rhd instruments
flexible cell solutions

Multi
Data Sampler
User Manual

Version 1.1 EN

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rhd instruments GmbH & Co. KG

Contents

1 Product description

The Multi Data Sampler is a four-channel universal analog DC data sampler. The four channels can be individually configured for input voltages between -10V to +10V.
The channels are internally sampled at 1 kHz with simultaneous sampling of all channels. The raw analog resolution is 18 bit. An oversampling (averaging) filter can be applied internally, reducing the effective sampling rate accordingly while reducing noise.

2 General information

Thank you for your confidence in our products and services. We wish you pleasure and success with your new Multi Data Sampler device.

» **To avoid physical injuries and damage, please read this instruction manual carefully before using the device for the first time.**

» **Please pay attention to all safety notes in this instruction manual.**

» **Please keep this manual safe. In case of selling or leaving the device to third parties, please do not forget to hand this manual over as well.**

» **The operation of the Multi Data Sampler device should only be performed by properly trained and experienced members of staff.**

» **The setup is developed to measure analog voltage signals and must not be used for any other purpose.**

» **To avoid unstable operating conditions and injury, the Multi Data Sampler setup as well as the individual components should not be used if**

- **they show noticeable damage,**
- **they were stored or operated under unapproved conditions (see operational condition, storage and rated values),**
- **they were exposed to high mechanical stress, exceeding normal usage,**
- **they were altered by members of staff not authorized by rhd instruments.**

The instructions in this manual were carefully checked for correctness. However, liability for any mistakes in form and content will not be assumed. Additionally, rhd instruments GmbH & Co. KG (in the following declared as rhd instruments) reserves the right to change the setup and design of the products presented and described within this manual. Such changes are necessary to guarantee the continuous development of the products and, thus, the improvement of product quality and reliability.

Markings in this manual

Marking	Meaning
 **WARNING**	Indicates a hazardous situation which, if not avoided, could result in a serious injury or death.
 **ADVICE**	Indicates potential physical damages and other important information associated with your device.
 **INFO**	Indicates general notable information regarding a device function.

3 Important general safety notes

» Connect the power supply according to the safety regulations for electrical equipment. Otherwise, there is risk of injury, damage to or destruction of the sensor and/or the controller

» The supply voltage must not exceed the specified limits to avoid damage to or destruction of the sensor and/or the controller

» Only use the original parts included in delivery. They are prepared for your device and guarantee the necessary safety for operator and device.

» Do not operate the device with wet hands. Operate the device only in dry rooms.

» Do not operate the device outdoors.

» Please follow only the instructions in this manual for cleaning the device.

» Make sure that cables and conductors are not damaged. Damage could be caused by heat, impact, contact with chemicals, or mechanical impacts like rubbing, bending, tearing, and rolling-over.

» Prevent the device from mechanical impact. In case the device fell down, please contact rhd instruments or a technician authorized by rhd instruments before switching it on again.

» If your device shows any visible damage or defect: Disconnect the power supply by pulling out the power connector. Never operate your device in a damaged state. Never repair the device on your own. The device should only be repaired by either rhd instruments or by a technician authorized by rhd instruments.

» Do not open the device. There are no user-serviceable parts inside.

» Please follow this instruction manual for maintaining your device.

» Only use original spare parts delivered by rhd instruments.

ADVICE: Connect and disconnect any cable connection carefully.

4 Components of the Multi Data Sampler Setup

» Please unpack your device carefully.

» Please check if the delivery is complete:

- 1x main device in enclosure
- 1x power supply unit 24 V
- 1x RHD-SERIAL USB to serial adapter
- 1x 2m Serial connection cable
- USB flash drive with application software

» Please check if the delivered items are undamaged.

ADVICE: If the delivered items are incomplete or damaged, please contact rhd instruments via e-mail (info@rhd-instruments.de) or via phone (+49-6151-8707187).

rhd instruments will reject any claims for warranty or responsibility in case damaged equipment is used.

In case any accessory of other manufacturers is used, rhd instruments will accept no liability.

5 Operation conditions, storage and rated values

5.1 Operating and storage conditions

Power supply	24 V DC, +/- 15%, Imax < 1 A
Temperature range during operation	$T_{env.\ operation}$ = +10 °C to +50 °C
Temperature range during storage	$T_{storage}$ = +10 °C to +50 °C
Relative humidty (RH) for working and storage conditions	(non-condensing) 0 to 80% RH
Atmosphere during storage	Non-corrosive
RS-232 signal levels	RS-232 compliant

5.2 Analog Characteristics

Differential input voltage range (max.)	-10.24 V to +10.24 V
Input common-mode voltage vs. GND	-8 V to +8 V
Resolution	18 bits
Input filter cutoff frequency	ca. 240 Hz (-3dB)
Digital Filter	Block-averaging of 1 to 256 values
Linearity error	< 0.1 %
Sampling rate (internal)	1000 Hz
Sampling rate (external interface)	400 Hz max.,50 Hz typ. **[INFO 1]**

INFO [1]: The response time of the serial interface is often limited by latency timers in the operating system (default in Windows 16ms), resulting in a maximum sampling rate of about 60 Hz.

6 Essential features at a glance

» High accuracy DC voltage measurement from analog sensors

» Four differential channels with individually configurable voltage ranges

» Simultaneous sampling of all four channels

» Industry-standard MODBUS RTU RS-232 interface

» Built-in averaging filter

» 4-pole LEMO connectors with signal and supply-voltage pins

Note:
If you have any questions, for example with regard to the compatibility of your measurement devices, do not hesitate to contact us via email (info@rhd-instruments.de) or phone (+49-6151-8707187).

7 Getting started

7.1 General instructions

Connect the 24 V power supply to the DC input jack at the back of the device. Connect the serial connection cable between the serial connector at the back of the device and the computer. Use the USB-Serial adapter if the computer does not have a native serial port.

Switch the device on using the switch at the back of the device.

The status LED at the back lights green to indicate operation.

7.2 Input connector

The push-pull connectors for sensor connections require the following connector:

Manufacturer: LEMO

Part number: FFA.0S.304.CLAC32

Datasheet: https://www.lemo.com/pdf/FFA.0S.304.CLAC32.pdf

Pin Number	Name	Description
1	Signal+	The positive differential signal input
2	Signal-	The negative differential signal input
3	24 V	The 24 V supply voltage, max 200 mA
4	GND	Supply ground and signal common-mode reference voltage

Terminate the connector to your sensor according to the manufacturer instructions.

Plug the connector into one of the channels at the front of the device.

7.3 Voltage Ranges

Each channel of the Multi Data Sampler can be set to one of 6 voltage ranges, or be disabled.

At least one channel must be enabled at all times. If all channels are set as disabled, the data sampler will keep the previous setting for subsequent samplings.

The following table describes the individual voltage ranges that are selectable via the SPAN1-4 registers of the serial interface. The Value column defines the value to set to the appropriate register to select the respective range. V-min and V-max describe the voltage limits of each range, for use in the linear interpolation calculation of the output value.

Value	Range	V-min [V]	V-max [V]
0x00	Channel Disabled	-	-
0x01	0 - +5.12 V	0	+5.12
0x02	-5 - +5 V	-5	+5
0x03	-5.12 - +5.12 V	-5.12	+5.12
0x04	0 - +10 V	0	+10
0x05	0 - +10.24 V	0	+10.24
0x06	-10 - +10 V	-10	+10
0x07	-10.24 - +10.24 V	-10.24	+10.24

INFO: The noise floor is usually not limited by the chosen voltage range. Using a smaller range than 0x07 typically yields no benefit.

7.4 Averaging Filter

Internally the input voltages are sampled at 1 kHz. The user can select a filter amount between 1 and 256 values. Depending on the selection, the given number of values are block-averaged, reducing the internal data rate to 1 kHz / N.

Please note: The maximum data rate available to the computer is further limited by the serial interface to a maximum of roughly 50 Hz.

7.5 Floating inputs

The analog inputs have a very large input impedance. That means that voltages on floating inputs are not shunted to zero, but will only slowly decrease in value due to low leakage currents. This is the normal behavior, used to minimize input offset voltage.

8 Initial software setup

8.1 RHD.MDSControl

8.1.1 General description

RHD.MDSControl is a configuration and control software for the MDS device. It allows changing device settings, firmware updates and rudimentary data logging.

8.1.2 Installation

RHD.MDSControl is shipped as an installation program:

rhd-mdscontrol-setup-*<version>*.exe

Execute the installer and follow the instructions to install the program. Per default, administrator privileges are not required. The software is installed into the %localappdata% directory per default.

After the installation, the program can be started with one of the created shortcuts in the start menu or on the desktop.

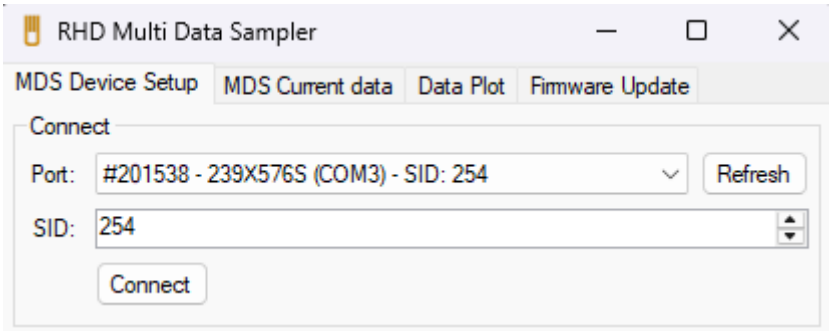
To uninstall the program, run the Uninstall program from the Start menu, or from the Windows application settings.

NOTE: It might be required to install additional driver software for e.g. a USB-to-Serial adapter device. This driver installation may require administrator privileges.

8.1.3 Connecting to the device

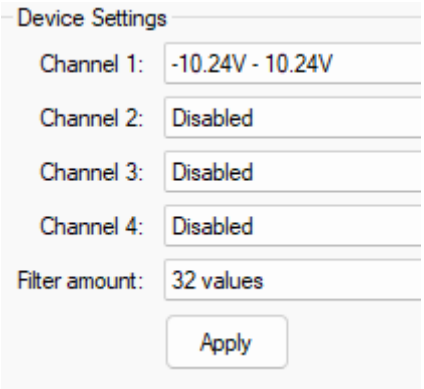
The device can be controlled using the RHD.MDSControl software, included on the USB flash drive.

After starting the software, it searches for connected and switched-on Multi Data Sampler devices and shows the found devices in a dropdown list. Select the device you wish to connect to and press the Connect button. After connecting, the software reads the current device settings and shows them in the UI. It also activates the Current Data display the Data Plot.



8.1.4 Device Settings

The device settings allow you to set the input voltage range for each channel, as well as the number of filter values.



After startup, only channel 1 is enabled with a range of -10.24 to +10.24 V. The filter amount is set to 32 values.

After changing the selection, click the Apply button to write the new values to the device.

8.1.5 Data Display

The MDS Current data and Data Plot tabs show the current data of the channels.

The MDS Current data tab shows bar graphs as well as textboxes with the raw voltage value.

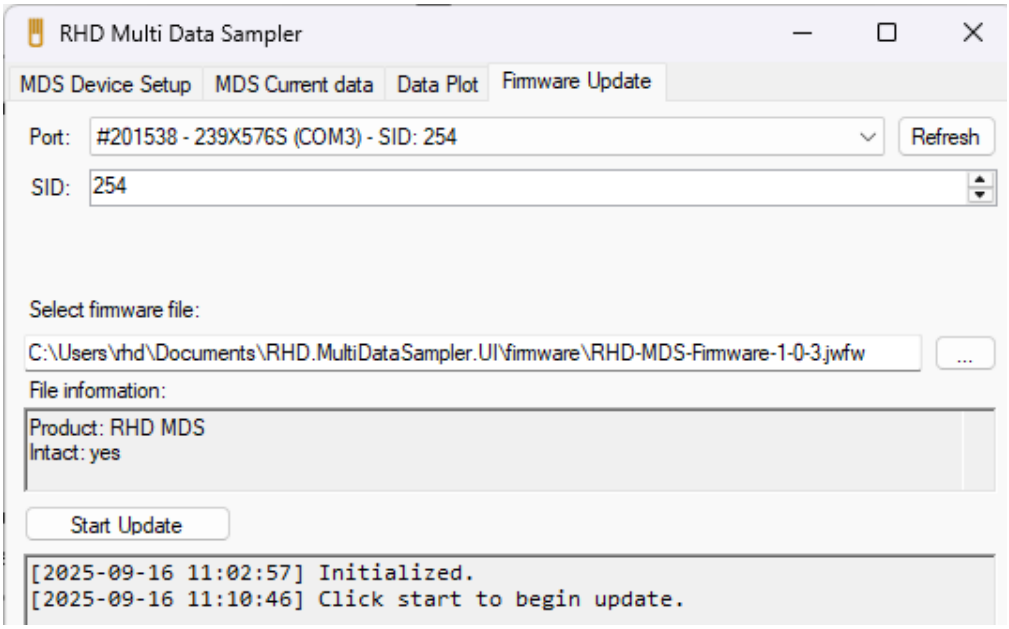
The Data Plot shows a plot of the channel voltages over time. The notes in the graphs shows the average and standard deviation of the channel values over the last 15 seconds. Click the Clear Data button to clear all data from the graph. Click the Pause collection button to temporarily stop collection graph data (resume with the same button).

The Settings button allows setting information about the data collection. Points are removed from the graph after a certain time, default after 12 hours. The settings window also allows limiting the rate at which datapoints are collected for the plot.

8.1.6 Firmware Update

To update the firmware of the device, first disconnect it on the MDS Device Setup tab. Then switch to the Firmware Update tab.

1. Disconnect the device on the MDS Device Setup tab
2. On the Firmware Update tab, select the device port
3. Select a firmware file from the dropdown menu (recommended), or click the "..." button next to the Select firmware file input and
    a. Select the .jwfw firmware file to upload.
    b. It is typically located in the <Install Path>\firmware folder
4. Click the Start Update button
5. The firmware update should start and upload it to the device
   If not, please refer to the Troubleshooting section
6. After the firmware update completes, you can reconnect to the device on the Device Setup tab



9 Device serial interface

9.1 Introduction

The RHD Multi Data Sampler uses a RS-232 serial interface for communication. The interface parameters are:

Name	Value
Interface Type	RS-232
Baudrate	115200
Parity	None
Databits	8
Stopbits	1
Handshake	Disabled

The **Modbus RTU** protocol is used for data transfers.

The Modbus interface supports function codes 3 (read multiple registers) and 16 (write multiple registers). It does NOT respond to broadcast requests. A full description of the Modbus protocol is beyond the scope of this documentation.

A **maximum of 16 registers** can be read or written in one transaction.

Some values are reported in a fixed-point integer format. In this case, the divisor is stated in the reference table. The table states units after dividing by the divisor. For example, the value reported by the TIME register has a divisor of 10. Divide the value read from the register by 10 to get the time in [seconds].

Values can be signed or unsigned. The table states unsigned values as i.e. uint16 and signed values as i.e. int16.

All registers are 16 bits wide. However, the device reports 32-bit integers as well as 32-bit floating-point values in special register pairs. These are denoted with LSB and MSB tags.

Here, one register returns the least significant and another register returns the most significant bits. You should always read or write these values with a single FC 3 or FC 16 message, in order to ensure that both registers report the parts of the same value.

In cases of signed integer variables, the sign bit is part of the MSB register, and it is recommended to use a bitwise conversion between unsigned and signed integers.

Example (reading a signed 32-bit integer):

```
uint16_t values[2];
read_registers(REG_SOME_INT32, 2, values); // MSB, LSB
```

```
uint16_t valueMSB = values[0];
uint16_t valueLSB = values[1];
uint32_t valueTemp = valueLSB | ((uint32_t)valueMSB << 16);
union
{
    uint32_t input;
    int32_t output;
} convert;
convert.input = valueTemp;
int32_t value = convert.output;
```

Floating point values are treated in the same way. The floating-point value is converted bitwise into an unsigned integer and the parts are returned as the two register values. Example (reading a 32-bit floating-point value):

```
uint16_t valuesFlt[2];
read_registers(REG_SOME_FLOAT_MSB, 2, valuesFlt); // MSB, LSB
uint16_t valueFltMSB = values[0];
uint16_t valueFltLSB = values[1];
uint32_t valueFltTemp = valueFltLSB | ((uint32_t)valueFltMSB << 16);
union
{
    uint32_t input;
    float output;
} convert;
convert.input = valueFltTemp;
float valueFlt = convert.output;
```

9.2 Value calculation

The values returned by the channel value registers encode the raw ADC reading, the channel number and the channel range. The value bits are:

31	30	29	28	27	26	25	24	23	22	21	20	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	D	C	C	R	R	R

RRR: Bits 0-2 describe the channel range used when sampling the value:

Value	Range	V-min [V]	V-max [V]
0x00	Channel Disabled	-	-
0x01	0 - +5.12 V	0	+5.12
0x02	-5 - +5 V	-5	+5
0x03	-5.12 - +5.12 V	-5.12	+5.12
0x04	0 - +10 V	0	+10
0x05	0 - +10.24 V	0	+10.24

0x06	-10 - +10 V	-10	+10
0x07	-10.24 - +10.24 V	-10.24	+10.24

CC: Bit 3-4 describe the channel that the value was sampled from

DDD...: Bit 5 - 31 describe the raw ADC value. The source ADC value is shifted left by 8 bits to reduce rounding error due to averaging. Hence, the raw value needs to be divided by 2^26 (1 << (18 + 8)) and then linear interpolated between the min/max voltage of the range.

```
uint32_t rawValue = read_register_long(REG_CHANNEL1_MSB);
uint8_t range = (uint8_t)(rawValue & 0x07);
rawValue >>= 3;
uint8_t channel = (uint8_t)((rawValue >> 3) & 0x03);
rawValue >>= 2;
double minVoltage = range_get_minvoltage(range);
double maxVoltage = range_get_maxvoltage(range);
double deltaRange = maxVoltage – minVoltage;
double maxValue = 67108864.0 // 2^26
double voltage = rawValue / maxValue * deltaRange + minVoltage;
```

ADVICE: The SPAN1-4 registers are range selection registers and, when read, may not report the correct range for a channel value.
Always use the range defined by bits 0-2 in the data values to determine which range was used for the value conversion!

Each channel also has a calibration value defined. The register value is interpreted as a signed 16-bit number. This number, *c*, is recalculated into a calibration factor by the following formula

$$f_{calib} = (10000000 + c)/10000000$$

For example, a value of -4745 equates to

$$f_{calib} = (10000000 - 4745)/10000000 = 0.99953$$

That means, the maximum calibration factor is $\pm 0.327\%$. If the raw value is 0, the calibration factor is 1.

The calibration factor is multiplied with the unscaled value to get the final value:

```
// voltage variable, see above
int16_t calib = read_register_int16(REG_CHANNEL1_CALIB);
double calibrationFactor = (10000000.0 + calib) / 10000000.0;
double calibratedVoltage = voltage * calibrationFactor;
```

9.3 Register listing

Bold register numbers are saved in the EEPROM if requested.

Num.	Tag	Type	Div.	Description
1	IDENT_1	uint16	1	Fixed value 0x5248 (21064)
2	IDENT_2	uint16	1	Fixed value 0x444D (17485)
3	IDENT_3	uint16	1	Fixed value 0x4453 (17491)
4	FIRMWARE_VERSION	uint16	1	The firmware version
5	CHANNEL_COUNT	uint16	1	The number of analog channels
6	STORECONFIG	uint16	1	Write to >0 to store settings permanently in internal EEPROM (**ADVICE [1]**)
7	REQUEST_RESET	uint16	1	Write to 0xAB to perform a device reset
8	SERIAL_YEAR	uint16	1	The device serial number year
9	SERIAL_NUMBER	uint16	1	The device serial number number
20	SPAN1	uint16	1	The range selection for channel 1
21	SPAN2	uint16	1	The range selection for channel 2
22	SPAN3	uint16	1	The range selection for channel 3
23	SPAN4	uint16	1	The range selection for channel 4
24	FILTERBITS	uint16	1	The number of values to average as a bit number, e.g. 2^n, e.g. 4 = 2^4 = 16 values averaged. Max. value: 8
25	DATA_SHIFT	uint16	1	The number of bits that the sampled ADC values are shifted to the left in the value registers. Fixed at 8.
40	TIME_MSB	uint32	10	The internal device time in [s]

41	TIME_LSB	uint32	10	The internal device time in [s]
42	VALUE_IDX	uint16	1	The current value index, incremented on each new ADC sample
43	CHANNEL1_MSB	uint32	1	The raw value of channel 1
44	CHANNEL1_LSB	uint32	1	The raw value of channel 1
45	CHANNEL1_CALIB	int16	1e7	Channel 1 calibration value
46	CHANNEL2_MSB	uint32	1	The raw value of channel 2
47	CHANNEL2_LSB	uint32	1	The raw value of channel 2
48	CHANNEL2_CALIB	int16	1e7	Channel 2 calibration value
49	CHANNEL3_MSB	uint32	1	The raw value of channel 3
50	CHANNEL3_LSB	uint32	1	The raw value of channel 3
51	CHANNEL3_CALIB	int16	1e7	Channel 3 calibration value
52	CHANNEL4_MSB	uint32	1	The raw value of channel 4
53	CHANNEL4_LSB	uint32	1	The raw value of channel 4
54	CHANNEL4_CALIB	int16	1e7	Channel 4 calibration value

ADVICE [1]: Avoid writing the EEPROM repeatedly.
EEPROM memory has a limited endurance of around 100,000 write cycles.

10 Troubleshooting

10.1 No data connection to the device can be established

- Ensure that the device is correctly connected to a serial port on the PC
- Ensure that the device is switched on
- Only one application can access a serial port at the same time. Make sure it is not in use by another application. Restart the PC and retry connecting to the device before starting any other application.
- Ensure that the Modbus SID value is set to 254

10.2 Invalid voltage reading

- Check the connection cable of your sensor for damage
- Verify that the sensor is connected to the correct channel
- Check that the selected voltage range for the channel is compatible with the sensor voltage output

10.3 High noise on the signal

- Check the connection cable of your sensor for damage
- Plug the Multi Data Sampler into the same outlet as the sensor, if the sensor has a dedicated power supply
- Ensure that the noise is not just a visual issue. Nominal noise level of the MDS is on the order of a few hundred microvolts

10.4 The firmware update does not start (wait for device reset)

- Check that the correct port is selected in the port dropdown on the Firmware Update tab. It is a separate selection from the Device Setup tab.
- Abort the firmware update, switch the MDS **off**, then start the update again. When it is waiting for device reset, switch the MDS back on

11 Settlement

Warranty will be granted for a period of 2 years starting at the date of delivery.
Explicitly left out from warranty are parts that are subject to premature wear and tear due to use or other natural wear and tear. These components are regarded as consumables.
Damage on the optical cable is excluded from warranty.
The costs for sending repaired or exchanged goods to the costumer will be paid for by rhd instruments.
rhd instruments has to be notified of apparent defects and damages which occurred during production or delivery within 14 days after receiving the delivery. If a notification of apparent defects and damages does not occur within this period of time, the goods shall be deemed to have been accepted; as a result, the order will be assumed to be completed and approved.
Please note: Only workshops authorized by rhd instruments are allowed to perform repairs on the devices. If any mechanical or electronic components of the products are altered by customers themselves or by unauthorized workshops, a claim for warranty against rhd instruments is forfeited.
In case of a claim or sending back goods for repairs to be performed, please ask for the decontamination form beforehand. In general, rhd instruments must be contacted via e-mail or phone prior to any shipping of damaged goods.

12 Contact and Technical Support

For any questions with regard to our products, orders, or request for repairs please contact rhd instruments:

info@rhd-instruments.de
Phone: +49 6151 8707187
Fax: +49 6151 8707189
Web: http://www.rhd-instruments.com

rhd instruments GmbH & Co. KG
Otto-Hesse-Straße 19 / T3
64293 Darmstadt
Germany

Sitz der Gesellschaft: Darmstadt
Amtsgericht Darmstadt HRA 85824
WEEE-Reg.-Nr. DE 54715752

Haftende Gesellschafterin: rhd instruments Verwaltungs GmbH
(Sitz: Darmstadt, Amtsgericht Darmstadt HRB 96374)

Geschäftsführer: Dr. Benedikt Huber und Dr. Marcel Drüschler

EU-Konformitätserklärung
EU Declaration of conformity
CE MultiDataSampler

Wir, die rhd instruments GmbH & Co. KG,
We, rhd instruments GmbH & Co. KG,

rhd instruments GmbH & Co. KG
Otto-Hesse-Str. 19 / T3
64293 Darmstadt
Germany

erklären, dass der MultiDataSampler in Konzeption und Bauart sowie in der von uns in Verkehr gebrachten Ausführung den grundlegenden Anforderungen der zutreffenden, aufgeführten EU-Richtlinien entspricht. Bei einer mit uns nicht abgestimmten Änderung an dem Gerät verliert diese Erklärung ihre Gültigkeit.

hereby declare, that the MultiDataSampler is in compliance with the basic requirements of all applicable EC-directives stated below with regard to design, type of model sold and manufactured by us. This certificate will be invalid if the product is modified without the prior written consent and agreement of the manufacturer.

Niederspannungsrichtline 2014/35/EU / Low-Voltage Directive 2014/35/EU
EMV Richtlinie 2014/30/EU / EMC Directive 2014/30/EU
RoHS-II Richtlinie 2011/65/EU / RoHS-II Directive 2011/65/EU

Angewandte (harmonisierte) Normen / (Harmonized) Standards applied:

DIN EN 61010-1: Sicherheitsbestimmungen für elektrische Mess-, Steuer-, Regel- und Laborgeräte, Teil 1: Allgemeine Anforderungen (IEC 61010-1:2010 + Cor. :2011)

Safety requirements for electrical equipment for measurement, control, and laboratory use - Part 1: General requirements

DIN EN 61326-1:2013: Elektrische Mess-, Steuer-, Regel- und Laborgeräte - EMV-Anforderungen - Teil 1: Allgemeine Anforderungen (IEC 61326-1:2012)

Electrical equipment for measurement, control and laboratory use - EMC requirements - Part 1: General requirements

Darmstadt, 12. Dezember 2024

B. Huber M. Drüschler

Dr. Benedikt Huber Dr. Marcel Drüschler
(Geschäftsführer rhd instruments Verwaltungs GmbH)