

**Ultra High Stability Multichannel Current Source  
for Superconducting Qubits**

**MS Series**



**Short Form Manual and Data Sheet**

**Applications:**

- **Quantum Computing**
- **Cryoelectronic Biasing**

**Features:**

- **32 Channels, 20 Bits, Ultra High Precision & Low Noise**
- **Fully floating channels, no common GND**
- **Few millisecc. response time**
- **0 to 10mA range, customizable**

[www.stahl-electronics.com](http://www.stahl-electronics.com)

## 1. General Information and Overview

### 1.1 Purpose and Description of the Device

MS Series DC Sources provide very precise output **voltages/currents with internal resolution of typically 20Bits**, featuring very high stability and very low noise. The typical response time is only a few milliseconds, making it suited for Quantum Computing Qubit biasing or other Cryogenic biasing applications. The device is housed in a standard 19-inch rack-mount case with a separate mains supply. User control of the device is accomplished by simple PC control programs, utilizing a standard USB connection, using LabVIEW, Python and many other languages.

These devices contain **no switching regulators** in the supply and output paths, thus avoiding switching spikes and unwanted noise, often encountered in low-cost devices. Individually **isolated channels** allow for greatly reduced low-frequency noise and higher wiring flexibility, resulting in enhanced **Qubit biasing stability** and long coherence times in quantum computing applications.

Typical applications, taking advantage of the very high stability (on a ppm-level) of these devices are:

- Quantum Computing Qubit Biasing
- Cryo Electronics
- High Precision Component Testing (ATE)



### 1.2 Functional Principle and Block Diagram

The following picture displays the internal structure. A USB interface receives commands from a PC, which are translated into electrical output currents, for up to 32 channels.

E.g. in version: **MS 32-20-5mA** (current source), there are **32** independent channels, each one **20Bit** resolved, featuring a **0 to 10mA range** (mid range value **5mA**).

A unique feature of this modular system consists in the implementation of completely **isolated channels**. Each output is completely isolated from all other channels, which eases the avoidance of any GND-based interference ('GND-loops'), thus providing greatly enhanced ruggedness of Qubit biasing against external (low frequency) interference and also relaxes the demands for isolated GND lines in a quantum computing cryostat.

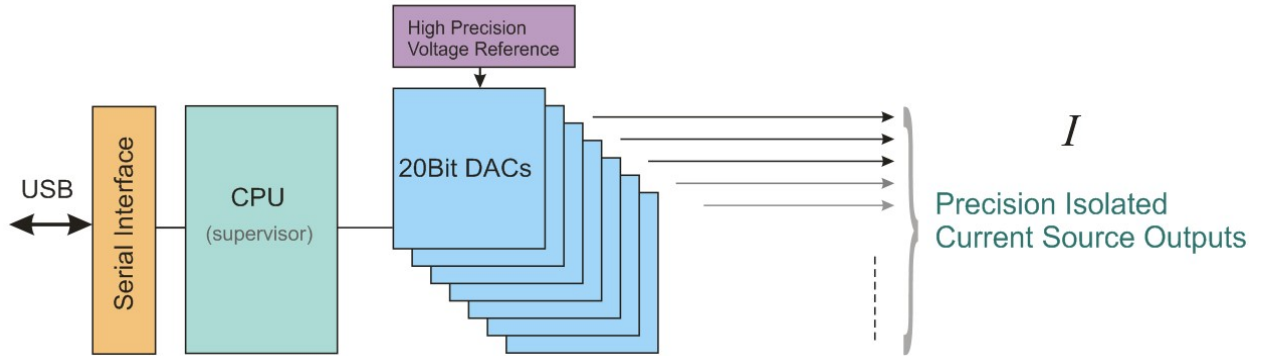


Fig. 1.1: Illustration of internal structure, note that each output channel is fully isolated, having no galvanic contact to any other channel

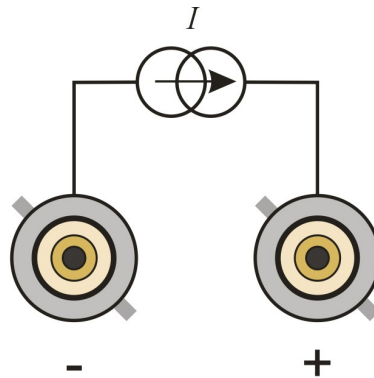


Fig. 1.2: Illustration of connector layout on front side; each channel is implemented using two BNC sockets. The socket shields are connected to the case (and thus grounded), whereas the two center pins represent the two poles of each current source output, freely floating versus case GND.

### 1.3 Device Variety

The Stahl-Electronics **MS Precision Multichannel Modular DC Sources** are envisaged for multichannel current and voltage applications, featuring fully isolated outputs and thus increased flexibility to systems, requiring low noise and low inference performance.

At time of this manual version the type MS 32-20-5mA (current source), has been released, featuring 32 independent current channels, each one 20Bit resolved, 0 to 10mA range (mid range value 5mA). Different channel counts and output ranges are being envisaged.

## 2. Safety Hints

Observe installation, operation, and safety instructions	Prior to operation, thoroughly review all safety, installation, and operating instructions accompanying this equipment.
Rear side switch turns device completely off	If the device is not in use for a longer time, it is recommended to turn the mains switch at the <i>rear</i> side of the mains supply off.
<b>Observe correct Mains Supply voltage</b>	<b>Attention: Apply only correct mains voltage. Observe supply voltage rating on rear side of device, being either 230Vac or 115Vac of mains supply. Incorrect voltage can destroy this device and can cause overheating and fire !</b>
This equipment must be connected to earth safety ground	This product is grounded through the grounding conductor of the power cord. To avoid electrical hazard, the grounding conductor must be connected to protective earth ground.
Do not modify the unit	Do not make electrical or mechanical modifications to this unit, which are not authorized by the manufacturer.
Do not operate in wet/damp conditions	To avoid electric shock hazard, do not operate this product in wet or damp conditions. Protect the device from humidity or direct water contact.
Disconnect power before servicing	To avoid electric shock, disconnect the main power by removing the power cord prior to any servicing.
Do not block chassis ventilation openings	Slots and openings in the chassis are provided for ventilation purposes to prevent overheating of the equipment. Case vents should continuously be cleared in order to ensure proper operation and to prevent overheating. If mounted in a rack, please allow 2cm clearance at the top cover with respect to the next device above. By means of software, the internal temperature sensor can be read out. A temperature over 55°C indicates inadequate air ventilation. Additionally a second sensor can be read out in the display's protocol mode (see section 4.1).
Beware of external magnetic fields	As it is common for most electronic devices, external magnetic fields can impair, damage or even destroy a device. A maximum external field strength of 5mT is admissible and must never be exceeded. This holds for static as well as alternating fields. If in doubt, check possible external field e.g. with a hall probe before switching the device on. In case an external field strength of 5mT is exceeded, once or permanently, the device may overheat or cause excessive power consumption.
Operate carefully with respect to risk of electrical shock	In case the floating ground input is used, the internally produced voltage adds up to the externally applied. Voltages therefore may appear at the outputs which are harmful in case of direct touch with the human body, or which may endanger other sensitive devices.
Routinely cleaning from dust	After long operation, or operation in a dusty environment it is strongly recommended to have the internal parts of the device cleaned by the manufacturer, or an appropriately qualified workshop in order to ensure proper operation and reduce the hazard of overheating.
Only operate with working air fan	The ventilation fan located at the rear side of the device always needs to work to ensure proper cooling. Please refer to section 6.
No outdoor operation	Outdoor operation of the device is not admissible.

### 3. Installation

#### 3.1. Mechanical and Electrical Installation

**Positioning:** Sufficient air cooling should be provided to the device (modular source and mains adaptor). Rack mounting into a standard 19” rack is as well possible as resting the device on a table. Case vents must be cleared (fan inlet and air outlet at rear side), in order to prevent overheating or thermal drifts. If in doubt about the sufficiency of air ventilation, provide a software readout of the internal temperature sensor for regular inspection, e.g. every 2 minutes.

#### Connecting to mains power:

Connect the mains adaptor to the mains power by using an appropriate power cord, being properly wired and providing a grounded outlet. The power cord must be suited with respect to possible load currents and should be rated to at least 1A current. **Attention: Observe Supply voltage rating on rear side of device! The voltage rating is either 230V<sub>ac</sub> or 115V<sub>ac</sub> of mains supply. Apply only correct supply voltage.**

#### Cabling of outputs:

Always provide appropriate cabling to the device, shielded cables are preferable to ensure avoidance of external noise pickup. In case the reference ground is floated always be aware about the potential hazard of high electrical voltages to human beings and sensitive objects of all kind (see also safety hints in section 2).

#### USB connection:

Use a standard type-A-B connection cable (USB 2.0 standard) to connect the device to the control computer. After connecting to a PC under Windows, the “Found New Hardware Wizard” should open (see next section for detailed description), regardless if the device is already switched on or not, since the corresponding receiver inside the device is powered by the USB bus itself and therefore autonomous. Cable length can be prolonged using an appropriate USB hub or repeater.

#### 3.2. Software installation

##### 3.2.1 USB-Driver

The device uses the USB bus for connecting to a control PC. After proper cabling of the USB connection (see section before) Windows should automatically identify the connected device. Depending on the Windows version, please allow up to **two minutes** to automatically identify the connected device and to install drivers. In case this fails, one may install the latest USB-CDM drivers from FTDI Ltd., which is the manufacturer of the USB bus interface circuitry.

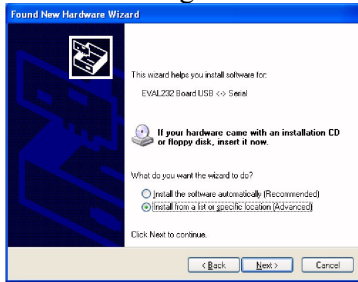
Note that the device appears as a RS232-controlled device (virtual-COM-port), normally communicating with 115’200Baud (8N1 protocol, no handshake) or others on request (see also appendix).

In case of a *manual* driver installation of drivers, follow the steps after start of the “Found New Hardware Wizard” (similar for other operating systems):

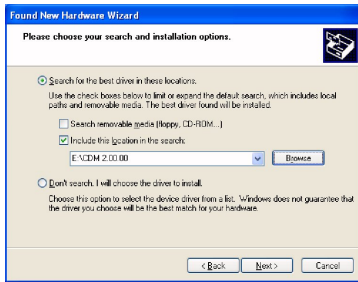


In this screen activate the last button “No, not this time” and continue with “Next”.

In the following window choose “Install from a list or specific location” => “Next”



Afterwards choose “Search for driver in these locations” and “Include this location in the search”. Browse now to the provided driver files and select the appropriate FTDI drivers.



Click “OK” and “Finish” to complete the first driver installation.

After a few seconds the first window will show up **again** (“Found New Hardware Wizard”). This is because the drivers come in two separate parts, which **both** have to be installed. Go through the installation steps in the same way as before. After completion, the USB drivers are ready for use and Windows indicates this by showing “Device Ready” (or similar) in the lower right screen corner for a couple of seconds.

Windows usually recommends to restart Windows now, but normally one can skip this point. Nevertheless note that the PC should be restarted *before* installing any other piece of hardware or software.

### 3.2.2 Self-written Code (C++, Python, MatLab)

It is easy, to access the device by self-written program code. Simple commands in plain text style (ASCII) can be used to set currents, query the status of the device, and so on. Some of these commands are described in the Appendix (see end of this manual) and, more comprehensively possibly in an envisaged "Programmers\_Guide". The simple command strings can be sent using own programs e.g. C++, Python, BASIC or Pascal dialects. The physical connection to the device needs to be established beforehand, like described above, section 3.2.1 .

Typical execution times for commands are in the order of 1 to 10ms, depending on the chosen speed rate (COM port settings), but also limited by the PC operating system and USB latency times (see also Appendix Section for further details).

## 4. Operation

After connecting the device to its dedicated power supply and the later to the mains (normally 230V~, 50Hz) the mains supply may be switched on and the device addressed from a PC. Wiring to the use setup should ideally be completed beforehand.

As shown in the picture above, the USB control port, as well as all BNC output terminals reside on the front side of the device.

The **Power-on-LED** (green) indicates proper operation of the internal supply circuitry. If the device is not in use, it is recommended to use the mains switch of the power supply to cut it completely off from mains for safety reasons. It is recommended to wait after turning the device on, at least 30min to obtain high stability performance.

## 5. Maintenance and Calibration

The MS Series Sources are designed for years of reliable operation. Under normal operating conditions, they do not require electrical maintenance, but routinely cleaning of dust, and in longer time intervals, replacement of rear fan (see below).

### *Routine cleaning*

All ventilation openings – top, bottom, sides, and rear panel – should be checked periodically and kept free of dust and other obstructions. A vacuum cleaner may be used to clean these vents when the unit is powered off. Do not use compressed air to clear the vents. The front panel may be cleaned periodically with a clean cloth and alcohol solution, when the unit is powered off. It is recommended to send the device to the manufacturer routinely in 5-year intervals for internal cleaning from dust.

### *Fan life time and temperature monitoring*

The ventilation fan at the rear side of the housing is a part which shows deterioration and finally failure in time. Exchange of this part is recommended after latest 50.000 hours of operation. Please contact manufacturer for replacement after long term operation. Complete failure may severely impair the accuracy specifications due to overheating of the device. Temperature fuses and other protection measures ensure a certain degree of safety against fire hazard in this case. Nevertheless, it is strongly recommended to read out regularly the device's temperature by software means in order to monitor the internal temperature and therefore to ensure avoidance of damage to the device. Values above 55 degree Celsius indicate a problem, which must be investigated.

### *Fan speed monitoring*

A fan speed monitoring circuit routinely checks the fan rotation speed and gives an acoustic warning signal (intermittent sound) in case of low rotation speed and in case of a fatal failure (permanent warning sound). A few seconds after turning the device on, the warning sounder is shortly active demonstrating proper operation.

### *Calibration*

Under normal operating conditions, the MS Sources will not require regular calibration. However, they can be returned to factory for complete electrical and mechanical inspection and calibration purposes. Calibration by user is also possible using special commands (see appendix).

6. Specifications (preliminary, version October 2025)

Output Specifications, preliminary (version Oct.2025)			
<b>Output Range</b>	Versions: 0 to 10mA other on request	on BNC outputs, inner conductors of two BNC form a 2-pole current source, BNC shield serves for shielding purposes	
<b>Number of Outputs</b>	32, other on request		
<b>Output Connectors</b>	BNC sockets, non-isolated, other on request		
<b>Output Reference Ground</b>	All outputs are isolated from each other, no common GND. Isolation resistance typ. 40MΩ between channels		
<b>Electromotive force R_diff</b>	Electromotive force, EMF equals approx. +11.4V (terminated high-Z) Differential output resistance typ. > 3.5MΩ		
<b>Programming Resolution</b>	20 Bits		
<b>Accuracy</b> (temperature T = 295K +/-1K)			
	typical error	maximum error	typical drift
<b>% of Setting</b>	0.002%	0.005%	0.0003% per day
<b>Offset error</b> Version 0 to 10mA	±55nA	±110nA	expected ±1nA per day
<b>Linearity error</b> Version 0 to 10mA	±50nA	±75nA	
<b>Temperature drift</b> Version 0 to 10mA			
related to set value	5ppm/K	13ppm/K	
related to Offset	20nA/K	35nA/K	
<b>Output Noise and Fluctuations</b>			
	typical	maximum	conditions
<b>Ripple</b> (50Hz, 100Hz) Version 0 to 10mA	2nA to 3nA rms	6nA rms	
<b>Noise</b> 10Hz...10kHz Version 0 to 10mA	5nA rms	15nA rms	
<b>Channel separation</b>	145 dB	better 130dB	static channel crosstalk, with respect to midrange setting
<b>Remote Control / Communication Parameter</b>			
<b>Remote Connection</b>	<p><b>USB 2.0</b> compatible connection to PCs, fully galvanic isolation provided. The device acts as RS232-controlled device (8N1 protocol, no handshake), communicating with 115200 Baud. Remark: '8N1' = 8 data bits, no parity check, 1 stop bit.</p> <p>Note: <b>RS 485</b> and <b>RS 232</b> interface optionally on demand</p>		

<b>USB Isolation Rating</b>	max. +/-100V on USB socket vs. case GND
<b>Command Language</b>	clear ASCII code command codes see Appendix and Programmers Guide
<b>Device Response Time</b>	1 to 10ms, see detailed specifications
<b>Software Support</b>	USB drivers are required. ASCII sample code is provided
<b>Power Supply</b> (contains linear regulators only, no switching circuitry)	
<b>AC Supply Rating</b> (country depending)	<u>Attention:</u> fixed AC input voltage 230V <sub>AC</sub> at 50Hz; Fuse: medium fast blow 0.5A or: AC input voltage 115V <sub>AC</sub> at 50 to 60Hz; Fuse: medium fast blow 1A Power Consumption typ. 15.6W to 20.0W Note that application of wrong mains supply voltage damages the device.
<b>Environmental Operating Conditions</b>	
<b>Storage Temperature</b>	-10C° to +50C°.
<b>Magnetic Field</b>	max. 5 mT admissible
<b>Humidity &amp; Temperature</b>	non-condensing humidity, temperatures between +10°C and +28°C
<b>Miscellaneous</b>	
<b>Internal Cooling Fan</b>	life time typ. 50'000 to 100'000 hours; acoustic warning in case of failure and low speed. Note: do not operate device with failing fan, since this leads to increased fire hazard.
<b>Case dimensions</b>	<i>Source module</i> , rack mount 19.00" wide x 13" deep. 3 height units. <i>Mains adapter</i> , rack mount 19.00" wide x 11" deep. 3 height units. Front-panel mounting holes are configured for M6 rack bolts.
<b>Weight</b>	approximately 6.6 kg, configuration dependent, mains adapter approx. 3.5kg

## 10. Output characteristics

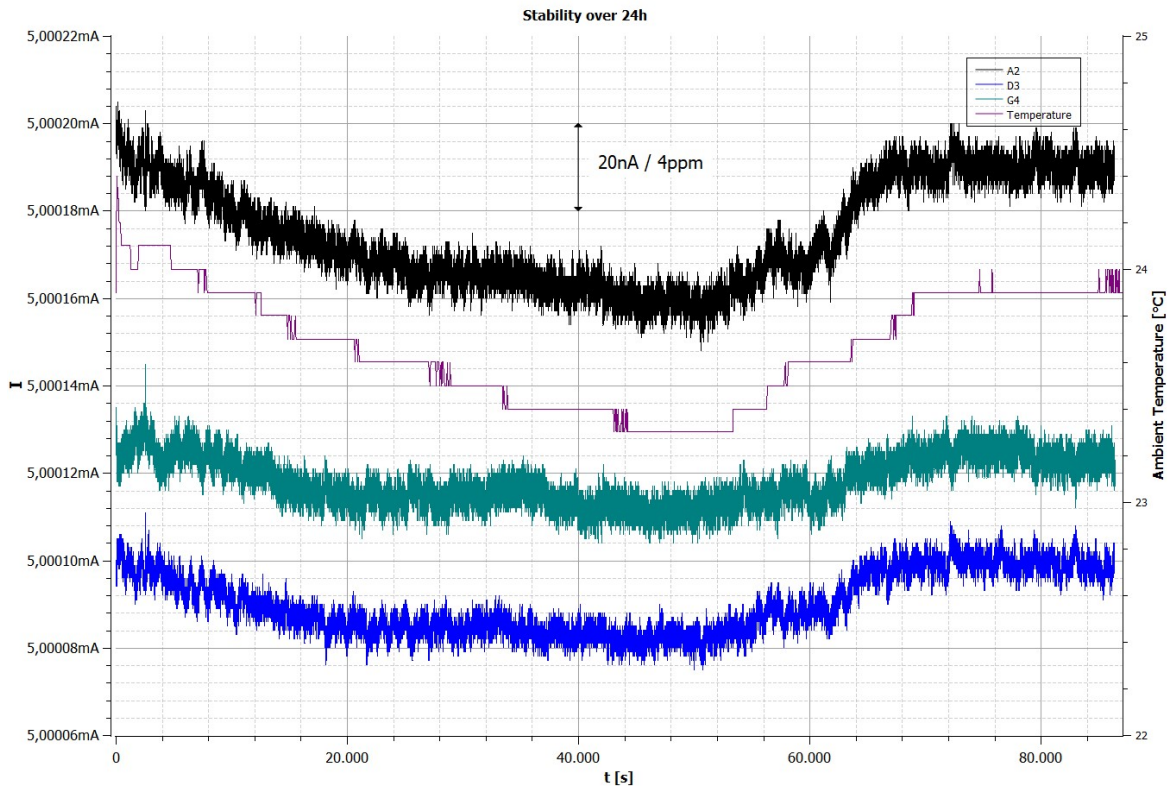


Fig. 10.1

24h-output current stability of three arbitrary channels, set to 5mA (= midrange). Short term fluctuations are typically around 10nApp (4.1nA rms) over seconds and minutes, corresponding to less than 1ppm rms during these intervals. The graphs depicts 24h period traces (~ 90'000 sec), displaying also the laboratory temperature variation of about 0.7 degree C, and resulting temperature coefficient around 5ppm/K

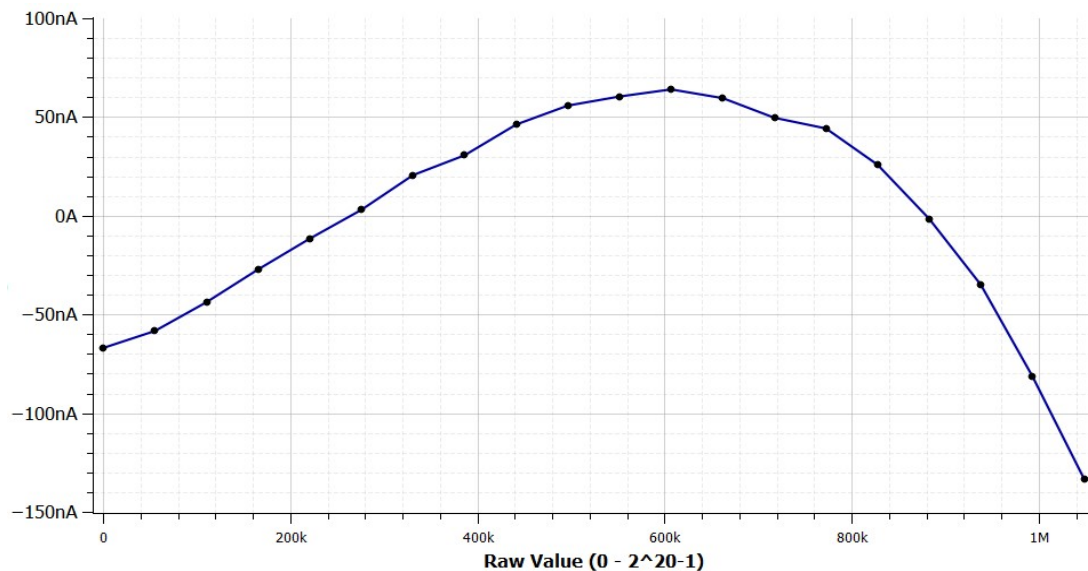
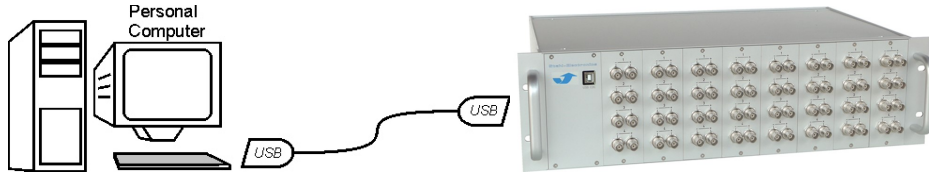


Fig. 10.2

Non-linearity error of output, deviation versus set value over complete range 0 to 10mA. Typical deviation is around 50nA (i.e. 10ppm at 5mA set value), which may be compensated by software means.

## Appendix



### Remote-Control Interface

The precision DC source device can be controlled in an easy way using **LabVIEW™** source code blocks, or other self-written program code, based on simple ASCII commands. Standard program compilers/interpreters like **Python**, **C++**, **MATLab** or **Pascal/Delphi** dialects may be easily used for own code writing, also generic command-line terminal programs (e.g. HyperTerminal™) will do. However, the physical line connection to the device (USB-connection) needs to be established beforehand, like described in section 3.2.1. USB-drivers for Windows™ versions, Mac OS and Linux are readily provided, however, most PC automatically recognize the connected USB device automatically anyway. Please check (eventually) the USB-manufacturers homepage ([www.ftdichip.com](http://www.ftdichip.com)) for latest updates.

Note that the physical communication behaves like a traditional RS232 device, communicating with standard settings (old version until production year 2016: 9600 Baud, 8N1 protocol, no handshake) or with faster settings, especially 115200 Baud, or customized. If a faster speed option is installed (denominated as 'fast mode' in the table below), the latter is marked with a label at the rear side USB socket. In self-written code the 115200 Baud rate parameter (or faster) needs to be set explicitly, since 9600 Baud is Windows standard otherwise. In Windows operating systems the device appears on a 'COM'-port (VCP = virtual COM port), as soon as connected to the control PC after driver installation. The COM-Port number is assigned by Windows upon connecting the device by USB cable and may change from time to time. The COM-Port settings may be checked inside the Windows™ system control panel.

Note that other remote modules, like Ethernet adapter are being in preparation (as of Oct. 2025).

### Command List and Syntax

Please refer to corresponding programmers guide / command set manual for further details.

## Declaration of Conformity



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We declare that the product

**MS Series High Stability Multichannel Current Source**  
**Options: all options included**

complies with the European Union provisions with respect to directives

2014/35/EU applicable standard DIN EN 61010-1

2014/30/EU regarding electromagnetic compatibility (EMC), applicable standard  
EN 61326-1:2013,

2011/65/EU RoHS, including EU 2015/863, applicable standard EN 50581:2013

Authorized person: Dr. Stefan Stahl

Place, date	
Mettenheim, Sept. 1, 2025	signature