcontroller. This causes a limited resolution of analog steps. The resolution is the same for set values (VSEL etc.) and actual values (VMON/CMON) and is 26214. Due to tolerances, the truly achievable resolution may be slightly less.

There is a maximum sample rate of 500 Hz. This means the system can acquire analog set values and states on digital pins 500 times per second. Apparent resolution may be affected if the ramp rates were very fast for large value swings.

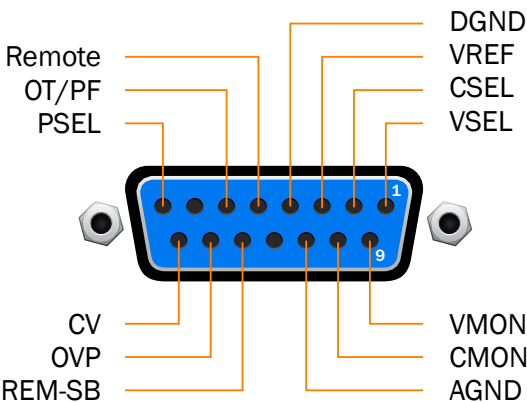
4.8.3 Acknowledging alarms

Hardware alarms (see 4.9. Alarms and Monitoring) are always indicated in the front display and some of them are also reported as signal on the analog interface socket (see 4.8.5. Analog interface specification), for example the overvoltage alarm (OV), which is considered critical.

In case of a hardware alarm occurring during remote control via analog interface, the DC output will be switched off the same way as in manual control. While alarms OT and OV can be monitored via the corresponding pins of the interface, other alarms can't. Those could only be monitored and detected via the actual values of voltage and current being all zero contrary to the set values.

The hardware alarms OV, OC and OP have to be acknowledged after any of them occurred, either by the user of the system or by the controlling unit. This can be done with pin REM-SB switching the DC output off and on again with the pattern HIGH-LOW-HIGH edge with a minimum of 50ms for LOW (when using the default level setting for this pin).

4.8.4 Analog connector wiring



	<p>Digital Input (DI)</p> <p>The internal circuit requires that a switch with low resistance should be used (relay, switch, circuit breaker etc.) in order to send a clean signal to the DGND.</p> <p>A digital output from a circuit or PLC may not be sufficient if not an "open collector".</p>		<p>Analog Input (AI)</p> <p>High resistance input (impedance >40 k-.100 kΩ) for an OA circuit.</p>
	<p>Digital Output (DO)</p> <p>A quasi open collector, realised as high resistance pull-up against the internal supply. In condition LOW it can carry no load, merely switch, as shown in the diagram with a relay as example.</p>		<p>Analog Output (AO)</p> <p>Output from an OA circuit, only minimally impedant. See specifications table above.</p>

4.8.5 Analog interface specification

Pin	Name	Type*	Description	Default levels	Electrical specification
1	VSEL	AI	Set voltage value	0–10 V or 0–5 V correspond to 0–100% of U_{Nom}	Accuracy 0–5 V range: < 0.4% **** Accuracy 0–10 V range: < 0.2% **** Input impedance R_i >40 k–100 k
2	CSEL	AI	Set current value	0–10 V or 0–5 V correspond to 0–100% of I_{Nom}	
3	VREF	AO	Reference voltage	10 V or 5 V	Tolerance < 0.2% at $I_{max} = +5$ mA Short-circuit-proof against AGND
4	DGND	POT	Ground for all digital signals		For control and status signals.
5	REMOTE	DI	Switching internal /remote control	Remote = LOW, $U_{Low} < 1$ V Internal = HIGH, $U_{High} > 4$ V Internal = Open	Voltage range = 0–30 V $I_{Max} = -1$ mA at 5 V U_{Low} to HIGH typ. = 3 V Rec'd sender: Open collector against DGND
6	OT / PF	DO	Overheating alarm Power fail	Alarm = HIGH, $U_{High} > 4$ V No Alarm = LOW, $U_{Low} < 1$ V	Quasi open collector with pull-up against V_{cc} ** With 5 V on the pin max. flow +1 mA $I_{Max} = -10$ mA at $U_{CE} = 0,3$ V $U_{Max} = 30$ V Short-circuit-proof against DGND
7	-	-	-	-	-
8	PSEL	AI	Set power value	0–10 V or 0–5 V correspond to 0–100% von P_{Nom}	Accuracy 0–5 V range: < 0.4% **** Accuracy 0–10 V range: < 0.2% **** Input impedance R_i >40 k–100 k
9	VMON	AO	Actual voltage	0–10 V or 0–5 V correspond to 0–100% von U_{Nom}	Accuracy 0–5 V range: < 0.4% **** Accuracy 0–10 V range: < 0.2% **** at $I_{Max} = +2$ mA Short-circuit-proof against AGND
10	CMON	AO	Actual current	0–10 V or 0–5 V correspond to 0–100% von I_{Nom}	
11	AGND	POT	Ground for all analog signals		For -SEL, -MON, VREF Signals
12	-	-	-	-	-
13	REM-SB	DI	DC output OFF (DC output ON) (ACK alarms ***)	Off = LOW, $U_{Low} < 1$ V On = HIGH, $U_{High} > 4$ V On = Open	Voltage range = 0–30 V $I_{Max} = +1$ mA at 5 V Rec'd sender: Open collector against DGND
14	OVP	DO	Overvoltage alarm	Alarm OV = HIGH, $U_{High} > 4$ V No alarm OV = LOW, $U_{Low} < 1$ V	Quasi open collector with pull-up against V_{cc} ** With 5 V on the pin max. flow +1 mA $I_{Max} = -10$ mA at $U_{CE} = 0,3$ V, $U_{Max} = 30$ V Short-circuit-proof against DGND
15	CV	DO	Constant voltage regulation active	CV = LOW, $U_{Low} < 1$ V CC/CP = HIGH, $U_{High} > 4$ V	

* AI = Analog Input, AO = Analog Output, DI = Digital Input, DO = Digital Output, POT = Potential

** Internal V_{cc} approx. 14.3 V

*** Only during remote control

**** The error of a set value input adds to the general error of the related value on the DC output of the unit



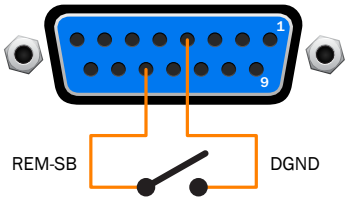
The accuracy of set values, as given in the table above, is only related to the input pin and adds to the general accuracy of the corresponding value on the DC output.

4.8.6 DC Output On/Off using REM-SB

Analog connector pin REM-SB can be used to switch the DC output of the unit on and off.

Enabling DC output when the switch is connected requires the unit be in remote control mode. However, even without remote control being active, in both manual control and remote control modes, this switch circuit can be used to block the DC terminal from being switched on.

It is recommended that a low resistance contact such as a switch, relay, or transistor is used to switch the pin to ground (DGND).



A digital output, e.g. from a PLC, may be unable to cleanly pull down the pin as it may not be of low enough resistance. Check the specification of the controlling application. Also see pin diagrams above.

• **When remote control has been activated**

During remote control via analog interface, only pin REM-SB determines the state of the DC output, according to the levels definitions in [4.8.5. Analog interface specification](#). The function logic and the default levels can be inverted by a parameter in the setup menu of the unit. See [4.2.2.2. Menu “Settings”](#).



If the pin is unconnected or the connected contact is open, the pin will be HIGH. With parameter “Analog interface REM-SB” being set to “normal,” this results in “DC output on”. So when activating remote control, the DC output will instantly switch on.

• **When remote control is not active**

When the system is in a manual mode, pin REM-SB can serve as lock, preventing the DC output from being switched on by any means. This results in the following possible situations:

DC output	+	Pin REM-SB	+	Parameter REM-SB	→	Behaviour
is off	+	HIGH	+	normal	→	DC output not locked. It can be switched on by pushbutton “On/ Off” (front panel) or via command from digital interface.
		LOW	+	inverted		
	+	HIGH	+	inverted	→	DC output locked. It can not be switched on by pushbutton “On/ Off” (front panel) or via command from digital interface. When trying to switch on, a popup in the display an error message will be generated.
		LOW	+	normal		

When the DC output is already switched on, toggling the pin will switch the DC output off, similar to what it does in analog remote control:

DC output	+	Pin REM-SB	+	Parameter REM-SB	→	Behaviour
is on	+	HIGH	+	normal	→	DC output remains on, nothing is locked. It can be switched on or off by pushbutton or digital command.
		LOW	+	inverted		
	+	HIGH	+	inverted	→	DC output will be switched off and locked. Later it can be switched on again by toggling the pin. During lock, pushbutton or digital command can delete the request to switch on by pin.
		LOW	+	normal		

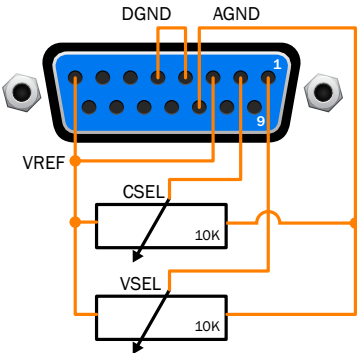
4.8.7 Control of Current and Power

The set values VSEL and CSEL are generated from the reference voltage VREF, using potentiometers for each. Hence the power supply can selectively work in current limiting or power limiting mode. According to the specification of maximum 5 mA for the VREF output, potentiometers of at least 10 kΩ must be used.

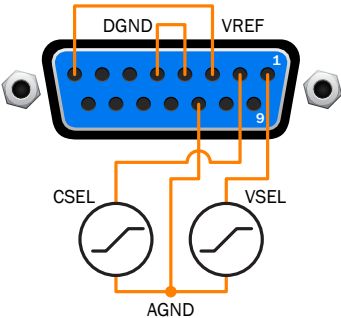
The power set value PSEL is always tied to VREF and will thus be permanently 100%.

If the control voltage is fed from an external source, it is necessary to consider the input voltage ranges for set values (0–5 V or 0–10 V). Keep in mind that using the 0–5 V range for 0–100% cuts the effective resolution in half.

Control with potentiometers

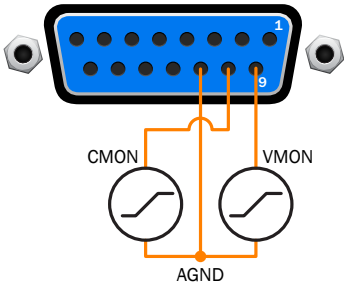


Control with external voltage sources



4.8.8 Reading Values

The DC output values of current and voltage can be monitored through the analog interface using a standard multimeter or anything else that records analog signals.



4.9 Alarms and Monitoring

4.9.1 Definition of terms

Hardware alarms are defined as conditions like overvoltage or overtemperature, signalled in any form to the user of the system in order to take notice.

Those alarms are always indicated in the front display as readable abbreviated text, as well as status readable via digital interface when controlling or just monitoring remotely and, if activated, emitted as audible signal (buzzer). Furthermore, the most important alarms are also signalled by output pins on the analog interface.

There is furthermore an alarm history available in the submenu **Overview**. It counts alarms that occurred since the last time the unit was switched on, for statistics and later check.

4.9.2 Hardware alarm handling

A hardware alarm incident will usually lead to DC output switch-off. Some alarms must be acknowledged (see below), which can only happen if the cause of the alarm is not persistent anymore. Other alarms acknowledge themselves if the cause has vanished, like the OT and the PF alarm.

► How to acknowledge an alarm in the display (during manual control)

Push button  or  once.

► How to acknowledge an alarm on the analog interface (during analog remote control)

Switch off the DC output by pulling pin REM-SB to the level that corresponds to DC output off, then switch it on again. See section 4.8.6. **DC Output On/Off using REM-SB** for levels and logic.

► How to acknowledge an alarm in the alarm buffer/status (during digital control)

Read the error buffer (SCPI protocol) or send a specific command to acknowledge, i.e. reset alarms (Modbus RTU).

Some hardware alarms are configurable by adjusting a threshold:

Alarm	Meaning	Description	Range	Indication
OVP	OverVoltage Protection	Triggers an alarm if the DC output voltage reaches the defined threshold. This can be caused by the unit being faulty or by an external source. The DC output will be switched off.	$0\text{ V} - 1.1 \cdot U_{\text{Nom}}$	Display, analog IF, digital IF
OCP	OverCurrent Protection	Triggers an alarm if the DC output current reaches the defined threshold. The DC output will be switched off.	$0\text{ A} - 1.1 \cdot I_{\text{Nom}}$	Display, digital IF
OPP	OverPower Protection	Triggers an alarm if the DC output power reaches the defined threshold. The DC output will be switched off.	$0\text{ W} - 1.1 \cdot P_{\text{Nom}}$	Display, digital IF

These hardware alarms can't be configured and are based on hardware:

Alarm	Meaning	Description	Indication
PF	Power Fail	AC supply over- or undervoltage. Triggers an alarm if the AC supply is out of specification or when the unit is cut from supply, for example when switching it off with the power switch. The DC output will be switched off.	Display, digital IF
OT	OverTemperature	Triggers an alarm if the internal temperature reaches a certain limit. The DC output will be switched off.	Display, analog IF, digital IF

► How to configure the hardware alarms OVP, OCP and OPP

1. Switch off the DC output and push **Menu** to call the setup menu.
2. In the menu navigate to **Settings** and press **Enter**. Then in the submenu, navigate to **Protection** and press **Enter** again.
3. Set the limits for the hardware alarms relevant to your application if the default value of 110% of nominal is unsuitable.
4. Accept the settings by pressing **Enter** or discard them with **ESC**.



Those thresholds are reset to defaults when using the function "Reset" in setup menu.

► How to configure the alarm sound

1. Switch off the DC output and push **Menu** to call the setup menu.
2. In the menu navigate to **HMI Setup** and press **Enter**. Then in the submenu, navigate to **Alarm Sound** and press **Enter** again.
3. In the following screen set parameter **Alarm Sound** to either **OFF** or **ON**.
4. Accept the settings by pressing **Enter** or discard them with **ESC**.

4.10 Control Panel Lock

In order to avoid the accidental alteration of a value during manual operation the rotary knobs or the key strip of the control panel can be locked so that no alteration will be accepted without prior unlocking. These controls are collectively also known as the human-machine interface, or HMI. You can choose between a simple lock and a PIN lock, which requires to enter the correct PIN every time someone wants to unlock the HMI.


► How to lock the HMI

1. Switch off the DC output and push **Menu** to call the setup menu.
2. In the menu, navigate to **HMI Setup** and push **Enter**. Then in the submenu, navigate to **HMI Lock** and push **Enter** again.
3. Make your selection for parameter HMI Lock. With selection **Lock All** everything on the HMI is locked, and you can't even switch on the DC output. In order to be able to do at least that, use **ON/OFF Possible**.
4. The lock is activated as soon as you confirm your selection with **Enter**. The system will automatically exit the menu and jump back to normal display with status **Locked** now being indicated.

Alternatively to the procedure above you can also lock the HMI while the DC output is switched on, by accessing the quick menu. Refer to [4.5.6. The quick menu](#).

If an attempt is made to alter something whilst the HMI is locked, a requester appears in the display asking if the lock should be disabled.

► How to unlock the HMI

1. Rotate any knob or push any button except **On** button.
2. A request pop-up will appear: 
3. Unlock the HMI by pushing **Enter** within 5 seconds, otherwise the pop-up will disappear and the HMI remains locked. In case the HMI lock with PIN has been activated before, you are then requested to enter the correct PIN, otherwise the HMI will remain locked.





4.11 Loading and Saving a User Profile

The menu **Profiles** serves to select between a default profile and up to 5 user profiles. A profile is a collection of all settings and set values. Upon delivery, or after a reset, all 6 profiles have the same settings and all set values are 0. If the user changes settings or sets target values then these create a work profile which can be saved to one of the 5 user profiles. These profiles or the default one can then be switched. The default profile is read-only.

The purpose of a profile is to load a set of set values, settings limits and monitoring thresholds quickly without having to readjust these. As all HMI settings are saved in the profile, including language, a profile change can also be accompanied by a change in HMI language.





On calling up the menu page and selecting a profile the most important settings can be seen, but not changed.

► How to save the current values and settings (work profile) as a user profile

1. Switch off the DC output and push button  to call the setup menu.
2. In the menu navigate to **Profiles** and push .
3. In the submenu (see figure to the right) select a user profile (1-5) to save to and push  again.
4. From the selection on screen chose **Save settings into Profile n** and overwrite that profile with the current settings and values by confirming with .

Default Prof.	Profile 2	Profile 4
Profile 1	Profile 3	Profile 5

► How to load a user profile

1. Switch off the DC output and push button  to call the setup menu.
2. In the menu navigate to **Profiles** and push .
3. In the submenu (see figure to the right) select a user profile (1-5) to load and push  again.
4. In the screen you can now select **View Profile n** in order to check the stored settings and to decide, whether this profile is going to be loaded or not. Navigate to **Load Profile n** and confirm with  to finally load the profile into the work profile.

Default Prof.	Profile 2	Profile 4
Profile 1	Profile 3	Profile 5

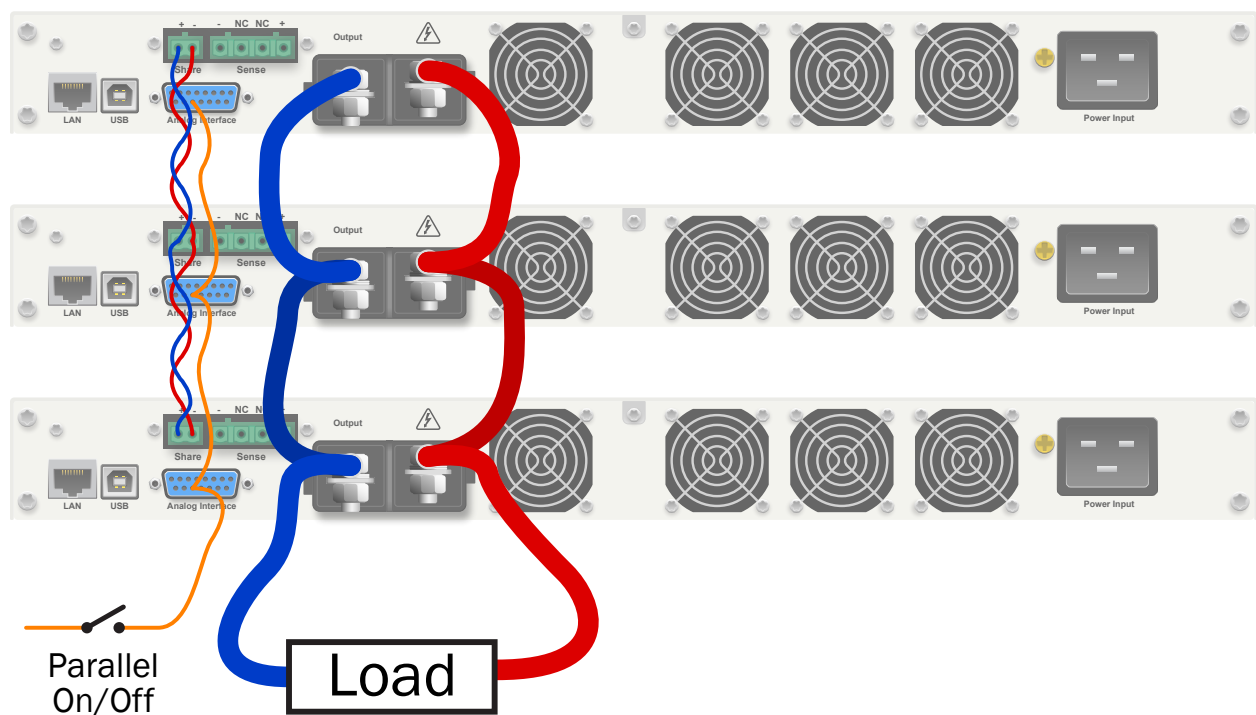
4.12 Parallel Operation in Share Bus Mode

Multiple units of same model number can be connected in parallel in order to create a system with higher total current and thus higher power. To achieve that, the units have to be connected with their DC outputs and their Share Bus. The Share Bus will balance the units in their internal voltage regulation and thus current regulation, which will result in a balanced load distribution.

In the parallel operation, a specific unit, a Share Bus master, has to be picked as the leading unit which drives the Share Bus slaves. The master unit will remain fully controllable, also via analog or digital interface. The slaves, however, are restricted regarding set value adjustment. Their set values are just limits for the units, while control is via the Share Bus. A slave unit still can be controlled remotely, but not like a master unit. All slaves can be monitored by any of the interfaces.



The Share Bus controls the process variable U (voltage) only. This means the DC outputs of slave units have to be switched on or off either manually or remotely, which is very easy in analog remote control using pins REM-SB connected in parallel as well.



4.12.2.1 Wiring the DC outputs

The DC output of every unit in the parallel operation is simply connected to the next unit using cables with cross section according to the maximum current and with short as possible length.

4.12.2.2 Wiring the Share bus

The Share bus is wired from unit to unit ideally with an twisted pair of cables with non-critical cross section. We recommend to use 0.5 mm² to 1.0 mm². A maximum of 10 units can be connected via Share bus.



The Share bus is poled. Take care for correct polarity of the wiring!







4.12.2.3 Configuring units for Share Bus operation

For correct Share Bus operation in parallel connection, the formerly picked master unit has to be configured as “Share Bus master”. By default, these power supplies are set as “Share Bus slaves”, so that this configuration step is not necessary for all slave units.



Only one unit in the Share Bus connection must be configured as Share Bus master, else the Share Bus won't work.

► How to configure a system as Share Bus master

1. Switch off the DC output and push button  to call the setup menu. Push  again to enter submenu **Set-**
tings.
2. In the submenu navigate to **General** and push  once again.
3. Use arrow button  to navigate to item **Share Bus mode** on the 2nd page and switch to setting **Master** by using the right rotary knob.
4. Accept the settings with  or discard them with .

4.12.2.4 Operating the Share Bus system

After successful configuration and initialisation of the master and slave units, it is recommended to check all set values and protection settings of all slaves and possibly adjust to identical values.

The slaves can be controlled manually as usual or remotely via the analog or via digital interfaces, but they don't react to set values changes the same way as the master. They can, if needed, be monitored by reading actual values and status.

The master unit is not restricted and can be used like a stand-alone unit. Alarms and other problem situations

Parallel operation, due to the connection of multiple units and their interaction, can cause additional problem situations which do not occur when operating individual units. For such occurrences the following regulations have been defined:

- If one or more slave units are switched off on the AC side (power switch, supply undervoltage) and come back later, they're automatically included again in the system. The remaining units will continue to work without interruption, but the entire system will provide less power
- If the DC output of the master unit is switched off due to a defect or overheating, then the total parallel system can provide no output power
- If accidentally multiple or no units are defined as master the Share Bus parallel system cannot be initialised

In situations where one or multiple units generate a hardware alarm like OV, PF or OT following applies:

- Any alarm of a slave is indicated on the slave's display only

4.12.1 Series connection

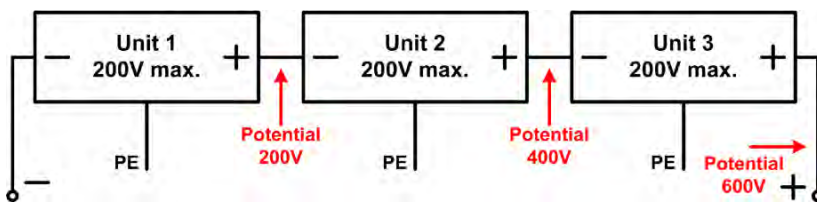
Series connection of two or multiple units is possible. But for reasons of safety and isolation, some restrictions apply:



- Both, negative (DC-) and positive (DC+) output poles, are coupled to GND via type X capacitors
- Any DC minus pole of any unit in the series connection must not be shifted in its potential against GND higher than what's stated in the technical specifications!
- The Share Bus must not be wired and used!
- Remote sensing must not be used!
- Series connection should only be wired for units with the same current rating, like for example MPW 300-01-0080-100 1U with another MPW 300-01-0080-100 1U unit.

Series connection is not supported by the software and hardware of the system. This means, all units must be controlled separately regarding set values and DC output status, whether it is manual control or digital remote control. In remote control, an almost synchronous control can be achieved by using the Ethernet ports and sending message as broadcast, so they address multiple units at once.

The figure below depicts an example series connection of three identical units with 200 V nominal output voltage and the resulting potential shift of the DC- output pole against GND:



5 Programming Introduction

This section include general concepts and details to be aware of when programming and running remote control.

5.1 Remote Communication Interfaces

The table below identifies which interfaces support which protocols.

Interface	Modbus RTU	Modbus TCP	SCPI
USB Type B	Yes	x	Yes
Ethernet	Yes	Yes	Yes



When using Modbus on a standard Ethernet interface, use the Modbus RTU format on any available TCP port other than 502. To use Modbus TCP, port 502 must be used.

5.1.1 USB

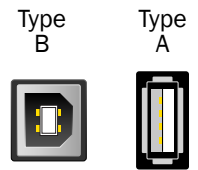
All mPower DC systems include a Type B USB port on the rear panel. This port is intended for full programmatic control of the system. Either of the Modbus RTU or SCPI protocols can be used.

There is no configuration for the USB port, but the mPower USB driver should be installed. See section [2.9. USB Port Connection](#).

5.1.1.1 Front USB

Other mPower Series have a front USB port which might be either a Type A or a Type B connector. The Type A connector is used on the 310 Series models, whereas the Type B is used on 320 Series.

Thes ports do not serve the same purpose as the rear Type B port. If you end up working with one of these models, for remote programming of the power supply, use only the rear Type B USB port.



5.1.2 Ethernet

The mPower 300 Series includes standard TCP access via the default port 5025 (which is user adjustable). TCP data transfer can be used for communication using SCPI or Modbus RTU (a.k.a. Modbus RTU over Ethernet). For the Modbus TCP protocol (which is not the same as Modbus over Ethernet), port 502 is used (and is not user adjustable).

The port and other network related parameters can be adjusted in the system's control panel setup menu, from USB, or through the web browser interface (port 80).

A TCP/IP socket connection (IP:port) is intended for normal remote control access to the system when using an Ethernet interface.



The TCP connection can be automatically disconnected by the system after a certain amount of time elapses with no data transmission. This is due to an adjustable timeout (default: 5 s). There is also another related option named **TCP keep-alive** which, if activated, makes the timeout ineffective, unless **TCP keep-alive** is not configured in the network.

5.2 Remote Communication Sources

After connecting a power supply digital interface to a computer, remote software access can be gained in several ways.

- The control and monitoring software EA Power Control, available through Marway.
- LabView VIs, available through Marway.
- A custom programmed application created by the user or contractor.
- General purpose third-party software, like a terminal program that can send text messages (SCPI).

5.3 Remote Communication Protocols

All mPower DC 300 models support two command protocols: Modbus and SCPI. The exact compatibility between protocols and interfaces is listed in [5.1. Remote Communication Interfaces](#).

With Modbus, mPower DC uses the two standardized variations Modbus RTU and Modbus TCP. Each variation shares the same core register commands, but differs in its message format.

The mPower DC control system does not require that the remote protocol be declared. There is no “mode” for Modbus vs. SCPI as the remote protocol. Rather, command structure is automatically recognized. (In fact, commands from either protocol could technically be arbitrarily intermixed.)

5.3.1 Protocol Detection

The mPower control system uses the first byte of the remote command message to automatically distinguish the message as being either Modbus RTU or SCPI. A Modbus RTU message begins with the slave address (which is a single byte). In all mPower DC 3 Series, this slave address is 0x00. The Modbus RTU protocol uses the address of 0x00 as a broadcast address. However, for mPower DC products, they will not be on a true “bus” (i.e. RS-485). Since communication will be over USB, some form of Ethernet, or RS232, the communication is always “point-to-point” from the remote control source to the power supply.

For the built-in USB and Ethernet (not on port 502), the internal system counts on the the first byte as 0x00 to indicate the message will be a Modbus RTU. A value between 0x01 and 0x29 in the first byte will cause a Modbus communication error, whereas starting with 0x2A (ASCII character *), the message will be considered a text message, and interpreted as a SCPI command.



The Modbus RTU slave address is always 0. This address cannot be changed.

As a result of mPower’s auto-protocol-detection scheme, SCPI cannot be used on Ethernet TCP port 502. Since Modbus TCP requires a wrapper in which the first byte cannot be 0x00, the system cannot distinguish Modbus TCP from SCPI. Therefore, in the mPower system, port 502 (which is an IANA reserved port for Modbus TCP), is assumed to always be receiving Modbus TCP traffic.

5.4 Control Location

Since the power supply can be controlled from the onboard controls, and from multiple remote control interfaces, there is the concept of control location—that is, the location, or source, of where control is being managed. The power supply software concerns itself with this concept by managing whether control is allowed from the local controls only, from remote controls only, or from either location. In order to run programmed sequences, remote control must be allowed.

See the discussion in section [4.6. Manual vs Remote Control](#).

5.5 Command Message Timing

Program code from a PC or PLC can send commands to a power supply faster than those commands can be processed. It is the responsibility of the program code to make sure that the power supply is ready for each command. This often involves creating arbitrary delays in the program code between commands. How long those delays need to be sometimes takes experimentation. However, there are some guidelines to help establish a starting point.

5.5.1 Reading response time

There are generally two methods of communicating with a port:

- 1) Open port > write query to port > read response from port > close port
- 2) Open port > write query to port > read response from port > repeat (write-read) X times > close port

Each method has advantages and disadvantages. The primary advantage of method 2 over method 1 is that writing and reading X times within one session is expected to take less time compared to a full session per cycle. The primary advantage of method 1 over method 2 is that closing the port also closes the connection which makes communication more stable—especially if the time between two write-read cycles is very long.

The values in the table below have been acquired using method 1.

		Typical response times	
Series	Protocol	USB	Ethernet
mPower 300 Series	SCPI	1–3 ms	5–8 ms
	Modbus	≈ 1 ms	≈ 5 ms

5.5.2 Writing response time

Unlike reading, there's not a predictable response time for write commands. Each command performs unique tasks in the power supply, and some take longer to accomplish than others. Timing is further complicated by the interface used as each operates at various speeds, with varying overhead.

When developing code to automate process sequences, it will be necessary to experiment with the product, computer, and communication bus together to acquire repeatable timing data.

5.5.3 Time between messages

The minimum time between two messages shown below, primarily depends on the typical read time as discussed above.

Series	Minimum delay between messages	Recommended delay between messages
mPower 300 Series	USB: 2 ms Ethernet: 8 ms	USB: 5 ms Ethernet: 15 ms

5.6 Connection Timeout

Socket connection to systems which support an Ethernet port have a connection timeout. This variable and user-adjustable timeout (see Operating Guide for the system) closes the socket connection automatically on the system side if there was no communication going on between system and controlling unit (PC, PLC etc.) for the adjusted time. After the socket has been closed, connection can be established again any time. The timeout becomes automatically ineffective if **TCP keep-alive** is activated, and supported in the network.

5.7 Fragmented Messages

With all communication interfaces, it is possible for the host computer (PC/PLC) to send partial messages, or messages with timing gaps between bytes. When this happens, what the power supply sees is a partial command, a delay, and the rest of the command is received. Since there is no requirement for a termination byte in Modbus or SCPI, the power supply could interpret these two data burts as two commands rather than one. Of course, neither would be recognizable, and the system will respond with errors.

How long of a delay between bytes is a problem? To help create some predictability in these scenarios, a variable timeout named **Com Timeout** is available. This timeout defines the maximum time delay tolerated between data burts. As long as gaps between bytes is less than this timeout, the power supply will continue to accept data as a single message.

If the communication between the host and power supply experiences communication errors, and fragmented messages are suspected, the timeout can be used. Increase the value a little at a time until reliable communications are restored. It's advised to keep the timeout setting as low as possible, because at the end of every message, the timeout has to elapse before the system can process the command.

When using SCPI, sending an additional termination character (LF, CR, or CRLF), which is not required but accepted, will terminate the timeout immediately and let the system consider the message as completely received, so it can process.

5.8 Resolution and Tolerances

When setting output and limit values for voltage, current, power, and resistance, resolution and tolerance have to be allowed for. Resolution affects the realistic incremental steps which values can be set to. Tolerance informs the amount of inaccuracy which can be expected.

In all mPower 300 systems, there is an internal resolution of 26,214. This means that a value such as the DC output volts has 26,214 possible values (or steps) between 0 volts and the maximum nominal rating of volts for the system. A system which has a nominal rating of 80 volts has 26,214 possible steps between 0 and 80. A system which has a nominal rating of 750 volts has 26,214 possible steps between 0 to 750. For the 80 V system, every “step” in value is an increment of $80 \text{ V} \div 26214 \text{ steps}$, or 0.00305 V/step. For the 750 V system, each step is $750 \div 26214 \text{ steps}$, or 0.02861 V/step.

Let’s say it was desired to set the output of each system to 10.00 Vdc. For the 80 V unit, $10.00 \text{ V} \div 0.00305 \text{ V/step}$ results in 3,278.68 steps. A fraction of a step is not possible. So, the system is capable of either 3,278 or 3,279 steps. Multiplied back out, we end up with either 9.9979 Vdc or 10.00095 Vdc. For the 750 V unit, using the same math, the two possible results are 9.98489 Vdc or 10.0135 Vdc. Obviously these are very small differences, but differences nonetheless that you might see between setting and reading values.

Further, no control system is perfectly accurate, or perfectly repeatable. Every system has some plus or minus fluctuation of the actual result. The spec sheet for a given unit may indicate that the voltage tolerance is 0.1% (of nominal rating). This means that for an 80 Vdc system, setting any given output target can result in a value $0.1\% \times 80 \text{ V}$, or 80 mV. Therefore, setting a target of 24.00 Vdc means the actual measured value could be between 23.92 V and 24.08 V.

Both resolution and tolerance influence the final values, and explain why you will see small differences in set value targets and the actual measurements when reading values.

6 Modbus Protocol

6.1 Modbus Overview

One advantage in using the Modbus command protocol is that some form of the commands can be used on every other communication interface available on the mPower DC 3 Series systems (300, 310, 311, 320), except for the GPIB interface of the 310 series). So, having learned Modbus, and its registers in particular, that knowledge is useful for almost all other interfaces, and across all other mPower DC models.

Keep in mind that for the mPower products, when we talk about Modbus, there are two types: Modbus RTU and Modbus TCP. Modbus RTU is the traditional standard. Modbus TCP is a modified form.

This section starts off with a number of topics which apply to all uses of Modbus before taking a detailed look at the traditional Modbus RTU protocol, the Modbus TCP protocol, and some register-specific notes.

A detailed listing of all registers is shown at the end of this chapter, and is available as a separate PDF document *mPower-300-Series-Modbus-Register-List* available on our website.

6.1.1 Modbus RTU

The traditional Modbus RTU message consists of hexadecimal bytes in three segments called the Address, the Protocol Data Unit (PDU), and the CRC Checksum. The PDU is made up of sub-elements starting with the function code (FC), and then varies depending on the message purpose.

For Modbus RTU, all of these traditional elements are used. For example, here's the Modbus RTU message format to write a single register. Details of the message format are covered in [6.5. Modbus RTU in Detail](#).

Review the table in [5.1. Remote Communication Interfaces](#) to identify which interfaces that Modbus RTU can be used with.

PDU (protocol data unit)				
Address	Func. Code	Start register	Data word	CRC
0x00	0x06	0..65535	Value to write	Checksum Modbus-CRC16

For mPower DC products, the address (first byte) must always be 0x00. The mPower control system uses the first byte to auto-distinguish the message as being either Modbus or SCPI. A value between 0x01 and 0x29 in the first byte will cause a Modbus communication error, whereas starting with 0x2A (ASCII character *), the message will be considered a text message, and therefore a SCPI command. (See [5.3.1. Protocol Detection](#) for additional details.)

6.1.2 Modbus TCP

For Modbus TCP, the CRC checksum is removed, and an additional message header is added. This example shows an arbitrary transaction identification of 0x4711. The rest of the Modbus TCP message is the same as Modbus RTU, except for eliminating the checksum. Information about the header can be found in [6.6. Modbus TCP in detail](#).

Review the table in [5.1. Remote Communication Interfaces](#) to identify which interfaces that Modbus TCP can be used with.

MBAP Header	Address	Func. Code	Start register	Data word
0x4711 0x0000 0x0006	0x00	0x06	0..65535	Value to write

6.2 Set Value Resolution

When reading or writing set values, the numeric value is always a percent of the power supply's nominal rating (e.g. 80 V, 40A, 1000W). The percent is represented in hexadecimal where 0x0000 = 0% and 0xCCCC = 100%.

Note however, that some numeric values can be more than 100% of the nominal rating. For example, the voltage, current, and power set values can be up to 102% of the nominal rating. Therefore, for these registers, the acceptable maximum value is more than 0xCCCC (100%), and is actually 0xD0E5 (102%).

Similarly, the threshold alarms can be up to 110% of the ratings. Therefore, 0xE147 is the maximum acceptable value. When reading the actual voltage, current, or power registers can be as high as 125% of the nominal rating (0xFFFF).

All numeric values have ranges, and many have ranges which exceed 100% nominal ratings. The register reference will detail the exact range and maximum hexadecimal value.



All set values are not only limited by the unit's nominal values, but are also limited by Limits settings. Just as they would be when manually entering values, set values sent to registers which exceed the Limits settings are rejected by the power supply. It is good practice to read back the value after setting Limits to verify that the value was accepted and stored.

6.2.1 Hex Percent and Decimal Value Conversion

Real values have to be translated to percent values before transmitting them to the system. Also, percent values read from the system are usually translated into real values in order to process them further (in the program code managing the power supply). As described in the section above, 0xCCCC (hex) = 52,428 (decimal) = 100% nominal value (U, I, P)

Translation is done by using these formulas in your software:

Percent hex value to decimal real value	Decimal real value to percent hex value
$\text{Real value} = \frac{\text{Rated value} * \text{percent value}}{52428}$ <p>Example: The nominal voltage of your unit is 80 V and actual voltage was read as 0x2454 (decimal: 9300). According to the formula above, the real actual value will be $(80 * 9300) / 52428 = 14,19$ V.</p>	$\text{Percent value} = \frac{52428 * \text{real value}}{\text{Rated value}}$ <p>Example: the power set value shall be 3150 W, the power rating of your unit is 3500 W. According to the formula above we get a power set value of $(52428 * 3150) / 3500 = 47185 = 0xB851$.</p>

6.3 Communication with USB Port

See [2.9. USB Port Connection](#) for USB driver information.

To communicate remotely with the power supply using Modbus requires terminal software on the PC side which is able to open a COM port, and both receive and send binary messages in hexadecimal format. There are several general purpose packages which do this, and even some Modbus-aware software packages which can help with some message translation tasks. (Do an internet search for “Modbus rtu terminal software” to find options.)



- In order to use remote control to change values, or switch the DC output on or off, you must activate remote control first—either with a remote command, or from the manual control panel menu.
- Remember that remote control may be blocked. See [5.4. Control Location](#).

6.4 Reading Register Lists

Along with this programming guide, there is a register list for the 300 Series as a separate PDF file. The list give an overview of the remote programming features available for the named series when using binary communication protocols like Modbus. They are also a reference when controlling a unit in programming environments like LabView or MatLab.

The register list explains how the data in a binary message has to be interpreted or how a register is specified. This will help the user to implement remote communication into custom software applications. Users who decide to work with SCPI command language usually do not need these lists. Later in this document, the SCPI commands are referenced in a separate chapter.

6.4.1 Function Columns

The heads of the 5 columns next to the Modbus address column contain the names and codes of the supported Modbus functions. An x in these columns marks the assignment of a register to any of the functions. For example, the coil registers are usually writable and readable, so they're assigned to **Read Coils (0x01)** and **Write Single Coil (0x05)**.

6.4.2 Data type Column

Data type	Length	
char	1 Byte	Single byte, used for strings
uint(8)	1 Byte	Single byte
uint(16)	2 Bytes	Double byte, al word or 16bit integer
uint(32)	4 Bytes	Double word, al long or 32bit integer
float	4 Bytes	Floating point value according to IEEE745 standard

6.4.3 Access Column

This column defines for every register whether the access is read only, write only or read/write. Writing to a register which allows write access (W, RW) is only possible during remote control.

R = Register is read only

W = Register is write only, and would not return a reasonable value when read from

RW = Register can be read or written

6.4.4 Number of registers Column

With Modbus, a register always has a length of 2 bytes or a multiple of 2 bytes. This column tells how many 2-byte values are used by the register. The value is always half of the value in the **Data length in bytes** column.

6.4.5 Data Column

This column tells additional information about the data which can be written to or read from the register. Two, four, or more bytes can be interpreted in different ways, depending on data type and content.

6.5 Modbus RTU in Detail

This protocol can be used with the built-in USB and Ethernet interfaces. The addressed object when using Modbus protocol is called a register. This document uses the terms address, register, or register address.

6.5.1 Message types

The Modbus message system distinguishes between control messages, query messages, and response messages. Query messages will cause the system to send a response message. Control messages only cause it to reply with an echo of the message (in order to confirm reception).

The bytes in a Modbus message are read from left to right (big endian format), except for the 16 bit Modbus RTU checksum where low byte and high byte are switched.

6.5.2 Address

The first byte of every Modbus message (the address) has to be 0x00. See [5.3.1. Protocol Detection](#).

6.5.3 Functions

The second byte of a message contains a Modbus function code ("FC"), which determines whether the message is a READ or WRITE message. It also determines, whether one or multiple registers are accessed. mPower systems support the following Modbus functions:

Function		Function name		Description	Example of use
Hex	Dec	Long	Short		
0x01	1	READ Coils	RSC, RC	Always reads 1 bit, but is returned as a full register with a 16 bit value. For example, the value 0xFF00 means logic 1, or TRUE. <u>This is different from the Modbus standard, and may cause problems with Modbus software tools.</u>	Query the input / output condition
0x03	3	READ Holding Registers	RHR	Used to read n subsequent registers. Results in n*2 bytes of data in the response message.	Read the model name string (1-40 bytes)
0x05	5	WRITE Single Coil	WSC	Used to write 16 subsequent bits which are interpreted as 1 bit (TRUE or FALSE). <u>This is different from the Modbus standard, and may cause problems with Modbus software tools.</u>	Switch system to remote control.
0x06	6	WRITE Single Register	WSR	Used to write one register.	Set values (U, I, P etc.)
0x10	16	WRITE Multiple Registers	WMR	Used to write n subsequent registers. be used to write beyond the limits of a register block, for example when trying to write multiple set values (U, I, P) at once.	Write multiple values at once within a register block or write the user text



The register list defines which of the above functions may be used with every register.

6.5.4 Control messages (write)

When sending a status, a value, multiple values, or text, the data part of the message requires to define at least the target register and one value to write. The protocol checks the message only regarding the max. length of the register. After the data part, the checksum is expected. So in case the data part would only contain the minimum two bytes and thus the message would fulfil the protocol requirements for the selected function code, the checksum would be expected at the position of the 7th byte. If there were additional data bytes at that position or zeros and the checksum would be at a different position in the message, the system would return an error. Therefore, the system will return an error, no matter if the message is too short or too long, because the checksum is wrong. For message examples see [6.5.9. Examples of Modbus RTU messages](#).

WRITE Single Register

Byte 0	Byte 1	Bytes 2+3	Bytes 4+5	Bytes 6+7
Addr	FC	Start reg.	Data word	CRC
0x00	0x06	0-65535	Value to write	Checksum Modbus-CRC16

WRITE Multiple Registers

Byte 0	Byte 1	Bytes 2+3	Bytes 4+5	Byte 6	Bytes 7-253	Last 2 Bytes
Addr	FC	Start reg.	Number	Count	Data bytes	CRC
0x00	0x10	0-65535	0-123	Number*2	n values to write	Checksum Modbus-CRC16

WRITE Single Coil

Byte 0	Byte 1	Bytes 2+3	Bytes 4+5	Bytes 6+7
Addr	FC	Register	Data word	CRC
0x00	0x05	0-65535	0x0000 (FALSE) or 0xFF00 (TRUE)	Checksum Modbus-CRC16



The entire 16 bits of the data word represents 1 coil only, for writing and reading.

6.5.5 Query message

When querying something from the system, the response is expected to be immediate, and will be of varying length, but always of the same format. For the query, the start register and the number of registers or coils to read are required. The base of the Modbus data format is a register, a 16 bit integer value. When querying one register with **READ Holding Registers**, the system will return two bytes, and when querying two registers it returns 4 bytes etc. For **READ Coils**, the response will always be two bytes.

For message examples see [6.5.9. Examples of Modbus RTU messages](#).

READ Holding Registers

Byte 0	Byte 1	Bytes 2+3	Bytes 4+5	Bytes 6+7
Addr	FC	Start reg.	Number	CRC
0x00	0x03	0-65535	Number of regs to read (1-125)	Checksum Modbus-CRC16

READ Coils

Byte 0	Byte 1	Bytes 2+3	Bytes 4+5	Bytes 6+7
Addr	FC	Start reg.	Number	CRC
0x00	0x01	0-65535	Must always be 1	Checksum Modbus-CRC16



Reading coils here is not according to the Modbus specification. Reading a coil always returns 16 coils, but all 16 are considered as one bit with either TRUE (0xFF00) or FALSE (0x0000).

6.5.6 Response messages

A response from the system is usually expected after a query or if something has been set and the system confirms the execution.

Expected response for WRITE Single Register:

Byte 0	Byte 1	Bytes 2+3	Bytes 4+5	Bytes 6+7
Addr	FC	Start reg.	Data	CRC
0x00	0x06	0-65535	Written value echoed	Checksum Modbus-CRC16

Expected response for WRITE Single Coil:

Byte 0	Byte 1	Bytes 2+3	Bytes 4+5	Bytes 6+7
Addr	FC	Start reg.	Data	CRC
0x00	0x05	0-65535	Written value echoed	Checksum Modbus-CRC16

Expected response for WRITE Multiple Registers:

Byte 0	Byte 1	Bytes 2+3	Bytes 4+5	Bytes 6+7
Addr	FC	Start reg.	Data	CRC
0x00	0x10	0-65535	Number of written registers	Checksum Modbus-CRC16

Expected response for READ Holding Registers:

Byte 0	Byte 1	Byte 2	Bytes 3-253	Last 2 Bytes
Addr	FC	Data length in bytes	Data	CRC
0x00	0x03	2-250	Queried registers content	Checksum Modbus-CRC16

Expected response for READ Coils:

Byte 0	Byte 1	Byte 2	Bytes 3+4	Bytes 5+6
Addr	FC	Data length in bytes	Data	CRC
0x00	0x01	2	Queried bit as 1 register (always 16 coils)	Checksum Modbus-CRC16

Unexpected response (communication error):

Byte 0	Byte 1	Byte 2	Last 2 Bytes
Addr	FC		CRC
0x00	Function code + 0x80	Error code	Checksum Modbus-CRC16



A communication error can have several reasons, like a wrong checksum or when attempting to switch a system to remote control that has been set to **Local** or if it's already remotely controlled by another interface. See the communication error code list in [6.5.8. Communication errors](#).

6.5.7 The Modbus checksum

The checksum at the end of Modbus RTU messages is a 16 bit checksum, but is not calculated as the usual CRC16 checksum. Furthermore, the byte order of the checksum in the message is reversed. Information about Modbus CRC16 and source code for implementation and calculation are available on the Internet, for example here:

http://www.Modbus.org/docs/Modbus_over_serial_line_V1_02.pdf, section 2.5.1.2.

6.5.8 Communication errors

Communication errors are only related to digital communication with the system. Other alarms or errors of any kind which can be generated and indicated by the system must not be mixed up with these.

The system will return unexpected error messages in case the previously sent message is in wrong format or if the function cannot be executed by some reason. For example, when trying to write a set value with **WRITE Single Register** while the system is not in remote control. Then the message is not accepted and the system will return an error message instead of a confirmation message. The message format can be wrong if the checksum is bad or if you try to read a bit with function **READ Holding Registers** instead of **READ Coils**.

In case of an error, the response message contains the original function code added to 0x80, in order to identify the response as error message.

Overview of function codes in error messages:

FC error	Belongs to
0x81	READ Coils
0x83	READ Holding Registers
0x85	WRITE Single Coil
0x86	WRITE Single Register
0x90	WRITE Multiple Registers

Overview of the communication error codes which can be returned by the system:

Code		Error	Explanation
0x01	1	Wrong function code	The function code in byte 1 of the Modbus message is not supported. See 6.5.3. Functions for supported codes. The error also occurs when trying to read or write a register with a function code for which the register is not defined.
0x02	2	Invalid address	The register address you were trying to access with read or write is not defined for your system. Every system series may have a different number of registers. Refer to the separate Modbus register list of the series your system belongs to.
0x03	3	Wrong data or data length	The length of data in the message is wrong or the data itself. For example, a set value always requires two bytes of data. If the data part of the message would be one byte only or three bytes, then the data length would be wrong. Otherwise, when sending a set value of, for example, 0xE000 to a register for which the maximum value is defined as 0xCCCC, this would be wrong data.
0x04	4	Execution	Command could not be executed, depends on the situation
0x05	5	CRC	The CRC16 checksum at the end of the Modbus RTU message is wrong or has been transmitted in wrong byte order (high byte first instead of low byte)

Code		Error	Explanation
0x07	7	Access denied	Access to a certain register is not allowed or read only while trying to write, or vice versa. The error also occurs when trying to write to a writable address while the system is not in remote control or in remote control from a different interface
0x17	23	System in local	Indicates, that write access to the system is blocked by the Local condition, so only read access is possible. Local means that remote control is not allowed.

An example: You attempted to switch the system to remote in order to control it from PC, but instead of an echo of your message it returns something like this: 0x00 0x85 0x07 0x52 0x92. This is an error message. The position of the function code contains the value 0x85. According to the first table above, this is related to the function **WRITE Single Coil**. The error code in the message is 0x7 which means, according to the second table above, the system has denied the access. This can have different reasons, for example that the system is already in remote control via a different interface.

6.5.9 Examples of Modbus RTU messages



The examples can also be used for Modbus TCP, but they need to be extended by the required Modbus TCP header and stripped of the unnecessary checksum.

6.5.9.1 Writing a set value



Set values are adjustable limits for the physical values Current, Voltage, Power, and Resistance (where available). They can only be written to a system if it has been switched to remote control before via a digital interface.

Example: You want to set the current to 50%. According to the register lists, **Set current value** is at address 501 (0x1F5) and assigned function is **WRITE Single Register**. Expecting the system to already be in remote control mode, the message to build is this:

Message to send:	Addr	FC	Start	Data	CRC	Expected response:	Addr	FC	Start	Data	CRC
	0x00	0x06	0x01F5	0x6666	0x325F		0x00	0x06	0x01F5	0x6666	0x325F

In this case, the system is expected to return an echo of your message, indicating successful execution of the command. The display of the system should now show 50% of what's the maximum current of your system. For a power supply with 510 A nominal current, it should show 255.0 A, or for a model with 170 A current rating, it should show 85 A.

6.5.9.2 Query all actual values at once

The system holds three readable actual values of voltage, current and power. Actual values can be queried separately or all at once. The advantage of a combined query is, that you gain a snapshot of the most recent actual values. When querying separately, values may have changed already when sending the next query.

According to the register list, the actual values start from register 507. Three registers shall be read:

Message to send:	Addr	FC	Start	Data	CRC	►
	0x00	0x03	0x01FB	0x0003	0x7417	

Possible response:	Addr	FC	Len	Data	CRC
	0x00	0x03	0x06	0x2620 0x0C9B 0x091B	0x9EC0

6.5.9.3 Read the nominal voltage of a system

The nominal voltage, like the other nominal values of current, power or resistance, is an important value to read from a system. They're all referenced for translating set values and actual values. It's recommended to read them from the system right after opening the digital communication line, unless the software shall not be universal.

According to the register list, the nominal voltage is a 4-byte float value in register 121.

Query message:	Addr	FC	Start	No.	CRC	►
	0x00	0x03	0x0079	0x0002	0x1403	

Possible response:	Addr	FC	Len	Data	CRC
	0x00	0x03	0x04	0x42A00000	0xFE9A

Also see [6.5.6. Response messages](#). The response contains a float value according to IEEE754 format, which translates to 80.0.

6.5.9.4 Read system status

All mPower DC 3 Series systems report their system status in register 505.

Query message:	Addr	FC	Start	No.	CRC	►
	0x00	0x03	0x01F9	0x0002	0x1417	

Possible response:	Addr	FC	Len	Data	CRC
	0x00	0x03	0x04	0x00000483	0xA992

Also see [6.5.6. Response messages](#). The response contains the value 0x483 which states that the system is in remote control via the USB port, that the DC output is switched on, and that CC (constant current) mode is active.

6.5.9.5 Switch between remote and manual control

Before you can control a system from remote, it's required to switch it to remote control. This is done by sending a certain command.



The system will never switch to remote control automatically, and cannot be remote controlled in this state. Reading from all readable registers is always possible.



The system will never exit remote control automatically, unless it's switched off, or the AC supply is cut. Remote control can be terminated by a command.

Switching to remote control may be inhibited by several circumstances and is usually indicated by an error message:

- Condition **Local** is active (check the display on the front of your system or read the system status), which will prevent any remote control. (See 5.4. **Control Location**.)
- The system is already remotely controlled by another interface.
- The system is in setup mode, meaning a user has accessed the setup menu and not left it yet.

► How to switch a system to remote control:

1. If you are using the Modbus RTU protocol, you need to create and send a message according to the description above, for example (in hex bytes): 00 05 01 92 FF 00 2D FA.
2. Once the switchover to remote control has been successful, the system will usually indicate the new condition in the display or with a LED, as well as it echoes the message as a confirmation.

In case switching to remote control would be denied by the system, because option **Allow remote control = No** is set, then the system will return an error message like 00 85 17 53 5E. According to Modbus specification, this is error 0x85 with error code 0x17.

Leaving remote control can be done in two ways: using the remote command, or by switching the system to **Local**.

► How to exit remote control:

1. If you are using the Modbus RTU protocol, you need to build and send a message according to the description above, for example (in hex bytes): 00 05 01 92 00 00 6C 0A.

6.6 Modbus TCP in detail

This section is only about the differences to RTU. The core of a Modbus TCP message is Modbus RTU. Refer to [6.5. Modbus RTU in Detail](#) for more information. Differences of Modbus TCP compared to Modbus RTU:

- The message requires an additional MBAP header (6 bytes).
- The checksum is omitted (2 bytes).
- Transmission only via reserved port 502; any other port won't accept Modbus TCP frames.

The MBAP header is specified like this:

Bytes	Meaning	Explanation
0 + 1	Transaction identifier	This identifies the message. It's copied by the system in the response and is used to identify a certain message in a pool of incoming transmissions if multiple system are communicating with the PC and the response is not immediately. The identifier is an arbitrary value between 0 and 65535.
2 + 3	Protocol identifier	Here always 0 = Modbus protocol
4 + 5	Length	Number of remaining bytes in the message, i.e. the length of the Modbus RTU core message minus 2.



Note that when transferring Modbus RTU messages via any Ethernet interface it's called Modbus RTU over Ethernet, which is not the same as Modbus TCP. Modbus TCP is run on port 502, and Modbus RTU over Ethernet can run on a port other than 502.

6.6.1 Example for a Modbus TCP message

The example for READ Holding Registers from [6.5.9.3. Read the nominal voltage of a system](#), extended by the MBAP header (arbitrary transaction identifier 0x4711 used):

Query message:	MBAP Header	Addr	FC	Start	No.
	0x4711 0x0000 0x0006	0x00	0x03	0x0079	0x0002



Possible response:	MBAP Header	Addr	FC	Len	Data
	0x4711 0x0000 0x0007	0x00	0x03	0x04	0x42A00000

The example is a query for reading the system's nominal voltage. The response contains a floating point value in Data, which translates to 80(V).

6.7 Specific Register Notes

Many of the commands/registers are self-explanatory, but not all of them. Below are ones which likely need additional explanation.

6.7.1 Register 171

This allows to write and read a user-defined string of up 40 characters, which is intended to be used to identify a system.

6.7.2 Register 411

Described for SCPI in [7.13. Alarm management commands](#).

When using Modbus, this register is intended to reset alarm bits as represented in the system status (register 505, see below). Until these are reset, which is considered as an acknowledgement, the bits from previously occurred alarms remain set, even if the alarms have subsided. Alarms which are still present while register 411 is used to reset the alarm bits will of course be excluded from resetting. There is an exception: the system alarm OT (bit 19, overtemperature). This will be cleared automatically once the unit has cooled down. After resetting the alarm bits, system alarms can only be read in form of an alarm counter (registers 520 - 524).

6.7.3 Registers 500-502 (set values)

These are the most important registers to work with, because they define the DC output values of voltage, current, and power. With Modbus, any set value is transmitted as percent value of the nominal system values (0–100%), whereas for SCPI, real values are used.

6.7.4 Register 505 (system status)

This register represents the system condition in one 32-bit value. Some bits are grouped, and have to be interpreted as a set. According to the register list, bits 0-4 of register 505 are a group that represents the control location (see [5.4. Control Location](#)). By reading this register, you can furthermore detect if the system is already in remote control to see if command “Remote mode = on” was executed by the system.

With SCPI, some but not all of these 32 bits of this register are represented in the status registers Questionable and Operation. See [7.5. Status registers](#).

6.7.5 Registers 9000 - 9004 (adjustment limits)

For SCPI, this is explained in [7.10. Adjustment limit commands](#). Modbus users should also read that section for the general handling of these settings. Apart from that, setting these parameters is like setting a set value (U, I, P, R).

6.7.6 Registers 10007 - 10573

These registers can be used to remotely configure the various built-in or optionally available digital interfaces. The registers are connected to the corresponding settings in the system's setup menu, where featured.

ModBus address (dec)	ModBus address (hex)	Read coils (0x01)	Read holding registers (0x02)	Write single coil (0x05)	Write single register (0x06)	Write multiple registers (0x10)	Description	Access	Data type	Data length in bytes	Number of registers	Data	Example or description
0	0x0000	x					Device class	R	uint16	2	1		28, 30, 38 = 300 Series
1	0x0001	x					Device type	R	char	40	20	ASCII	PS 9080-60 2U
21	0x0015	x					Manufacturer	R	char	40	20	ASCII	
41	0x0029	x					Manufacturer address	R	char	40	20	ASCII	
61	0x003D	x					Manufacturer ZIP code	R	char	40	20	ASCII	
81	0x0051	x					Manufacturer phone number	R	char	40	20	ASCII	
101	0x0065	x					Manufacturer website	R	char	40	20	ASCII	
121	0x0079	x					Nominal voltage	R	float	4	2	Floating point number IEEE754	80
123	0x007B	x					Nominal current	R	float	4	2	Floating point number IEEE754	60
125	0x007D	x					Nominal power	R	float	4	2	Floating point number IEEE754	1500
131	0x0083	x					Article no.	R	char	40	20	ASCII	06230209
151	0x0097	x					Serial no.	R	char	40	20	ASCII	1234567890
171	0x00AB	x			x		User text	RW	char	40	20	ASCII	
191	0x00BF	x					Firmware version (KE)	R	char	40	20	ASCII	V3.02 16.08.2016
211	0x00D3	x					Firmware version (HMI)	R	char	40	20	ASCII	V2.08 22.09.2016
231	0x00E7	x					Firmware version (DR)	R	char	40	20	ASCII	V1.0.4.1 30.06.2016

402	0x0192	x				Remote mode	RW	uint(16)	2	1 Coils : Remote	0x0000 = off; 0xFF00 = on
405	0x0195	x		x		DC output	RW	uint(16)	2	1 Coils : Output	0x0000 = off; 0xFF00 = on
407	0x0197	x		x		Condition of DC output after PF alarm	RW	uint(16)	2	1 Coils : Condition	0x0000 = off; 0xFF00 = auto
408	0x0198		x		x	Condition of DC output after power ON	RW	uint(16)	2	1 Reg : Condition	0xFFFF = off; 0xFFFE = Restore
410	0x019A	x		x		Restart of the device (warm start)	RW	uint(16)	2	1 Coils : Restart	0xFF00 = execute
411	0x019B	x		x		Acknowledge alarms	RW	uint(16)	2	1 Coils : Alarms	0xFF00 = acknowledge
416	0x01A0	x		x		Analog interface: Reference voltage (pin VREF)	RW	uint(16)	2	1 Coils : VREF	0x0000 = 10V; 0xFF00 = 5V
417	0x01A1	x		x		Analog interface: REM-SB level	RW	uint(16)	2	1 Coils : REM-SB Level	0x0000 = normal; 0xFF00 = inverted
418	0x01A2	x		x		Analog interface: REM-SB action	RW	uint(16)	2	1 Coils : REM-SB Action	0x0000 = DC off; 0xFF00 = DC on/off
422	0x01A6	x		x		Speed of internal voltage controller	RW	uint(16)	2	1 Coils : Controller speed	0x0000 = Slow; 0xFF00 = Fast
425	0x01A9	x		x		Condition of DC output after leaving remote	RW	uint(16)	2	1 Coils : Condition	0x0000 = off; 0xFF00 = auto
440	0x01B8		x		x	Analog interface: Pin 14 configuration	RW	uint(16)	2	1 Reg: Alarms 1	0x0000 = OVP (default); 0x0001 = OCP; 0x0002 = OPP; 0x0003 = OVP + OCP; 0x0004 = OVP + OPP; 0x0005 = OCP + OPP; 0x0006 = OVP + OCP + OPP
441	0x01B9		x		x	Analog interface: Pin 6 configuration	RW	uint(16)	2	1 Reg: Alarms 2	0x0000 = OT + PF (default); 0x0001 = OT; 0x0002 = PF
442	0x01BA		x		x	Analog interface: Pin 15 configuration	RW	uint(16)	2	1 Reg: Status DC	0x0000 = CV; 0x0001 = DC on/off
500	0x01F4	x		x		Set voltage value	RW	uint(16)	2	1 0x0000 - 0x0DE5 (0 - 102%)	Voltage value (for translation see programming guide)
501	0x01F5	x		x		Set current value	RW	uint(16)	2	1 0x0000 - 0x0DE5 (0 - 102%)	Current value (for translation see programming guide)
502	0x01F6	x		x		Set power value	RW	uint(16)	2	1 0x0000 - 0x0DE5 (0 - 102%)	Power value (for translation see programming guide)
505	0x01F9		x			Device state	RW	uint(32)	4	2 Bit 0 : 4: Control location Bit 7 : DC output state Bit 9-10 : Regulation mode Bit 11 : Remote Bit 14 : Remote sensing Bit 15 : Alarms Bit 16 : OVP Bit 17 : OCP Bit 18 : OPP Bit 19 : OT Bit 21 : Power fail Bit 22 : Power fail Bit 23 : Power fail Bit 24 : UVD Bit 25 : OVD Bit 26 : UCD Bit 27 : OCD Bit 28 : OPD Bit 30 : REM-SB	0x00 = free; 0x01 = local; 0x02 = remote; 0x03 = USB; 0x04 = analog; 0x06 = Ethernet 0 = off; 1 = on 00 = CV; 01 = CR; 10 = CC; 11 = CP 0 = off; 1 = on 0 = off; 1 = on 0 = none; 1 = active 0 = none; 1 = active 0 = none; 1 = active 0 = none; 1 = active 0 = none; 1 = active 0 = none; 1 = active 0 = none; 1 = active 0 = none; 1 = active 0 = none; 1 = active 0 = none; 1 = active 0 = none; 1 = active 0 = DC enabled; 1 = REM-SB disables DC output
507	0x01FB	x				Actual voltage	RW	uint(16)	2	1 0x0000 - 0xFFFF (0 - 125%)	Actual voltage (for translation see programming guide)
508	0x01FC	x				Actual current	RW	uint(16)	2	1 0x0000 - 0xFFFF (0 - 125%)	Actual current (for translation see programming guide)
509	0x01FD	x				Actual power	RW	uint(16)	2	1 0x0000 - 0xFFFF (0 - 125%)	Actual power (for translation see programming guide)
520	0x0208	x				Count of OV alarms since power up	RW	uint(16)	2	1 0x0000 - 0xFFFF	Count
521	0x0209	x				Count of OC alarms since power up	RW	uint(16)	2	1 0x0000 - 0xFFFF	Count
522	0x020A	x				Count of OP alarms since power up	RW	uint(16)	2	1 0x0000 - 0xFFFF	Count
523	0x020B	x				Count of OT alarms since power up	RW	uint(16)	2	1 0x0000 - 0xFFFF	Count
524	0x020C	x				Count of PF alarms since power up	RW	uint(16)	2	1 0x0000 - 0xFFFF	Count
550	0x0226	x		x		Overvoltage protection threshold (OVP)	RW	uint(16)	2	1 0x0000 - 0xE147 (0 - 110%)	OVP threshold (for translation see programming guide)
553	0x0229	x		x		Overcurrent protection threshold (OCP)	RW	uint(16)	2	1 0x0000 - 0xE147 (0 - 110%)	OCP threshold (for translation see programming guide)
556	0x022C	x		x		Overpower protection threshold (OPP)	RW	uint(16)	2	1 0x0000 - 0xE147 (0 - 110%)	OPP threshold (for translation see programming guide)
577	0x0241	x		x		Condition of DC output after OT alarm	RW	uint(16)	2	1 Reg: Condition	0x0000 = off; 0x0001 = Restore

9000	0x2328	x	x	Upper limit of voltage set value (U-max)	RW	uint16	2	1	0x0000 - 0xD0E5 (0 - 102%)	Voltage value (for translation see programming guide)
9001	0x2329	x	x	Lower limit of voltage set value (U-min)	RW	uint16	2	1	0x0000 - 0xD0E5 (0 - 102%)	Voltage value (for translation see programming guide)
9002	0x232A	x	x	Upper limit of current set value (I-max)	RW	uint16	2	1	0x0000 - 0xD0E5 (0 - 102%)	Current value (for translation see programming guide)
9003	0x232B	x	x	Lower limit of current set value (I-min)	RW	uint16	2	1	0x0000 - 0xD0E5 (0 - 102%)	Current value (for translation see programming guide)
9004	0x232C	x	x	Upper limit of power set value (P-max)	RW	uint16	2	1	0x0000 - 0xD0E5 (0 - 102%)	Power value (for translation see programming guide)

10007	0x2717	x	x		Ethernet: TCP keep-alive	RW	uint(16)	2	1	Coils: Keep-alive on/off	0x0000 = off, 0xFF00 = on
10008	0x2718	x	x		Ethernet: DHCP	RW	uint(16)	2	1	Coils: DHCP on/off	0x0000 = off, 0xFF00 = on
10010	0x271A	x	x		Protocol: Modbus	RW	uint(16)	2	1	Coils: MODBUS on/off	0x0000 = off, 0xFF00 = on
10011	0x271B	x	x		Protocol: SCPI	RW	uint(16)	2	1	Coils: SCPI on/off	0x0000 = off, 0xFF00 = on
10017	0x2721	x	x		Ethernet: DHCP status	RW	uint(16)	2	1	Bits: DHCP running	0 = manual, 1 = DHCP
10502	0x2906	x	x	x	Ethernet: IP address	RW	uint(32)	4	2	Bytes 0 - 3: 0.255	192.168.0.2 (default)
10504	0x2908	x	x	x	Ethernet: Subnet mask	RW	uint(32)	4	2	Bytes 0 - 3: 0.255	255.255.255.0 (Standard)
10506	0x290A	x	x	x	Ethernet: Gateway	RW	uint(32)	4	2	Bytes 0 - 3: 0.255	192.168.0.1 (default)
10508	0x290C	x	x	x	Ethernet: Host name	RW	char	54	27	ASCII	"Client" (default)
10535	0x2927	x	x	x	Ethernet: Domain name	RW	char	54	27	ASCII	"Workgroup" (default)
10562	0x2942	x	x	x	Ethernet: DNS	RW	uint(32)	4	2	Bytes 0 - 3: 0.255	0.0.0.0 (default)
10566	0x2946	x			USB: Connection timeout (in milliseconds)	RW	uint(16)	2	15	65535	Default: 5 ms
10567	0x2947	x			Ethernet: MAC	RW	uint(48)	6	3	Bytes 0 - 5: 0.255	00-50-C2-C3-12-34 or 00-50-C2-C3-12-34
10572	0x294C	x			Ethernet: Port	RW	uint(16)	2	10	65536 (except 80)	5025 (default)
10573	0x294D	x			Ethernet: TCP Socket timeout (in seconds)	RW	uint(16)	2	15	65535, 0 = inactive	Default: 5 s

7 SCPI protocol

SCPI is an international standard for a clear text based command language. Details about the standard itself can be found on the internet.

Be aware that not all models feature all of the commands discussed in this guide. As commands are discussed, if they are not applicable to all series, the text will indicate to which series they're compatible.

7.1 Syntax

The following syntax formats can occur in commands and/or responses according to “1999 SCPI Command reference” specification.

Values	This numeric value corresponds to the value in the display of the system and depends on the nominal values of the system. Rules: - The value must be sent after the command and separated by a space - Instead of a numeric value you can also use:	
	MIN	corresponds to the minimum value of the parameter
	MAX	corresponds to the maximum value of the parameter
<NR1>	Numeric values without decimal place	
<NR2>	Numeric values with decimal place (floating point)	
<NR3>	Like <NR2>, but with multiplier (kilo, milli etc.)	
<NRf>	<NR1> or <NR2> or <NR3>, negative values supported	
Unit	V (Volt), A (Ampere), W (Watt), OHM, s (Seconds)	
<CHAR>	0..255: Decimal value	
<+INT>	0..32768: Positive integer value (output from system)	
<B0>	1 or ON: Function is/will be activated	
	0 or OFF: Function is/will be deactivated	
<B1>	NONE: manual operation active, switching to remote control possible	
	LOCAL: local (manual) operation only, reading of data possible	
	REMOTE: system is in remote control	
<ERR>	Error with number (-800 bis 399) and description	
<SRD>	String data, various formats: - IP address as number string with dots as separator, for example “192.168.0.2” - Key words, for example AUTO or OFF	
<Time>	[s]s.s[s][s][s][s][s] / Default format is seconds (s.s)	
;	The semicolon is used separate multiple commands within one message	
:	The colon separates the SCPI keywords (main system, subsystems)	
[]	Lowercase letters and the content of square brackets are optional	
?	The question mark identifies a message as query. A query can be combined with a control message (command concatenation). Note, that it's required to wait for the response of the query before the next control message can be sent.	
->	Response from system	

7.1.1 Concatenated commands

It's possible to concatenate up to 5 commands in one message. Each command must be separated by a semicolon (;).

Example:

```
VOLT 80;CURR 20;POW 3kW
```

The commands in the string are processed from left to right, so the order of commands is important to achieve correct results. When querying multiple values or parameters at once, the returned string is also in concatenated format, with the queried returns separated by semicolons.

7.1.2 Upper and lower case

SCPI uses upper case commands by convention, though the mPower control system also accepts lower case.

7.1.3 Long form and short form

SCPI commands have a long form and a short form. The short form (e.g. SOUR) and the long form (e.g. SOURCE) can be used arbitrarily. To distinguish both forms, the commands as described in the following sections are written partly in upper case (indicating the short form), and partly in lower case (indicating the additional part of the long form).

7.1.4 Termination character

Some interfaces (GPIB is one) require a termination character to the message, but others don't (such as USB). When not required, the termination character is optional, but often used anyway in order to maintain software compatibility between several different interfaces.

The termination character to use is **0xA** (LF, line feed).

7.1.5 Errors

Errors in terms of SCPI are only communication errors. According to the standard, systems using SCPI do not return errors immediately. They have to be queried from the system. The query can occur directly with the error command (see [SYSTem:ERRor?](#)) or by first reading the signal bit **err** from the STB register (see [7.5. Status registers](#)).

The error format is defined by the standard and is made of a string containing a number (the actual error code) and an explanatory text. The following are error strings generated by mPower systems:

Error code / error text	Description
0, "No error"	No error
-100, "Command error"	Command unknown
-102, "Syntax error"	Command syntax wrong
-108, "Parameter not allowed"	A command was sent with a parameter though the command doesn't use parameters
-200, "Execution error"	Command could not be executed
-201, "Invalid while in local"	Control command could not be executed, because system is in LOCAL mode
-220, "Parameter error"	Wrong parameter used
-221, "Settings conflict"	Command could not be executed because of the condition of the system (being in MENU etc.)
-222, "Data out of range"	Parameter could not be set because it exceeded a limit

-223, "Too much data"	Too many parameters per command or too many commands at once
-224, "Illegal parameter value"	A parameter not specified for the command has been sent
-999, "Safety OVP"	Alarm Safety OVP (only available with specific models) has been triggered (see system manual). It requires to power cycle the system.

7.2 Value Format

In the SCPI command language real values are used in their decimal numeric text form, with or without unit identification. For example, if you wanted to set a current of 177.5 A you would use the simple command **CURR 177.5** or, with units, **CURR 177.5 A**. Likewise, values returned in responses are also in the decimal numeric text form.

7.3 Getting Started

7.3.1 Ping

It's always recommended to ping a system first, in order to test if it responds at all. With SCPI, this is usually done by querying the identification string:

Protocol	Command
SCPI	*IDN?

As an immediate response, the system might send, for example (which happens to be Company Name, Part No., Serial No., HMI firmware version, KE firmware version, DR firmware version, User Text (none shown)):

Protocol	Response
SCPI	Marway Power Solutions, MPW 300-11-0080-100, 1960140001, V2.18 30.08.2019 V2.28 12.08.2019 V1.6.6,

7.3.2 Switch between remote and manual control



The system does not switch to remote control automatically, and cannot be remotely controlled without being explicitly in remote control mode. However, *reading* status and values is always possible.



The system does not exit remote control automatically (when a remote command completes). The system must be switched off (or lose AC supply), or commanded to switch back to manual control (through control panel, or remote command).

Before you can remotely control a system, you need to switch it to remote control by sending a command. Switching to remote control may be inhibited by several circumstances and is usually indicated by an error message:

- Condition **Local** is active (check the display or control panel on the front of your system), which will prevent any remote control (see [5.4. Control Location](#)).
- The system is already remotely controlled by another interface
- The system in setup mode, means the user has accessed the setup menu and not left it yet

► How to switch a system to remote control:

2. If you are using SCPI command language, send a text command (the space is required):

`SYST:LOCK 1 –or– SYST:LOCK ON`

Leaving remote control can be done in two ways: using the dedicated command or by switching the system to **Local** condition. We will consider the first option, because this is about programming.

► How to exit remote control:

1. If you are using SCPI command language, send a text command (the space is required):

`SYST:LOCK 0 –or– SYST:LOCK OFF`

7.4 Standard IEEE commands

To support the legacy interface standards of GPIB and IEEE 488, some of the traditional commands have been implemented.

*CLS

Clears the error queue and the status byte (STB).

*IDN?

Returns the system identification string, which contains following information, separated by commas.

1. Manufacturer
2. Model name
3. Serial number
4. Firmware version(s) (in case there are several, these are separated by a space)
5. User text (arbitrary user-definable text, as definable with SYST:CONFIG:USER:TEXT)

*RST

Sets the system to a defined state:

1. Switch to remote control (same as SYST:LOCK 1)
2. Set DC output to off
3. Clear alarm buffer
4. Clear status registers to default condition (QUESTionable Event, OPERation Event, STB)

*STB?

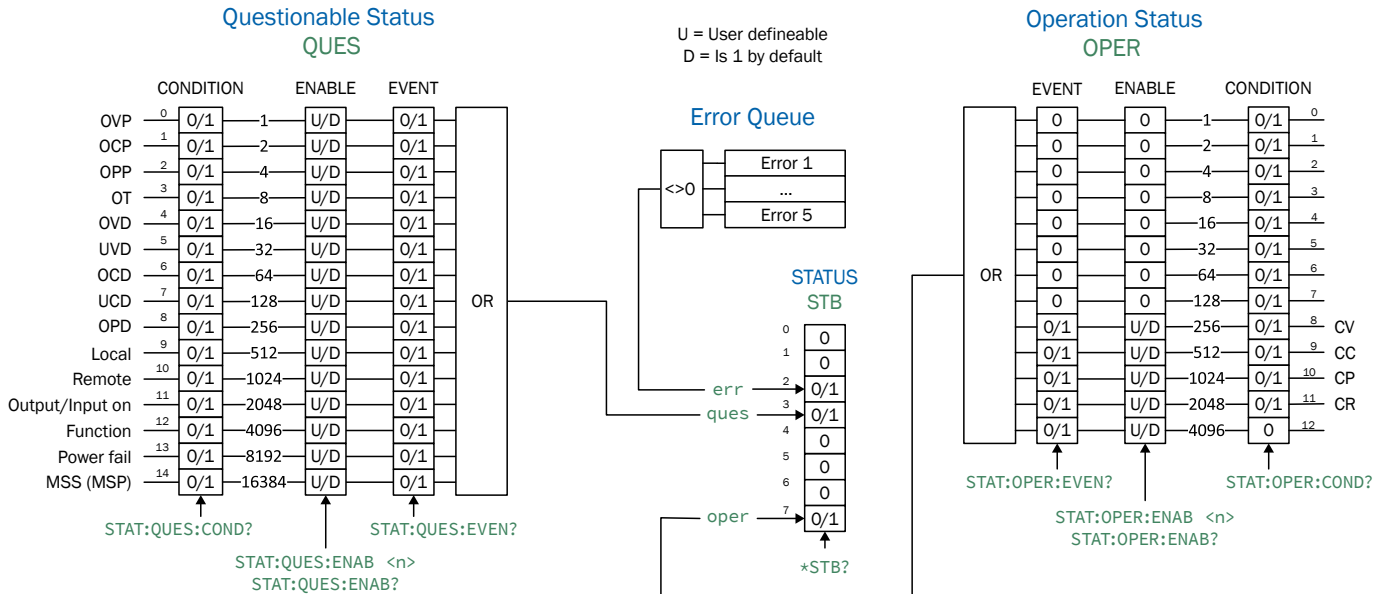
Reads the SStatus Byte register. The signal run of the various system conditions and events is illustrated in the register model below. The STB bits in particular:

- Bit 0: **sec_ques**, Second Questionable Status Register is active (one or more events have occurred)
- Bit 1: not used
- Bit 2: **err**, Error Queue → one or more errors in the error buffer. By reading the error buffer or sending *CLS it's flushed and the bit err is reset
- Bit 3: **ques**, Questionable Status Register is active (one or more events have occurred)
- Bit 4: not used
- Bit 5: not used
- Bit 6: not used
- Bit 7: **oper**, Operation Status Register is active (one or more events have occurred)

7.5 Status registers

Not all system conditions and alarms can be read with dedicated SCPI commands. As an alternative, the remaining system-related information are grouped in status registers. Using regular polling, the status byte (STB) can be a starting point for reading the system status. It tells which status register has recorded at least one event. Apart from that, the other status registers could also be polled directly. The difference would be that the user would have to determine which bits in the register have changed by comparing the most recent value with an older value. The bits in the status byte register will do that job for you. If they remain 0, nothing has happened.

Once a bit in the STB indicates (changes to 1) that there was an event recorded in QUES or OPER register, you could read the corresponding event register of OPER and QUES, in order to find out which bits have changed in the COND register.



Events recorded in the event registers `STAT:QUES:EVENT` and `STAT:OPER:EVENT` only record positive transitions (changes from 0 to 1).



There are differences in the status registers amongst the product series based on available features. The Operating Guide of a given product series will have the details of which the features are available for that series's registers by identifying the various alarms and events.



System alarms like OVP are signaled in the subregisters `CONDITION` and `EVENT`. Each has to be acknowledged separately using commands `SYST:ERR?` and `SYST:ERR:ALL?`. These commands are considered as alarm acknowledgement, and will clear the corresponding bit in `CONDITION`, but only if the alarm condition is not present anymore. Alarms which have been acknowledged can be determined from the system in the form of an alarm counter. It's recommended to regularly poll alarms from the system and to query `STAT:QUES?` prior to `SYST:ERR?`.

STATus:QUEStionable?

Reads the Questionable status CONDITION or EVENT register.

Returns a 16 bit value representing system information from the register model in 7.5. Status registers.

Query Forms:

STATus:QUEStionable:CONDition?

STATus:QUEStionable:EVENT?

STATus:QUEStionable?

Examples:

STAT:QUES? -> 3072

Reads the event register. This example reveals that bits 10 and 11 are set which identifies that **Remote = active** and **Output/input on = on**.

STAT:QUES:COND?

Reads the condition register of the questionable status register. The value contains the current snapshot of a number of status bits.

STATus:QUEStionable:ENABle <NR1>

Sets or reads the ENABLE register of the Questionable status register. The ENABLE register is a filter that enables all or single bits to signal an event to the status byte STB. By default, all bits of the ENABLE register are set. In case you want to ignore certain bits, you just need to add the values of the remaining bits and send the value to the ENABLE register.

Returns the sum of the decimal-valued bits in the register.

Query Forms:

STATus:QUEStionable:ENABle? <0-32767>

Example:

STAT:QUES:ENAB 3081

Sets the enable register of the questionable status registers to 3072 and enables the bits **OVP** (1), **OT** (8), **Remote** (1024), and **Output/Input on** (2048) for event reporting to STB. (Note that $1 + 8 + 1024 + 2048 = 3081$.)

STATus:OPERation?

Reads the Operation status EVENT or CONDITION register.

Returns a 16 bit value, which represents system information as defined in the register model in 7.5. Status registers.

Query Forms:

STATus:OPERation:CONDition?

STATus:OPERation:EVENT?

STATus:OPERation?

Examples:

STAT:OPER? -> 256

Reads the operation register (identical to :EVENT?). A possible response would be a value of 256, which tells, that bit 8 is set and according to the register model bit 8 signals, that CV (constant voltage regulation) is active.

STAT:OPER:COND?

Reads the condition register of the operation status registers.

STATus:OPERation:ENABle <NR1>

Sets or reads the Enable register of the Questionable status register. The Enable register is a filter. It enables single or all bits of the condition registers to change the corresponding bit in the event register. This also impacts the summary bit in the status byte STB. By default, all bits of the Enable register are set to 1. If you want to use only some specific bits, add the bit values (see register model) and send the total to the Enable register.

Returns a value which represents the bits set to 1 in the Enable register (as seen in [7.5. Status registers](#)).

Query form:

STATus:OPERation:ENABle?

Value range:

<NR1> = 0, 256–3840

Since bits 0–7 are not used, the minimum value other than 0 starts with 256. Also, bit 12 is always zero, therefore the maximum sum of the bits is 3840.

Example:

STAT:OPER:ENAB 1792

Sets the Enable register of the Operation register to value 1792 and enables bits CV, CC and CP for reporting events to the STB.

7.6 Status commands

Status commands are used to alter the status of the system in terms of activating remote control or switching the DC output, or to query the current status.

SYSTem:LOCK <B0>

This command is used to activate remote control of a system. Remote control has to be activated first before you can send any command which change system status or values. Once remote control has been activated via one of the digital interfaces, only that interface is in charge.

The activation of remote control can be refused by the system due to several reasons. It's usually replied in form of a SCPI error which is put into the SCPI error buffer. This buffer can be read with the error command.

Query form:

`SYSTem:LOCK:OWNer?`

Value range for set:

`ON, OFF`

Value range for query:

`REMOTE, NONE, LOCAL`

Examples:

`SYST:LOCK ON`

Absolute short form. Requests the system to switch to remote control. The system then usually indicates activated remote control either by a LED or a status text in the display.

`SYSTEM:LOCK:OWNER?`

→ `REMOTE`

Queries the lock owner regarding remote control. This can be used to verify whether the system has accepted the request to switch to remote control or not. It will return one of three different values:

`REMOTE` = System is in remote control via any of the available interfaces

`NONE` = System is not in remote control

`LOCAL` = System is in LOCAL condition, which denies or interrupts remote control.

OUTPut <B0>

This command is used to switch the DC output on or off.

Query form:

`OUTPut?`

Value range:

`ON, OFF`

Examples:

OUTP 1	Absolute short form. Switches the DC output on if remote control is active.
OUTPUT?	-> ON Queries the condition of the DC output, which will be returned as ON or OFF. Output state cannot be assumed as the output might be switched off due to a system alarm.

SYSTem:ERRor?

This command is used to read a single error, or all errors, from the system's internal SCPI error queue. This queue only contains errors in relation to commands (i.e. wrong syntax, too high values etc.). It cannot return any system alarm. Those are usually queried from the system by reading bits of the status registers (see [7.5. Status registers](#)). You can choose either to query the next error multiple times until it says "No error," or generally query all at once. After all errors have been read from the buffer, it will be purged. (See also [6.5.8. Communication errors](#).)

The queue is of type FIFO (first in, first out). This means that the first occurred error is returned first when querying them.



Querying errors with SYST:ERR? also clears bits related to system alarms in register QUEStionable (see [7.5. Status registers](#)), but only if the alarm condition has already receded. The query is considered as an acknowledgement by the user. Alarms which have been acknowledged this way can then not be read from the register anymore.

Query forms:

SYSTem:ERRor?	Queries the last or next error
SYSTem:ERRor:NEXT?	Queries the last or next error
SYSTem:ERRor:ALL?	Queries all errors in the buffer (up to 5)

Example:

SYST:ERR?	-> 0,No error Absolute short form. The system replies to this query with a string that first contains an error code (see error code list) and second an error description. This is returned every time no error is present, or after all errors have been returned.
SYSTEM:ERROR:ALL?	This query will let the system return up to 5 concatenated errors in one string, separated by comma plus space.

7.7 Set value commands



Remember, set values (U, I, P, R) are not only limited by the maximum nominal values of your particular system model, but are also limited by adjustment **Limits**.

[SOURce:]VOLTage <NRf> [Unit]

Sets the output voltage limit of the system within a certain range, which is either defined by adjustment limits, or is 0–102% nominal value. When queried, this reads the last setting. Alternatively, parameters MIN or MAX can be used to instantly set the voltage to the adjustable MINimum or MAXimum.

Returns a numeric value of the voltage limit setting.

Query form:

[SOURce:]VOLTage?

Value range:

<NRf> = 0–1.02 * nominal V 102% of nominal value for the model.

Examples:

VOLT 12 Absolute short form. Sets 12 V.

SOUR:VOLTAGE 24.5V Mixed form short/long, with unit. Sets 24.5 V, unless the voltage adjustment range has been limited otherwise.

SOURCE:VOLTAGE MIN Sets the voltage to the defined minimum, usually 0 V.

[SOURce:]CURRent <NRf> [Unit]

Sets the output current limit of the system within a certain range, which is either defined by adjustment limits, or is 0–102% nominal value. When queried, this reads the last setting. Alternatively, parameters MIN or MAX can be used to instantly set the current to the adjustable MINimum or MAXimum.

Returns a numeric value of the current limit setting.

Query form:

[SOURce:]CURRent?

Value range:

<NRf> = 0–1.02 * nominal V 102% of nominal value for the model.

Example:

CURR 170 Absolute short form. Sets 170 A.

SOUR:CURRENT 45.3A Mixed form short/long, with unit. Sets 45.3 A, unless the adjustment range of the current has been limited otherwise.

SOURCE:CURRENT MAX Sets the current to the defined maximum, which is either 102% of the rated current of the system, or to the value of adjustment limit **I-max**.

[SOURce:]POWer <NRf>[Unit]

Sets the output power limit of the system within a certain range, which is either defined by adjustment limits, or is 0–102% nominal value. When queried, this reads the last setting. Alternatively, parameters MIN or MAX can be used to instantly set the current to the adjustable MINimum or MAXimum.

Returns a numeric value of the current limit setting.

Query form:

[SOURce:]POWer?

Value range:

<NRf> = 0–1.02 * nominal V 102% of nominal value for the model.

Examples:

POW 3000	Absolute short form. Sets 3000 W, unless the power adjustment range has been limited otherwise.
SOUR:POWER 3.5kW	Mixed form short/long, with unit and magnitude Kilo. Sets 3.5 kW (3500 W), unless the adjustment range of the power has been limited otherwise.
SOURCE:POWER MIN	Sets the power to the defined minimum, which is usually 0 W.

7.8 Measure commands

Actual values, as returned by the measuring commands, are the DC output values as they are present at the moment they are queried. They are not necessarily identical to the corresponding set values. The system constantly measures the actual values, and returns the last snapshot when queried.

The number of decimal places in the returned value will be identical to the value format in the system display and varies from model to model. (There's more about decimal places in the Operating Guides.)

MEASure:[SCALar:]VOLTage[:DC]?

Queries the system to return the last measured DC output voltage value in Volts.

Example:

MEAS:VOLT? → 43.50 V

Absolute short form. Queries the actual voltage. A response, which should be instant, will return a value between 0% and 125% of nominal system voltage.

MEASure:[SCALar:]CURRent[:DC]?

Queries the system to return the last measured DC output current value in Amperes.

Example:

MEASURE:CURRENT? → 100.1 A

Queries the actual current only. A response, which should be instant, will return a value between 0% and 125% of nominal system current.

MEASure:[SCALar:]POWer[:DC]?

Queries the system to return the last calculated DC output power value in Watts.

Example:

MEAS:POW? → 2534 W

Absolute short form. Queries the consumed supplied power. A response, which should be instant, will return a value between 0% and 125% of nominal system power. No matter how the actual power format is in the system's display, here it will always be returned in Watts.

MEASure:[SCALar:]ARRay?

Queries the system to return the last measured actual values of voltage, current, and power (in that sequence), separated by commas, and with units.

Example:

MEAS:ARR? → 12.5 V, 33.3 A, 420 W

Absolute short form. A response, which should be instant, will return three values between 0% and 125% of nominal system values.

7.9 Protective feature commands

mPower systems feature a set of system alarms, partly for self-protection, partly for the protection of connected equipment. Additionally, there is a supervision feature which can monitor DC output attributes like voltage, current, or power for exceeding user-defined limits, and trigger user-definable actions like an acoustic alarm or shutdown of the DC output. Configuration of the supervision features can be done manually in the user profile, or by remote commands.

[SOURce:]VOLTage:PROTection[:LEVel] <NRf>[Unit]

This command is connected to the adjustable value OVP (overvoltage protection). The value is adjustable between 0 and 110% nominal system voltage. It defines a threshold where the system switches the DC output off whether the system has generated a voltage higher than this threshold, or the excess is coming from an outside source. When controlling a source, this feature usually serves to protect the connected load from overvoltage and thus damage. This can occur if the output voltage is accidentally adjusted to a dangerous level.

Query form:

[SOURce:]VOLTage:PROTection[:LEVel]?

Value range:

0–1.1 * nominal voltage of the system

Examples:

VOLT:PROT 88 Absolute short form. Sets the OVP threshold to 88 V. At a model with 80 V nominal voltage, this is 110% of the maximum voltage and the maximum OVP value.

[SOURce:]CURRent:PROTection[:LEVel] <NRf>[Unit]

This command is connected to the adjustable value OCP (overcurrent protection). The value is adjustable between 0 and 110% nominal system current. It defines a threshold where the system switches the DC output off. Once the output current reaches the threshold, the system will instantly switch the DC output off. The threshold is only effective if it's adjusted to a lower value than the output current, because otherwise the system would just limit the current, but not switch off. If current value and overcurrent protection are adjusted to the same value, the OCP has priority and will switch off rather than limit.

Query form:

[SOURce:]CURRent:PROTection[:LEVel]?

Value range:

0–1.1 * nominal current of the system

Example:

CURR:PROT 100 Absolute short form. Sets the OCP threshold to 100 A.

[SOURce:]POWer:PROTection[:LEVel] <NRf>[Unit]

This command is connected to the adjustable value OPP (overpower protection). The value is adjustable between 0 and 110% nominal system power. It defines a threshold where the system switches the DC output off. This feature helps to

protect equipment from exceeding a certain power load. Once the output power reaches the threshold, the system will instantly switch the DC output off. The threshold is only effective if it's adjusted to a lower value than the output power, otherwise the system will just limit the power, but not switch off. If power value and overpower protection are adjusted to the same value, the OPP has priority and will switch off rather than limit.

Query form:

`[SOURce:]POWer:PROTection[:LEVel]?`

Value range:

0–1.1 * nominal power of the system

Example:

`POW:PROT 1.5kW`

Absolute short form. Sets the OPP threshold to 1.5 kW.

7.10 Adjustment limit commands

Adjustment limits are additional, globally effective, adjustable limits for the set values U, I, and P. The purpose is to narrow the standard 0–100% adjustment range and to prevent, for example, accidentally setting too high a voltage for the connected equipment. One could use overvoltage protection (OVP) for a similar purpose, but it's generally better to prevent undesired set values in the first place.

In case a set value is sent to the system that would exceed an adjustment limit, no matter if too high or too low, the system will ignore it, and put an error into the error queue. At the same time, it's impossible to set the lower adjustment limit (:LOW) higher than the related set value or, vice versa, the upper adjustment limit.

These commands are connected to the **Limits** settings, as you can adjust them with the on-board controls in the setup menu of your system.

Command	Description
<code>[SOURce:]VOLTage:LIMit:LOW[?] <NRf>[Unit]</code>	Identical to value U-min, as configurable at the system control panel
<code>[SOURce:]VOLTage:LIMit:HIGH[?] <NRf>[Unit]</code>	Identical to value U-max, as configurable at the system control panel
<code>[SOURce:]CURRent:LIMit:LOW[?] <NRf>[Unit]</code>	Identical to value I-min, as configurable at the system control panel
<code>[SOURce:]CURRent:LIMit:HIGH[?] <NRf>[Unit]</code>	Identical to value I-max, as configurable at the system control panel
<code>[SOURce:]POWer:LIMit:HIGH[?] <NRf>[Unit]</code>	Identical to value P-max, as configurable at the system control panel

7.11 General query commands

These commands are used to query other information from the system.

Command	Description
<code>SYSTem:NOMinal:VOLTage?</code>	Queries the nominal, i.e. rated input/output voltage of a single system or an Initialized master-slave system
<code>SYSTem:NOMinal:CURRent?</code>	Queries the nominal, i.e. rated input/output current of a single system or an Initialized master-slave system
<code>SYSTem:NOMinal:POWer?</code>	Queries the nominal, i.e. rated input/output power of a single system or an Initialized master-slave system
<code>SYSTem:System:CLAss?</code>	Queries the system class and returns a value which defines to what series the system belongs to. This is an easy way to distinguish different system series.

7.12 System configuration commands

The commands as listed below are used to modify settings of the system configuration. The settings can be part of the current user profile (see system's operating manual). Any modification on the configuration requires activated remote control. These settings are automatically stored.

7.12.1 General configuration commands

Command	Description
<code>POWer:STAGe:AFTer:REMOte { AUTO OFF }</code> <code>POWer:STAGe:AFTer:REMOte?</code>	Defines, how the DC input/output of the system shall be after leaving remote control. AUTO = Last condition remains OFF = DC input/output will be switched off
<code>SYSTem:CONFig:INPut:REStore[?] {AUTO OFF}</code> <code>SYSTem:CONFig:OUTPut:REStore[?] {AUTO OFF}</code>	Defines the condition of DC input/output after the system is powered. This is connected to the system setting "DC input after power on" resp. "DC output after power on". AUTO = DC input/output will be restored to the condition it had when switching the system off the last time OFF = DC input/output will always be off
<code>SYSTem:CONFig:USER:TEXT <SRD></code> <code>SYSTem:CONFig:USER:TEXT?</code>	Writes or queries a user-definable text of up to 40 characters permanently to the system. This string can be used to add custom information to the unit, in order to distinguish it from other, identical models, alternatively to the serial number.

Command	Description
SYSTem:CONFIg:ANALog:REFeRence {5 10} SYSTem:CONFIg:ANALog:REFeRence?	Selects the voltage range for analog inputs and outputs of the analog interface. This has no effect on anything concerning digital remote control. 5 = 0–5 V range 10 = 0–10 V range (factory setting)
SYSTem:CONFIg:ANALog:REMSB:LEVeL {NORMAL IN- VERTED} SYSTem:CONFIg:ANALog:REMSB:LEVeL?	Determines how pin REM-SB of the analog interface (see system manual) shall be interpreted by the system: NORMAL = level and conditions as described in the manual (factory setting) INVERTED = level and conditions are interpreted as inverted
SYSTem:CONFIg:ANALog:REMSB:ACTIon {OFF AUTO} SYSTem:CONFIg:ANALog:REMSB:ACTIon?	Determines the action that is caused by using pin REM-SB of the analog interface in connection with DC input/output of the system: OFF = pin can only be used to switch the DC input/output off AUTO = pin can be used to switch off and on again, if the DC input/output was at least switched on once by pushbutton on the control panel or digital command
SYSTem:COMMUnicate:PROToCol:Modbus {ENABLE DISABLE} SYSTem:COMMUnicate:PROToCol:Modbus?	Enables or disables Modbus protocol on the system. This setting is stored. After disabling Modbus with this command, further Modbus messages are ignored, so that only SCPI commands are accepted. Only one of both protocols can be deactivated at the same time.
SYSTem:COMMUnicate:TIMEout {5–65535} SYSTem:COMMUnicate:TIMEout?	Defines a timeout in milliseconds (factory setting: 5 ms), a max. time that can elapse between two consecutive bytes, before the system considers the message as “completely received”. For details refer to section 5.7. Fragmented Messages . Note: this only applies for serial interfaces (USB, RS232).
SYSTem:ALARm:ACTIon:PFAil { AUTO OFF } SYSTem:ALARm:ACTIon:PFAil?	Defines, how the DC input/output of the system shall be after a power fail (PF) alarm, which could be a mains blackout or similar and after which the system could continue its work automatically. AUTO = DC input/output condition before PF is restored OFF = DC input/output will be switched off (default setting)
SYSTem:ALARm:ACTIon:OTEMPerature { AUTO OFF } SYSTem:ALARm:ACTIon:OTEMPerature?	Defines, how the DC input/output of the system shall be after the system has recovered, i. e. cooled down after an overtemperature (OT) alarm. AUTO = DC input/output condition before OT is restored (default setting) OFF = DC input/output will be switched off

7.12.2 Ethernet configuration commands

The commands below are related to any Ethernet interface port.

Command	Description
<code>SYSTem:COMMUnicate:LAN:ADDResS[?] <SRD></code>	Queries or sets the IP address of the selected Ethernet interface. When setting the IP, the string has to be in the typical IP format like this: 192.168.0.2
<code>SYSTem:COMMUnicate:LAN:CONTRol[?] {0-65535}</code>	Queries or sets the TCP port of the selected Ethernet interface. Default is 5025, used for Modbus RTU or SCPI communication. Systems supporting Modbus TCP have port 502 activated and reserved by default, so 502 is illegal to be set with this command.
<code>SYSTem:COMMUnicate:LAN:DHCP[?] {ON OFF}</code>	Activates (=ON) or deactivates (=OFF) the DHCP functionality for the selected Ethernet interface. Default is OFF, so the IP as set with :ADDR command above is used.
<code>SYSTem:COMMUnicate:LAN:DNS1[?] <SRD></code> <code>SYSTem:COMMUnicate:LAN:DNS2[?] <SRD></code>	Queries or sets the network address of the first DNS1 of the selected Ethernet interface, plus also for the second DNS2 (only with Anybus modules).
<code>SYSTem:COMMUnicate:LAN:DOMain[?] <SRD></code>	Queries or sets the domain name (refer to network terminology for details). This is a simple ASCII string of up to 54 characters. The domain can be used to select and access a particular system in the network without knowing the IP address.
<code>SYSTem:COMMUnicate:LAN:GATeway[?] <SRD></code>	Queries or sets the gateway address of the selected Ethernet interface. Format is the same as with the IP. This address is often not used and can thus be left at the default setting.
<code>SYSTem:COMMUnicate:LAN:HOSTname[?] <SRD></code>	Queries or set the host name (refer to network terminology for details). This is a simple ASCII string of up to 54 characters.
<code>SYSTem:COMMUnicate:LAN:KEEPAlive[?] {ON OFF}</code>	Enables / disables the "TCP keep-alive" for the selected Ethernet interface. Also see 5.6. Connection Timeout . Default setting: OFF
<code>SYSTem:COMMUnicate:LAN:MAC?</code>	Queries the MAC of the selected Ethernet interface, when physically present.
<code>SYSTem:COMMUnicate:LAN:SMASK[?] <SRD></code>	Queries or sets the subnet mask of the selected Ethernet interface. Format is the same as with the IP.
<code>SYSTem:COMMUnicate:LAN:TIMEout[?] {0 5-65535}</code>	Defines a socket connection timeout for the selected Ethernet interface. Also see 5.6. Connection Timeout . Setting this to 0 disables the timeout. Default setting: 5 seconds

7.13 Alarm management commands

In remote control operation it's important to manage alarms correctly. This can be done the same way as in manual control. When using the SCPI command language, system alarms are indicated through a status register which can be polled. Polling for errors should be performed after making changes to settings. Furthermore, most alarms have to be acknowledged.

7.13.1 Reading system alarms

Reading system alarms should happen in certain intervals, by querying the Questionable status register by either the subregister `CONDITION` or `EVENT`. The commands `STAT:QUES:COND?`, `STAT:QUES?`, or `STAT:QUES:EVEN?` return a value that represents certain bits (see [7.5. Status registers](#)), indicating various conditions. When a bit is set, it means a certain alarm is present. Refer to the system's operating manual for details about system alarms.

7.13.2 Acknowledging system alarms

In order to make the user take notice of system alarms, they have to be acknowledged after they occurred and vanished again. This will delete those alarms from the status register and should be only be done after they have been recorded. To delete/acknowledge an alarm, the command `SYST:ERR?` resp. `SYST:ERR:ALL?` is used, which also serves to query other errors.

In case one or multiple alarms are still present, they won't be cleared from the register.

There is one exception in handling, the OT (overtemperature) error. This doesn't require extra acknowledgement and thus won't be indicated anymore in `CONDITION` once it's gone.

7.13.3 Alarm counters

These counters count alarm occurrences since the last time the system was powered. They can be read by command anytime, are not stored when the system is switched off and are purged by reading.

Command	Description
<code>SYSTem:ALARm:COUNt:OVOLtage?</code>	Counts overvoltage alarms (OVP, adjustable threshold)
<code>SYSTem:ALARm:COUNt:OTEMperature?</code>	Counts overtemperature alarms (OT, not adjustable)
<code>SYSTem:ALARm:COUNt:OPOWer?</code>	Counts overpower alarms (OPP, adjustable threshold)
<code>SYSTem:ALARm:COUNt:OCURrent?</code>	Counts overcurrent alarms (OCP, adjustable threshold)
<code>SYSTem:ALARm:COUNt:PFAil?</code>	Counts power fail alarms (PF, not adjustable)

7.13.4 Example

You are running the system in remote control and poll the alarm status with `STAT:QUES:COND?` at a certain interval, and you always receive value 3072. This is the sum of the bit values of bits 10 (remote) and 11 (output on). It tells you that remote control is active and the DC output is switched on. Then a system alarm occurs caused by the unit overheating. When reading the register the next time, bit 3 should indicate the OT alarm for you to take notice. Additionally, the DC output might be indicated as switched off. Thus the returned value could be 1032 or 3080.

8 Service & Maintenance

8.1 Maintenance / Cleaning

The unit needs no maintenance. Cleaning may be needed for the internal fans, the frequency of which depends on the operating environment. The fans serve to cool the components which are heated by the inherent power loss. Heavily dirt filled fans can lead to insufficient airflow, and therefore the DC output would switch off too early due to overheating or possibly lead to defects.

Cleaning the internal fans can be performed with a vacuum cleaner or similar. For this, the unit needs to be opened.

8.2 Troubleshooting / Diagnosis / Repair

If the equipment suddenly performs in an unexpected way, which indicates a fault, or it has an obvious defect, this can not and must not be repaired by the user. Contact the factory for support.

It will usually be necessary to return the unit to the factory. If a return for testing or repair is to be carried out, ensure that:

- the factory has been contacted and it's clarified how and where the equipment should be sent, and that a Return Material Authorization (RMA) has been assigned.
- the unit is in fully assembled state and in suitable transport packaging, ideally the original packaging.
- optional extras such as an Interface interface module is included if this is in any way connected to the problem.
- a fault description in as much detail as possible is attached.
- if shipping destination is abroad, the necessary customs papers are attached.

8.2.1 Firmware updates



Firmware updates should only be installed when they can eliminate existing bugs in the firmware in the system or contain new features.

The firmware of the control panel, the communication unit, and the digital controller, if necessary, may be updated via the rear USB port. The software EA Power Control is needed which is available as a download from our website together with the firmware update, or upon request.

Every update includes the risk of an inoperable system. We recommend to install updates only if

- an imminent problem with your unit can directly be solved, especially if we suggested to install an update during a support case.
- a new feature has been added which you definitely want to use. In this case, the full responsibility is transferred to you.

The following also applies in connection with firmware updates:

- Simple changes in firmwares can have crucial effects on the application the units are use in. We thus recommend to study the list of changes in the firmware history very thoroughly.
- Newly implemented features may require an updated documentation as well as LabView VIs, which is often delivered only later, sometimes significantly later.

8.3 Calibration (readjustment)

8.3.1 Preface

The mPower 300 series features a function to readjust the most important output values when doing a calibration and in case these values have moved out of tolerance. The readjustment is limited to compensate small differences of up to 1% or 2% of the max. value. There are several reasons which could make it necessary to readjust a unit: component aging, component deterioration, extreme ambient conditions, high frequent use

In order to determine if a value is out of tolerance, the parameter must be verified first with measurement tools of high accuracy and with at least half the error of the mPower unit. Only then a comparison between values displayed on the mPower unit and true DC output values is possible.

For example, if you want to verify and possibly readjust the output current of model MPW 300-01-0080-100 which has 100 A maximum current, stated with a max. error of 0.2%, you can only do that by using a high current shunt with max. 0.1% error or less. Also, when measuring such high currents, it is recommended to keep the process short, in order to avoid the shunt heating up too much. It is furthermore recommended to use a shunt with at least 25% reserve.

When measuring the current with a shunt, the measurement error of the multimeter on the shunt adds to the error of the shunt and the sum of both must not exceed the maximum error of the unit under calibration.

8.3.2 Preparation

For a successful calibration and readjustment, a few tools and certain ambient conditions are required:

- A measurement device (multimeter) for voltage, with a max. error of half the mPower's voltage error. That measurement device can also be used to measure the shunt voltage when readjusting the current
- If the current is also going to be calibrated: a suitable DC current shunt, ideally specified for at least 1.25 times the max. output current of the mPower and with a max. error that is half or less than the max. current error of the mPower unit
- Normal ambient temperature of approx. 20-25 °C (68-77 °F)
- Warmed up mPower unit, which has been run for at least 10 minutes under 50% power
- An adjustable load, such as an electronic load, which is capable of consuming at least 102% of the max. voltage and current of the mPower unit

Before you can start calibrating, a few measures have to be taken:

- Let the mPower unit warm up in connection with the voltage / current source
- In case the remote sensing input is going to be calibrated, prepare a cable for the remote sensing connector to DC output, but leave it yet unconnected
- Abort any form of remote control, deactivate master-slave mode, set system to U/I mode
- Install the shunt between mPower unit and load and make sure the shunt is cooled somehow
- Connect external measurement device to the DC output or to the shunt, depending on whether the voltage is going to be calibrated first or the current

8.3.3 Calibration procedure

After the preparation, the system is ready to be calibrated. From now on, a certain sequence of parameter calibration is important. Generally, you don't need to calibrate all three parameters, but it is recommended to do so.








When calibrating the output voltage, the remote input “Sense” on the rear of the unit has to be disconnected.

The calibration procedure, as explained below, is an example with model MPW 300-01-0080-100. Other models are treated the same way, with values according to the particular mPower model and the required load.






8.3.3.1 Calibrating the set values

► How to calibrate the DC output voltage

1. Connect a multimeter to the DC output. Connect a load and set it to approx. 5% of the nominal current of the power supply as load current, in this example let's use 4 A.
2. Enter the setup menu with , then push . In the submenu navigate to **Calibration** using the arrow buttons. In the next screen select **Voltage** and then **Output value** and confirm with . The power supply will then switch the DC output on.
3. In the next screen the system will set a certain output voltage and start to measure it (**U-mon**). Simply confirm here with .
4. After this, the system requests you to enter the measured output voltage from the multimeter at **Measured value:**. Enter it using the right rotary knob, just like would adjust a set value. Assure yourself the value is correct and submit with .
5. Repeat points 3. and 4. for the next three calibration steps (total of four steps).

Voltage	Current	Save & exit
Sense volt.	Cal. date	







► How to calibrate the DC output current

1. Set the load to approx. 102% nominal current of the mPower unit, for the sample model with 100 A this would be 102 A.
2. Enter the setup menu with , then push . In the submenu navigate to **Calibration** using the arrow buttons. In the next screen select **Current** and then **Output value** and confirm with . The power supply will then switch the DC output on.
3. In the next screen the system will set a certain current limit, being loaded by the load or sink, and start to measure the output current (**I-mon**). Simply confirm here with .
4. After this, the system requests you to enter the output current at **Measured value**, which you are measuring with the shunt. Enter it using the right rotary knob, just like would adjust a set value. Assure yourself the value is correct and submit with .
5. Repeat points 3. and 4. for the next three calibration steps (total of four steps).


8.3.3.2 Calibrating the remote sensing

In case you are generally using the remote sensing feature, it is recommended to also readjust this parameter for best results. The procedure is identical to the calibration of voltage, except for it requires to have the sensing connector (Sense) on the rear to be plugged and connected with correct polarity to the DC output of the mPower unit.


► How to calibrate the DC output voltage for remote sensing

1. Connect a load and set it to approx. 3% of the nominal current of the power supply as load current, in this example ≈ 3 A. Connect the remote sensing input (Sense) to the load with correct polarity.
2. Put external multimeter in DC connection on the load.
3. Enter the setup menu with , then push . In the submenu navigate to **Calibration**. Push  again. In the next screen select **Sense volt** then **Output value** and confirm twice with . The power supply will then switch the DC output on.
4. In the next screen the system will set a certain output voltage and start to measure it (**U-mon**). Simply confirm here with .
5. After this, the system requests you to enter the measured sensing voltage from the multimeter at **Measured value**. Enter it using the right rotary knob, just like would adjust a set value. Assure yourself the value is correct and submit with .
6. Repeat points 4. and 5. for the next three calibration steps (total of four steps).

8.3.3.3 Calibrating the actual values

Actual values of output voltage (with and without remote sensing) and output current are calibrated almost the same way as the set values, but here you don't need to enter anything, just confirm the displayed values. Please proceed the above steps and instead of **Output value** select **Actual value** in the submenus. After the system shows measured values on display, wait at least 2s for measured value to settle and then simply confirm with , until you are through all steps.

8.3.3.4 Saving calibration data

After calibration you can furthermore enter the current date. To do so, navigate to menu item **Cal. date** and enter the date in format YYYY / MM / DD and submit with .

Last but not least save the calibration data permanently confirming menu item **Save & exit** with .



Leaving the calibration selection menu without saving via "Save & exit" will discard calibration data and the procedure would have to be repeated!

9 Contact and Support

9.1 General

If not otherwise arranged between Marway and the customer, repairs must be carried out by the Marway. The unit must be returned to Marway clearly labeled with a Return Materials Authorization (RMA) number. Contact Marway Support to obtain an RMA. Package the equipment adequately and send it, together with a detailed description of the problem, and if still under warranty, a copy of the invoice, to the following address.

Marway Power Solutions
1721 S. Grand Ave.
Santa Ana, CA 92705

9.2 Contact Options

Questions or problems with operation of the unit, use of optional components, with the documentation or software, can be addressed to technical support either by telephone or email.

Address	Email	Telephone
Marway Power Solutions 1721 S. Grand Ave. Santa Ana, CA 92705	Technical support: support@marway.com All other issues: info@marway.com	714-917-6200

10 Model Specifications Appendix

10.1 Approved Operating Conditions

- Use only inside dry buildings
- Ambient temperature 0-50 °C (32-122 °F)
- Operational altitude: max. 2000 m (1.242 mi) above sea level
- Max 80% relative humidity, non condensing

10.2 Model Data-Table Footnotes

Note that throughout the specs, Unom (nominal voltage), Inom (nominal current), and Pnom (nominal power) all refer to the product's rated values. Therefore, a unit rated for 360 V, 30 A, and 3 kW has a Unom of 360, an Inom of 30, and a Pnom of 3 or 3000 depending on whether the specification calls out kW or W.

For the model-specific data tables on the following pages, these are the referenced footnotes.

1. Related to the nominal values, the accuracy defines the maximum deviation between an adjusted values and the true (actual) value.
 - Example: an 80 V model has min. 0.1% voltage accuracy, that is 80 mV. When adjusting the voltage to 5 V, the actual value is allowed to differ up to 80 mV, which means it might be between 4.92 V and 5.08 V.
2. The display error adds to the error of the related actual value on the DC output
3. RMS value: LF 0–300 kHz, PP value: HF 0–20MHz
4. Typical value at 100% output voltage and 100% power
5. Allowed float (potential shift) on the DC output

10.3 MPW 300-01 : 1U, 1,500 Watt, 100–240 Vac

1500 W Models	80 V : 50 A 300-01-0080-050	200 V : 25 A 300-01-0200-025	360 V : 15 A 300-01-0360-015	500 V : 10 A 300-01-0500-010	750 V : 6 A 300-01-0750-006
AC Input					
Input voltage, frequency	150–264 Vac, 45–66 Hz to acheive maximum power output 100–150 Vac, 45–66 Hz yields derated 1000 W power output				
Input connection	1ph (L, N, GND)				
Input fuse (internal)	T16 A				
Leak current	< 3.5 mA				
Power factor	≈ 0.99				
Idle mode power consumption	≈ 70 W				
DC Output					
Max. output voltage U _{Nom}	80 V	200 V	360 V	500 V	750 V
Max. output current I _{Nom}	50 A	25 A	15 A	10 A	6 A
Max. output power P _{Nom}	1500 W with input ≥ 150 Vac 1000 W with input ≤ 150 Vac				
Overvoltage protection range	0–88 V	0–220 V	0–396 V	0–550 V	0–825 V
Overcurrent protection range	0–55 A	0–27,5 A	0–17,6 A	0–11 A	0–6,6 A
Overpower protection range	0...1650 W	0...1650 W	0...1650 W	0...1650 W	0...1650 W
Temperature coefficient	Voltage / current: 100 ppm/K				
Output capacitance (approx.)	5640 µF	1000 µF	470 µF	105 µF	49 µF
Voltage regulation					
Adjustment range	0–81.6 V	0–204 V	0–367.2 V	0–510 V	0–765 V
Accuracy ¹ (at 23±5 °C / 73±9 °F)	< 0.1% U _{Nenn}	< 0.1% U _{Nenn}	< 0.1% U _{Nenn}	< 0.1% U _{Nenn}	< 0.1% U _{Nenn}
Line regulation at ±10% ΔU _{Ac}	< 0.02% U _{Nenn}	< 0.02% U _{Nenn}	< 0.02% U _{Nenn}	< 0.02% U _{Nenn}	< 0.02% U _{Nenn}
Load regulation at 0–100% load	< 0.05% U _{Nenn}	< 0.05% U _{Nenn}	< 0.05% U _{Nenn}	< 0.05% U _{Nenn}	< 0.05% U _{Nenn}
Rise time 10–90% ΔU	Max. 15 ms	Max. 15 ms	Max. 15 ms	Max. 15 ms	Max. 15 ms
Transient time after load step	< 1.7 ms	< 1.4 ms	< 2.2 ms	< 2 ms	< 2 ms
Display: Resolution	See section 4.1.4. Resolution of the displayed values				
Display: Accuracy ³	≤ 0.2% U _{Nom}	≤ 0.2% U _{Nom}	≤ 0.2% U _{Nom}	≤ 0.2% U _{Nom}	≤ 0.2% U _{Nom}
Ripple ²	< 100 mV _{PP} < 5.2 mV _{RMS}	< 293 mV _{PP} < 51 mV _{RMS}	< 195 mV _{PP} < 33 mV _{RMS}	< 293 mV _{PP} < 63 mV _{RMS}	< 260 mV _{PP} < 40 mV _{RMS}
Remote sensing compensation	Max. 5% U _{Nenn}	Max. 5% U _{Nenn}	Max. 5% U _{Nenn}	Max. 5% U _{Nenn}	Max. 5% U _{Nenn}
Fall time (at no load) after switching DC output off	Down from 100% to <60 V: less than 10 s				
Current regulation					
Adjustment range	0–51 A	0–25.5 A	0–15.3 A	0–10.2 A	0–6.12 A
Accuracy ¹ (at 23±5 °C / 73±9 °F)	< 0.2% I _{Nom}	< 0.2% I _{Nom}	< 0.2% I _{Nom}	< 0.2% I _{Nom}	< 0.2% I _{Nom}
Line regulation at ±10% ΔU _{Ac}	< 0.05% I _{Nom}	< 0.05% I _{Nom}	< 0.05% I _{Nom}	< 0.05% I _{Nom}	< 0.05% I _{Nom}
Load regulation at 0–100% ΔU _{OUT}	< 0.15% I _{Nom}	< 0.15% I _{Nom}	< 0.15% I _{Nom}	< 0.15% I _{Nom}	< 0.15% I _{Nom}
Ripple ²	< 75 mA _{PP}	< 29 mA _{PP}	< 10 mA _{PP}	< 9.2 mA _{PP}	< 4.1 mA _{PP}
Display: Resolution	See section 4.1.4. Resolution of the displayed values				
Display: Accuracy ³	≤ 0.2% I _{Nom}	≤ 0.2% I _{Nom}	≤ 0.2% I _{Nom}	≤ 0.2% I _{Nom}	≤ 0.2% I _{Nom}

1500 W cont'd	80 V : 50 A 300-01-0080-050	200 V : 25 A 300-01-0200-025	360 V : 15 A 300-01-0360-015	500 V : 10 A 300-01-0500-010	750 V : 6 A 300-01-0750-006
Power regulation					
Adjustment range	0...1530 W	0...1530 W	0...1530 W	0...1530 W	0...1530 W
Accuracy ¹ (at 23±5 °C / 73±9 °F)	< 1% P _{Nom}	< 1% P _{Nom}	< 1% P _{Nom}	< 1% P _{Nom}	< 1% P _{Nom}
Line regulation at ±10% ΔU _{AC}	< 0.05% P _{Nom}	< 0.05% P _{Nom}	< 0.05% P _{Nom}	< 0.05% P _{Nom}	< 0.05% P _{Nom}
Load regulation at 10-90% ΔU*ΔI	< 0.75% P _{Nom}	< 0.75% P _{Nom}	< 0.75% P _{Nom}	< 0.75% P _{Nom}	< 0.75% P _{Nom}
Display: Resolution	See section 4.1.4. Resolution of the displayed values				
Efficiency ⁴ at 100% U _{DC}	≈ 91%	≈ 93%	≈ 94%	≈ 94%	≈ 95%
Efficiency ⁴ at 100% I _{DC}	≈ 89%	≈ 90%	≈ 92%	≈ 92%	≈ 94%
Analog interface					
Type	Sub-D, 15 pole, female				
Set value inputs	U, I, P				
Actual value output	U, I				
Control signals	DC output on/off, remote control on/off				
Status signals	CV, OVP, OT, PF				
Galvanic isolation to the device	Max. 1500 V DC				
Sample rate of inputs & outputs	500 Hz				
Insulation ⁵					
Negative terminal to GND Max.	±400 V DC	±400 V DC	±400 V DC	±400 V DC	±400 V DC
Positive terminal to GND Max.	±480 V DC	±600 V DC	±760 V DC	±900 V DC	±1150 V DC
Miscellaneous					
Cooling	Temperature controlled fans, front inlet, rear exhaust				
Ambient temperature	0..50 °C (32–122 °F)				
Storage temperature	-20–70 °C (-4–158 °F)				
Humidity	< 80%, not condensing				
Standards	EN 60950:2006 + A11:2009 + A1:2010 + A12:2011 + AC:2011 + A2:2013; EN 61326-1:2013-07				
Overvoltage category	2				
Protection class	1				
Pollution degree	2				
Operational altitude	< 2000 m (1.242 mi)				
Digital interfaces					
Featured	1x USB-B, 1x Ethernet				
Galvanic isolation from device	Max. 1500 V DC				
USB specification	USB 2.0, socket type B, VCOM driver				
USB response time	SCPI: max. 5 ms, Modbus RTU: max. 5 ms				
Ethernet specification	RJ45, 10/100Mbit, TCP/IP, ICMP, HTTP, DHCP				
Ethernet response time	SCPI: max. 7 ms, Modbus RTU: 9-17 ms				
Terminals					
Rear side	Share Bus, DC output, AC input, remote sensing, analog interface, USB-B, Ethernet				
Dimensions					
Enclosure (WxHxD)	19“ x 1U x 500 mm (19.7”)				
Total (WxHxD)	483 x 44 x min. 565 mm (19” x 1.75” x 22.2”)				
Weight	≈10.5 kg (23.1 lb)	≈10.5 kg (23.1 lb)	≈10.5 kg (23.1 lb)	≈10.5 kg (23.1 lb)	≈10.5 kg (23.1 lb)

10.4 MPW 300-11 : 1U, 3,000 Watt, 200–240 Vac

3000 W Models	80 V : 100 A 300-11-0080-100	200 V : 50 A 300-11-0200-050	360 V : 30 A 300-11-0360-030	500 V : 20 A 300-11-0500-020	65- V : 12 A 300-11-0750-012
AC Input					
Input voltage, frequency	207–264 Vac, 45–66 Hz to acheive maximum power output 180–207 Vac, 45–66 Hz yields derated 2500 W power output				
Input connection	1ph (L, N, GND)				
Input fuse (internal)	T16 A				
Leak current	< 3.5 mA				
Power factor	≈ 0.99				
Idle mode power consumption	≈ 70 W				
DC Output					
Max. output voltage U _{Nom}	80 V	200 V	360 V	500 V	750 V
Max. output current I _{Nom}	100 A	50 A	30 A	20 A	12 A
Max. output power P _{Nom}	3000 W with input ≥ 207 Vac 2500 W with input ≤ 207 Vac				
Overvoltage protection range	0–88 V	0–220 V	0–396 V	0–550 V	0–825 V
Overcurrent protection range	0–110 A	0–55 A	0–33 A	0–22 A	0–13,2 A
Overpower protection range	0...3300 W	0...3300 W	0...3300 W	0...3300 W	0...3300 W
Temperature coefficient	Voltage / current: 100 ppm/K				
Output capacitance (approx.)	8930 µF	1500 µF	705 µF	150 µF	70 µF
Voltage regulation					
Adjustment range	0–81.6 V	0–204 V	0–367.2 V	0–510 V	0–765 V
Accuracy ⁽¹⁾ (at 23±5 °C / 73±9 °F)	< 0.1% U _{Nenn}	< 0.1% U _{Nenn}	< 0.1% U _{Nenn}	< 0.1% U _{Nenn}	< 0.1% U _{Nenn}
Line regulation at ±10% ΔU _{Ac}	< 0.02% U _{Nenn}	< 0.02% U _{Nenn}	< 0.02% U _{Nenn}	< 0.02% U _{Nenn}	< 0.02% U _{Nenn}
Load regulation at 0–100% load	< 0.05% U _{Nenn}	< 0.05% U _{Nenn}	< 0.05% U _{Nenn}	< 0.05% U _{Nenn}	< 0.05% U _{Nenn}
Rise time 10–90% ΔU	Max. 15 ms	Max. 15 ms	Max. 15 ms	Max. 15 ms	Max. 15 ms
Transient time after load step	< 1.7 ms	< 1.4 ms	< 2.2 ms	< 2 ms	< 2 ms
Display: Resolution	See section 4.1.4. Resolution of the displayed values				
Display: Accuracy ⁽³⁾	≤ 0.2% U _{Nom}	≤ 0.2% U _{Nom}	≤ 0.2% U _{Nom}		
Ripple ⁽²⁾	< 76 mV _{PP} < 4.2 mV _{RMS}	< 234 mV _{PP} < 40 mV _{RMS}	< 156 mV _{PP} < 26 mV _{RMS}	< 234 mV _{PP} < 50 mV _{RMS}	< 260 mV _{PP} < 40 mV _{RMS}
Remote sensing compensation	Max. 5% U _{Nom}	Max. 5% U _{Nom}	Max. 5% U _{Nom}	Max. 5% U _{Nom}	Max. 5% U _{Nom}
Fall time (at no load) after switching DC output off	Down from 100% to <60 V: less than 10 s				
Current regulation					
Adjustment range	0–102 A	0–51 A	0–30.6 A	0–20.4 A	0–12.24 A
Accuracy ⁽¹⁾ (at 23±5 °C / 73±9 °F)	< 0.2% I _{Nenn}	< 0.2% I _{Nenn}	< 0.2% I _{Nenn}	< 0.2% I _{Nenn}	< 0.2% I _{Nenn}
Line regulation at ±10% ΔU _{Ac}	< 0.05% I _{Nenn}	< 0.05% I _{Nenn}	< 0.05% I _{Nenn}	< 0.05% I _{Nenn}	< 0.05% I _{Nenn}
Load regulation at 0–100% ΔU _{OUT}	< 0.15% I _{Nenn}	< 0.15% I _{Nenn}	< 0.15% I _{Nenn}	< 0.15% I _{Nenn}	< 0.15% I _{Nenn}
Ripple ⁽²⁾	< 114 mA _{PP}	< 29 mA _{PP}	< 10 mA _{PP}	< 9.2 mA _{PP}	< 4.1 mA _{PP}
Display: Resolution	See section 4.1.4. Resolution of the displayed values				
Display: Accuracy ⁽³⁾	≤ 0.2% I _{Nom}	≤ 0.2% I _{Nom}	≤ 0.2% I _{Nom}	≤ 0.2% I _{Nom}	≤ 0.2% I _{Nom}

3000 W cont'd	80 V : 100 A 300-11-0080-100	200 V : 50 A 300-11-0200-050	360 V : 30 A 300-11-0360-030	500 V : 20 A 300-11-0500-020	65- V : 12 A 300-11-0750-012
Power regulation					
Adjustment range	0–3060 W	0–3060 W	0–3060 W	0–3060 W	0–3060 W
Accuracy ⁽¹⁾ (at 23±5 °C / 73±9 °F)	< 1% P _{Nenn}	< 1% P _{Nenn}	< 1% P _{Nenn}	< 1% P _{Nenn}	< 1% P _{Nenn}
Line regulation at ±10% ΔU _{AC}	< 0.05% P _{Nenn}	< 0.05% P _{Nenn}	< 0.05% P _{Nenn}	< 0.05% P _{Nenn}	< 0.05% P _{Nenn}
Load regulation at 10-90% ΔU*ΔI	< 0.75% P _{Nenn}	< 0.75% P _{Nenn}	< 0.75% P _{Nenn}	< 0.75% P _{Nenn}	< 0.75% P _{Nenn}
Display: Resolution	See section 4.1.4. Resolution of the displayed values				
Efficiency ⁴ at 100% U _{DC}	≈ 91%	≈ 93%	≈ 94%	≈ 94%	≈ 95%
Efficiency ⁴ at 100% I _{DC}	≈ 89%	≈ 90%	≈ 92%	≈ 92%	≈ 94%
Analog interface					
Type	Sub-D, 15 pole, female				
Set value inputs	U, I, P				
Actual value output	U, I				
Control signals	DC output on/off, remote control on/off				
Status signals	CV, OVP, OT, PF				
Galvanic isolation to the device	Max. 1500 V DC				
Sample rate of inputs & outputs	500 Hz				
Insulation ⁵					
Negative terminal to GND Max.	±400 V DC	±400 V DC	±400 V DC	±400 V DC	±400 V DC
Positive terminal to GND Max.	±480 V DC	±600 V DC	±760 V DC	±900 V DC	±1150 V DC
Miscellaneous					
Cooling	Temperature controlled fans, front inlet, rear exhaust				
Ambient temperature	0..50 °C (32–122 °F)				
Storage temperature	-20–70 °C (-4–158 °F)				
Humidity	< 80%, not condensing				
Standards	EN 60950:2006 + A11:2009 + A1:2010 + A12:2011 + AC:2011 + A2:2013; EN 61326-1:2013-07				
Overvoltage category	2				
Protection class	1				
Pollution degree	2				
Operational altitude	< 2000 m (1.242 mi)				
Digital interfaces					
Featured	1x USB-B, 1x Ethernet				
Galvanic isolation from device	Max. 1500 V DC				
USB specification	USB 2.0, socket type B, VCOM driver				
USB response time	SCPI: max. 5 ms, Modbus RTU: max. 5 ms				
Ethernet specification	RJ45, 10/100Mbit, TCP/IP, ICMP, HTTP, DHCP				
Ethernet response time	SCPI: max. 7 ms, Modbus RTU: 9-17 ms				
Terminals					
Rear side	Share Bus, DC output, AC input, remote sensing, analog interface, USB-B, Ethernet				
Dimensions					
Enclosure (WxHxD)	19" x 1U x 500 mm (19.7")				
Total (WxHxD)	483 x 44 x min. 565 mm (19" x 1.75" x 22.2")				
Weight	≈ 11 kg (24.3 lb)	≈ 11 kg (24.3 lb)	≈ 11 kg (24.3 lb)	≈ 11 kg (24.3 lb)	≈ 11 kg (24.3 lb)

mPower™ DC Power Supplies 300 Series

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