MRL-6.1, MRL-6.1bt, MRL-6.1a, MRL-6.1abt

Data logger

Manual

Setup version 3.23.02 (Firmware 3.07.00)

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Sommer Messtechnik

Sommer Messtechnik
Strassenhäuser 27
6842 Koblach
Austria
www.sommer.at
E office@sommer.at
T +43 5523 55989
F +43 5523 55989-19

Validity

This manual applies to the Data logger with the setup version 3.23.02, including all its subversions.

Created: 01.01.2020 Last update: 09.06.2022

EU conformity

This product is in conformity with the following standards:

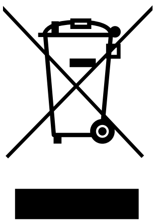
EMC	2014/30/EU	EN 301 489-1 V1.9.2
LVD	2014/35/EU	EN 62311:2008
		EN 62368-1:2014
RoHS II	2011/65/EU	
RoHS III	2015/863/EU	

Safety information

Please read this manual carefully before installing or operating this equipment. Non-compliance with the instructions given in this manual can result in failure or damage of the equipment or may put people at risk by injuries through electrical or mechanic impact.

- Make sure that the personnel responsible for installation, configuration and maintenance is familiar with the applicable regulations and standards!
- Do not perform any installations in bad weather conditions, e.g. thunderstorms.
- Prior to installation of equipment inform the owner of the measurement site or the authority responsible for it. Upon completion, secure the installation from trespassers.
- Maintenance and repair must be performed by trained personnel or an engineer of Sommer Messtechnik. Only replacement parts supplied by Sommer Messtechnik should be used for repairs.
- Make sure that NO power is connected to the equipment during installation and wiring!
- Only use a power supply that complies with the power rating specified for this equipment!
- Keep equipment dry during wiring and maintenance!
- If applicable, it is recommended to use accessories of Sommer Messtechnik with this equipment.

Disposal



After this device has reached the end of its lifetime, it must not be disposed of with household waste! Instead, dispose of the device by returning it to a designated collection point for the recycling of waste electrical and electronic equipment.

Dispose of batteries separately!

Feedback

Should you come across any error in this manual, or if you miss information to handle and operate the MRL-6.1 we are pleased to receive your feedback to office@sommer.at.

Content

1 What is the MRL-6.1?

The MRL-6.1 is a compact data logger designed to acquire, process and store all sorts of environmental data. It is compatible with all sensors offered by SOMMER Messtechnik and numerous third-party devices equipped with analog or SDI-12 interfaces. Its versatile input options and waterproof housing make the MRL-6.1 ideal for remote monitoring applications.

The MRL-6.1a is equipped with an additional analog output board that adds multiple analog, pulse and digital switch outputs. Optionally, the MRL-6.1 is available with a Bluetooth interface for wireless configuration.

2 Unpacking

When unpacking your MRL-6.1 sensor box please make sure that the following items are present:

Qty.	Name
1	MRL-6.1 in the required configuration
1	Manual and Commander Software on USB stick
5	Blanking plug for unused cable glands

In case of missing or damaged items please contact your Sommer Messtechnik sales partner.

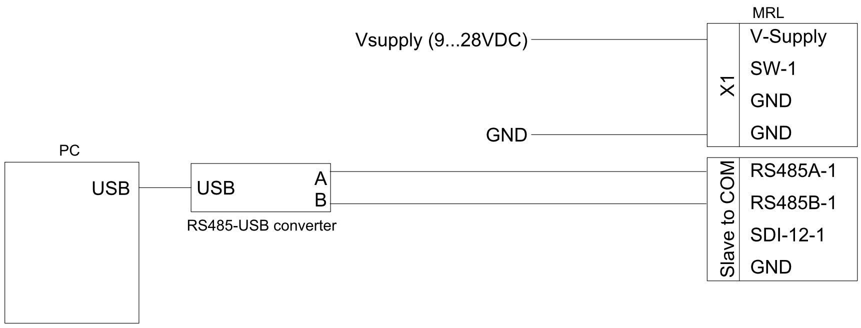
3 How do I start?

Follow the steps below to get the first measurement:

> **NOTE** Perform the first start-up in your lab or office before installing the equipment in the field!

3.1 Connect the MRL-6.1 to a PC

1. Install the Commander support software (see Installation of Commander)
2. Connect the RS-232 to USB converter cable to the MRL-6.1 and a USB port on your PC.
3. Connect a 9...28 VDC power supply to the MRL-6.1 as shown in the figure below.



4. Start the Commander software.
5. Click on Communication assistant on the right-hand side of the Commander window and follow the instructions. During this procedure the communication assistant will search for connected devices. Upon successful completion, the new connection is added to the connections list (tab Connections (F8)).
6. Click Connect to establish a connection with the MRL-6.1. If the connection was successful a green icon is displayed at the top-right corner of the Commander window.
7. Select the tab Parameters (F2) and click Download parameters from device on the left side of the Commander window. The complete parameter list is transferred from the sensor to your PC and displayed in the Parameter window.

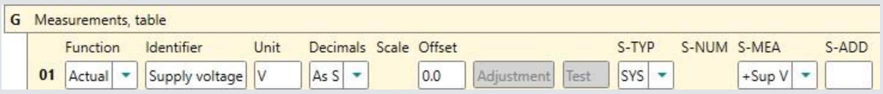
3.2 Configure the MRL-6.1

1. Navigate to Region format and set language and decimal character to your needs.
2. Set Measurement Interval and Storage interval in the main menu to the desired interval, e.g. 1 minute, i.e. *00:01:00*.

3. Add a measurement channel to the measurement table in the main menu as in the example below (see Measurement table for details).

EXAMPLE

MRL-6.1 supply voltage as measurement channel



4. Navigate to Technics > COM > Output protocol and set Measurement output to *Measured values push*.
   Send the parameters to the MRL-6.1 by clicking Upload modified parameters to device.

TIP

To configure the MRL-6.1 for your application, please read What do I need to configure? and see Data acquisition examples for various sensor connections.

3.3 View live measurements

1. Select the Measurement (F3) tab.
2. Make sure the MRL-6.1 is connected to the commander (green icon on top right corner of the Commander, see also Establish a connection with the Communication assistant). The acquired measurements are now displayed in Measurement values list and the Measurement data graph.

NOTE

For further configuration tasks like sensor connection or modem setup please go to section Operation.

To learn more about the Commander software go to section Support software Commander.

4 What can I do with it?

All data logger inputs, outputs and additional features are illustrated in Figure 1.

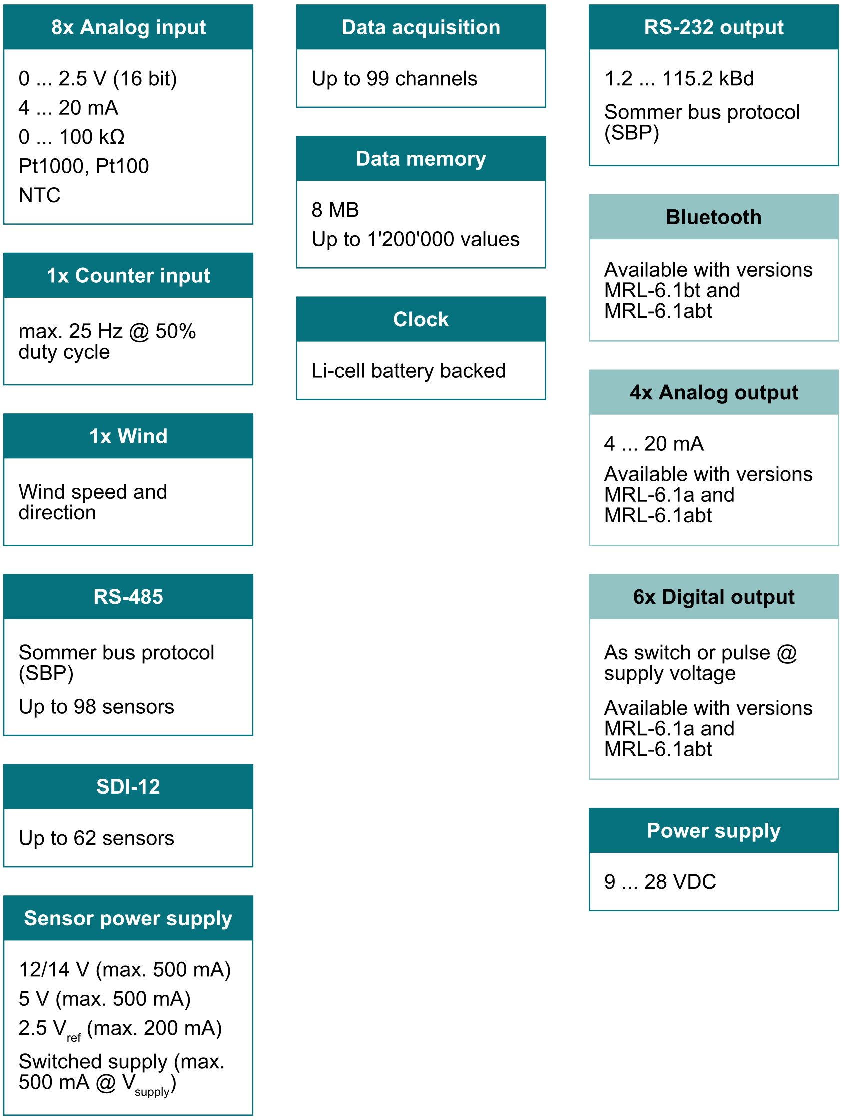


Figure 1 Data logger in- and outputs

4.1 Measurement options

The MRL-6.1 data logger is designed to acquire measurements of the following sensor types:

- Analog sensor with voltage and current output
- Resistive sensors, e.g. wind vanes with potentiometer output
- Sensors with frequency output, e.g. anemometers

- Sensors with pulse output, e.g. tipping bucket rain gauge
- Digital sensors using SDI-12 and Sommer RS-485 protocols

4.1.1 Analog measurements

The analog input terminals can be configured to the following signal types:

Analog input	Measurement options
An 1 ... 8	Single ended voltage 0 ... 2.5 V Differential voltage 0 ... 2.5 V Differential voltage 0 ... 1.25 V Differential voltage 0 ... 0.311 V Differential voltage 0 ... 0.032 V Resistance <100 kΩ Resistance <3 kΩ Resistance <300 Ω Current 4 ... 20 mA PT1000 PT100 AD592 NTC-thermistor
Wind direction	Resistance (potentiometer)

Analog input terminals

4.1.2 Counts & frequency

The available counter and frequency inputs are listed below:

Analog input	Measurement options
Counter	Pulse counter, impulse length >20 ms (equals 25 Hz at 50% duty cycle), high 2.2 ... 28 V, low 0 ... 0.6 V
Wind speed	Dedicated to wind speed only, max. frequency 1 kHz

Counter and frequency input terminals

4.1.3 SDI-12 data acquisition

The MRL-6.1 provides one SDI-12 port for communication with SDI-12 sensors. A total of 62 SDI-12 sensors with the addresses *0...9*, *a...z* and *A...Z* can be connected.

4.1.4 Serial RS-485 data acquisition

The RS-485 port of the MRL-6.1 provides an interface to connect digital SOMMER sensors using the Sommer Bus Protocol (SBP). A total of 98 Sensors with addresses *01...98* can be connected.

4.2 Signal output (MRL-6.1a and MRL-6.1abt only)

The analog output board offers signal conversion of the following types:

Input	Output
Voltage 0 ... 2.5 V Resistance <100 kΩ Counter Wind speed and wind direction RS-485 (SBP) SDI-12	Current 4 ... 20 mA Voltage low/high (low 0 ... 0.6 V, high 2.2 V ... V_{supply}) Impulse

All variables listed in Measurement table can thus be converted to the desired signal output.

4.3 Sensor power supply

Sensors can be powered by the voltage supply terminals listed in . Please consult the sensor manual for information on power requirements.

Output	Terminal	Maximum load
5V-Out	Supply 1	max. 500 mA
12/14V-Out	Supply 2	max. 500 mA
2.5V Reference	Reference	200 mA
Switched supply (@ data logger supply voltage)	Supply 3	max. 500 mA

Voltage supply terminals

4.4 Communication options

4.4.1 Direct connection to a PC

Communication between the MRL-6.1 and a PC can be established with the supplied USB to RS-232 converter. The Commander software or any terminal editor can be used to view and edit the data logger settings. Among others, the Commander provides a Communication assistant to connect to the data logger.

4.4.2 Bluetooth (MRL-6.1bt and MRL-6.1abt)

A connection between the MRL-6.1 and your PC can also be established via Bluetooth. If your PC is equipped with an internal or external Bluetooth-device, the Communication assistant of the Commander software can connect to the data logger (see Bluetooth (MRL-6.1bt and MRL-6.1abt) for detailed instructions).

4.4.3 Radio connection

Sommer Messtechnik offers ultra narrow band radios for remote communication between the MRL-6.1 and a base station, or between one or multiple sensors and the MRL-6.1 as base station. See Sommer radio devices for available products.

4.5 Data storage options

4.5.1 Internal data storage

Acquired measurement data are stored in a flash memory of 8 MB, which corresponds to approx. 1'200'000 values.

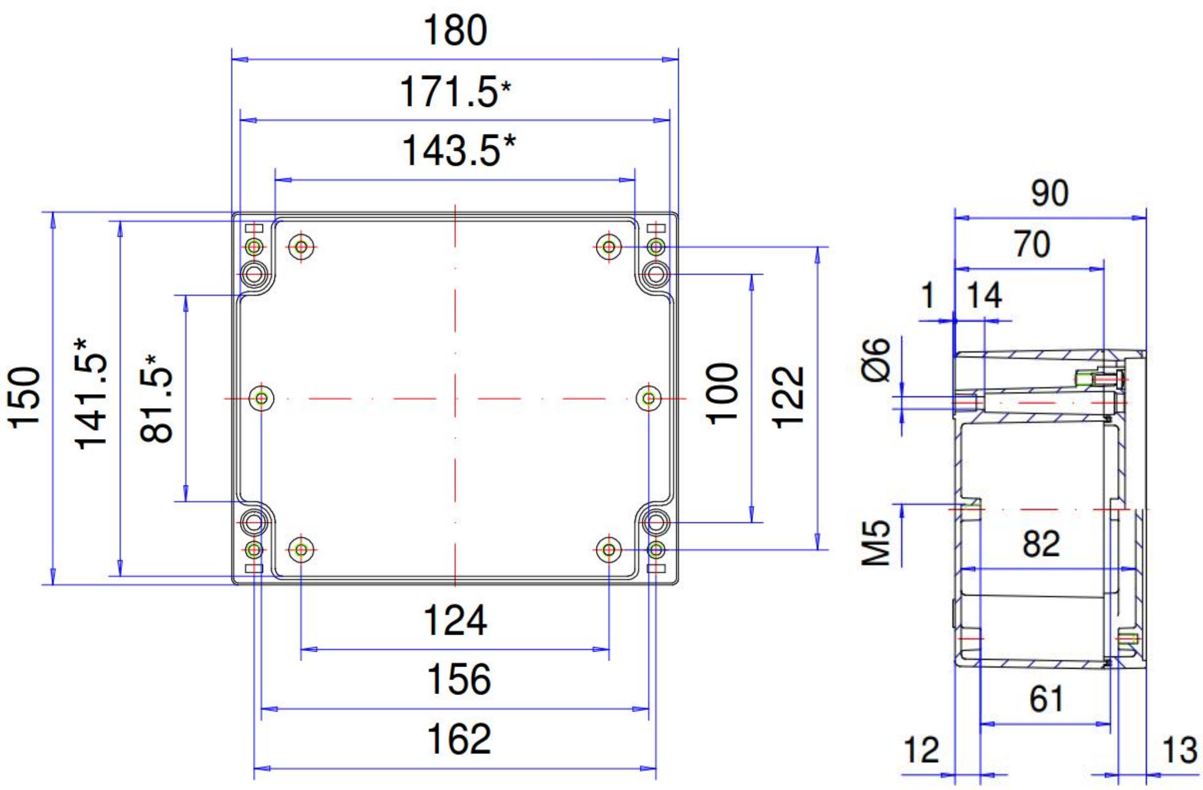
5 Versions

Art	Version
	MRL-6.1 (standard version)
	MRL-6.1bt with Bluetooth
	MRL-6.1a with analog output extension
	MRL-6.1abt with analog output extension and Bluetooth

6 Specifications

Device specifications	
Power supply	9...28 VDC; Overvoltage and reverse voltage protection deep-discharge protected if used with optional battery
Power consumption	min. 0.5 mA @ 12 V
Sensor supply	500 mA @ 5 V 500 mA @ 12/14 V 500 mA @ switched supply voltage
Referenced sensor supply	200 mA @ 2.5 V 100 mA @ 2.5 V (wind vane reference)
Inputs	8x Analog 0...2.5 V / 4...20 mA / Resistance; 16 bit resolution (internal 100 Ω-shunts) 1x Counter (max. 25 Hz @ 50% duty cycle) 1x Wind speed (frequency) 1x Wind direction (potentiometer) 1x RS-485 1x SDI-12 as primary/master (version 1.3) All analog inputs are equipped with overvoltage fine protection up to 36 V
Outputs	1x RS-232 (9600...115200 Baud) 1x Bluetooth® (MRL-6.1bt and MRL-6.1abt) 4x Analog current output (MRL-6.1a and MRL-6.1abt) 6x Switched output @ supply voltage (can be used as pulse output by adding a pull-down resistor)
Number of recorded variables	max. 99
Memory	8 MB non-volatile flash memory (equivalent to approx. 1'200'000 measurement values)
Measurement interval	2 s ... 12 h
Storage interval	10 s ... 12 h
Operating temperature	-40...60 °C (-40...140 °F)
Storage temperature	-40...60 °C (-40...140 °F)
Protection rating	IP67
Lightning protection	Integrated protection against indirect lightning with a discharge capacity of 6 kA Ppp

Device specifications	
Housing material	Aluminium, powder coated
Size L x W x H	180 x 150 x 90 mm (7.09 x 5.91 x 3.54 inch)
Weight	1.48 kg (3.26 lb)



Dimensions MRL-6.1

7 Components

7.1 Terminals

The pin-layout of the MRL-6.1 is shown in Figure 2 and the terminals are listed in the table below.

ATTENTION Do not connect voltages higher than 30 V to any terminal! Excess voltages can impair the functioning of the MRL-6.1, destroy the device and may lead to injuries.

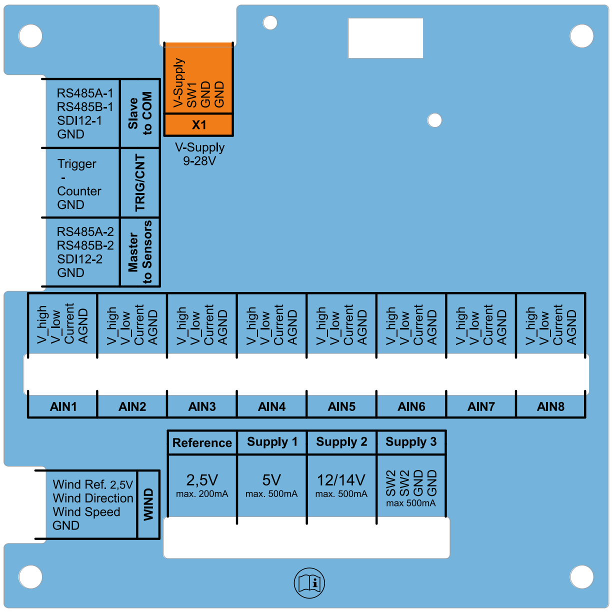


Figure 2 Connection terminals of MRL-6.1

Group	Pin	Description
X1	V-Supply	Supply voltage (+)
	SW1	inactive
	GND	Ground of SW1
	GND	Supply voltage (-)

Group	Pin	Description
Slave to COM (MRL-IE and MRL-IEa only)	RS485A-1	RS-485 A
	RS485B-1	RS-485 B
	SDI12-1	SDI-12 Slave
	GND	Ground of SDI12-1
TRIG/CNT	Trigger	Trigger input (MRL-IE and MRL-IEa only)
	-	not assigned
	Counter	Counter input
	GND	Ground
Master to Sensors	RS485A-2	RS-485 A Sensor input
	RS485B-2	RS-485 B Sensor input
	SDI12-2	SDI-12 Master
	GND	Ground of SDI12-2
WIND	2.5V	2.5 V reference voltage output
	Wind Dir	Wind direction (potentiometer) input
	Wind Speed	Wind speed input
	GND	Ground
AIN1 ... AN8	V_high	High voltage input
	V_low	Low voltage input
	Current	Current input
	AGND	Analog ground
Reference	2.5 V max. 200 mA	2.5 V sensor supply
		2.5 V sensor supply
		2.5 V sensor supply
		2.5 V sensor supply

Group	Pin	Description
Supply 1	5 V max. 500 mA	5 V sensor supply
		5 V sensor supply
		5 V sensor supply
		5 V sensor supply
Supply 2	12/14 V max. 500 mA	12/14 V sensor supply
		12/14 V sensor supply
		12/14 V sensor supply
		12/14 V sensor supply
Supply 3	SW2	Switched sensor supply
	SW2	Switched sensor supply
	GND	Ground
	GND	Ground

7.2 Analog output terminals (MRL-6.1a and MRL-6.1abt only)

The pin-layout of the analog ouput extension is shown in Figure 3

ATTENTION Do not connect voltages >30 V to any terminal! Excess voltages can impair the functioning of the MRL-6.1, destroy the device and may lead to injuries.

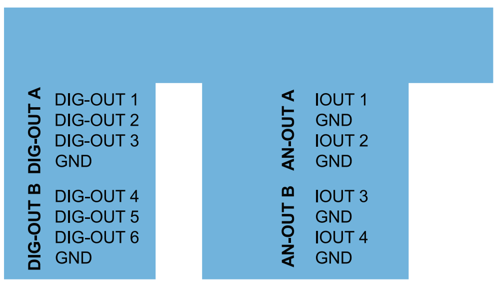


Figure 3 Connection terminals of the analog output extension

Group	Pin	Description
DIG-OUT A	DIG-OUT 1	Digital output (@ data logger supply voltage)
	DIG-OUT 2	Digital output (@ data logger supply voltage)
	DIG-OUT 3	Digital output (@ data logger supply voltage)
	GND	Ground
DIG-OUT B	DIG-OUT 1	Digital output (@ data logger supply voltage)
	DIG-OUT 2	Digital output (@ data logger supply voltage)
	DIG-OUT 3	Digital output (@ data logger supply voltage)
	GND	Ground
AN-OUT A	IOUT 1	Analog current output (4 ... 20 mA)
	GND	Ground
	IOUT 2	Analog current output (4 ... 20 mA)
	GND	Ground
AN-OUT B	IOUT 3	Analog current output (4 ... 20 mA)
	GND	Ground
	IOUT 4	Analog current output (4 ... 20 mA)
	GND	Ground

8 Installation

8.1 Where should I install the MRL-6.1?

The MRL-6.1 has been designed for applications in harsh environments. With its IP-67 protection rating it can be installed directly at the measurement facility.

If additional control and acquisition devices are used, the MRL-6.1 may also be mounted in a suitably sized cabinet.

> **ATTENTION** If the MRL-6.1 is installed outdoors, make sure the device cover and cable glands are tightened firmly and that unused glands are replaced with watertight blanking plugs (see accessories list in Unpacking).

8.2 Required tools and equipment

Prepare the following tools and equipment to install the MRL-6.1:

- 1x 5 mm Philips or flat screw driver (depending on mounting bolts)

8.3 How do I install the MRL-6.1?

8.3.1 Mounting

The MRL-6.1 can be mounted to a mounting plate of an electrical cabinet or any other back-plate with four M5 cylinder head screws with hexagon or torx socket or M4 cylinder head screws with simple or cross slot. The mounting holes can be accessed by removing the cover strips on both sides of the MRL-6.1 (see figure below).

8.3.2 Power supply

The MRL-6.1 can be powered with a 9...28 VDC power supply connected to terminal X1. It consumes a minimum of 0.5 mA at 12 V; the actual consumption depends on the connected sensors and their power requirements.

8.3.3 Signal cables

Please consider the maximum cable lengths for the applied transmission protocol:

Protocol	Max. cable length
SDI-12	~60 m (depending on wire cross section and number of sensors)
RS-485	~300 m

NOTE Cable lengths longer than 60 m require a heavier gauge wire if the power supply drops below 11 V.

The analog outputs of the optional analog output board (included in the MRL-6.1a) accept an electrical load of max. 250 Ω at 9 V, 380 Ω at 12 V and 900 Ω at 24 V (including wires, shunt resistor, etc). The loads on the digital outputs are restricted to 69 ... 10'000 Ω at 9 V, 92 ... 10'000 Ω at 12 V and 185 ... 10'000 Ω at 24 V.

8.3.4 Surge protection

Direct and indirect lightning strikes can damage or destroy the data logger. Carefully selected and designed measurement sites reduce this risk. For proper surge protection please consult the applicable regulations in your country, an expert in lightning protection or SOMMER Messtechnik.

9 Operation

9.1 Status of LEDs

The LEDs on the front panel of the MRL-6.1 indicate the device status. The meaning of each LED and its flashing sequence are described below.

Active	Description
● (grey)	Device in sleep mode
● (green) 3s ● (grey) 3s ● (green)	Continuous measurements active
Status	**Description**
● (grey)	Bluetooth in standby or not installed
● (yellow) 3s ● (grey) 3s ● (yellow)	Bluetooth connected
Error (only during active measurements)	**Description**
● (grey)	No error
● (red) 3s ● (grey) 3s ● (red)	Error on last measurement

9.2 How to open the data logger housing

The data logger has a waterproof design which requires the sensors, SIM card and MicroSD card to be connected internally.

> ⚠ **ATTENTION** To avoid any damage disconnect the power supply before opening the housing!

To open the housing remove the cover strips on both sides of the data logger and loosen the four bolts with a Philips or flat-head screwdriver. Then, remove the lid by turning it carefully upside down. Be careful not to strain any signal wires.

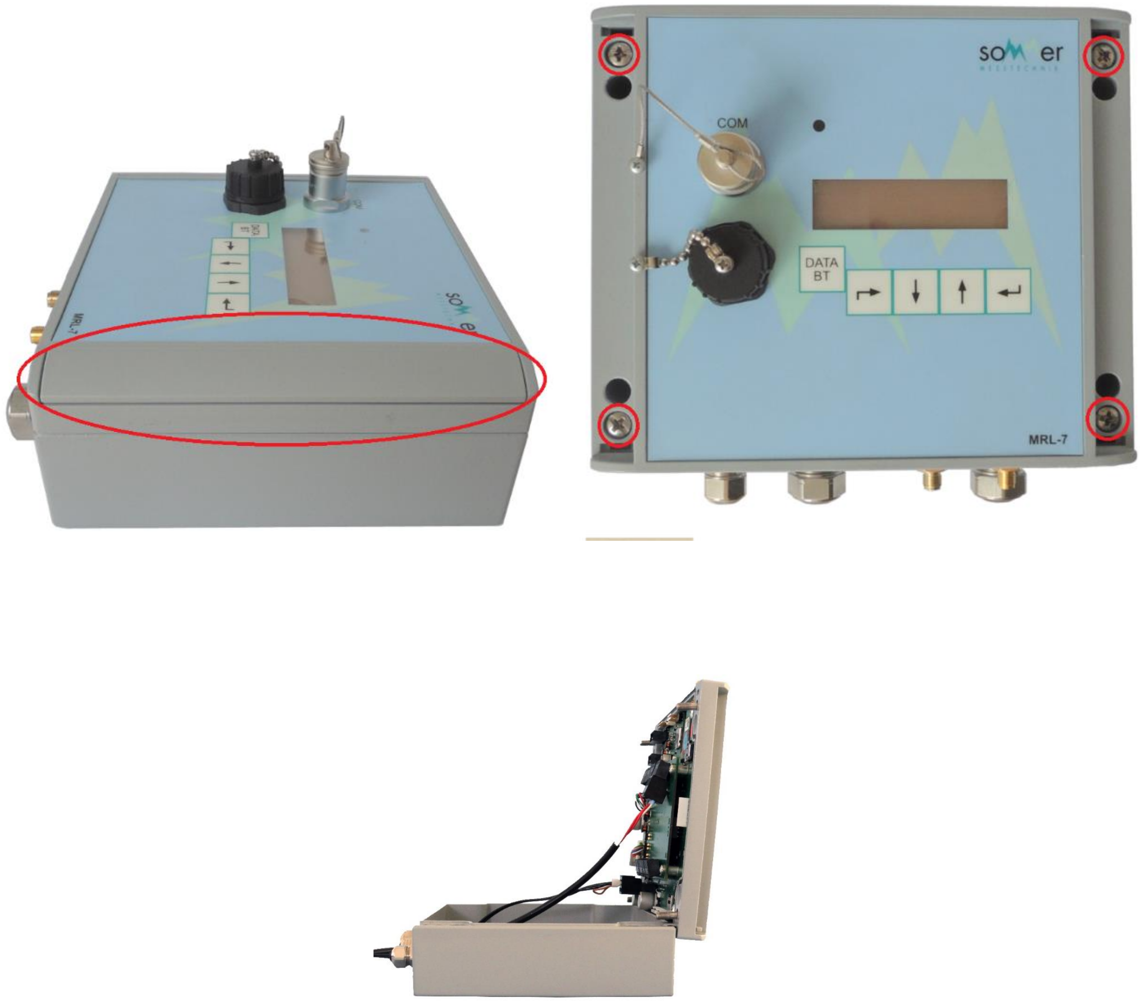


Figure 4 Open the MRL-6.1 housing

> **ATTENTION**
> Before closing the data logger make sure that the rubber seal is not broken and firmly sitting in its groove!
>
> When closing, tighten diagonally positioned screws step by step!

9.3 How to use the spring clips

To connect a sensor to the MRL-6.1, 2- or 4-pin spring clips as shown in Figure 5 are used.

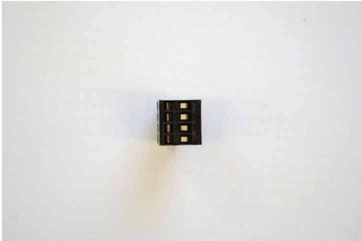
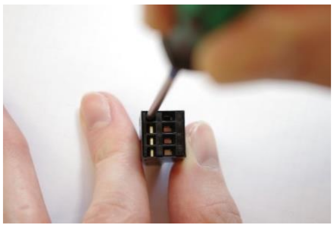
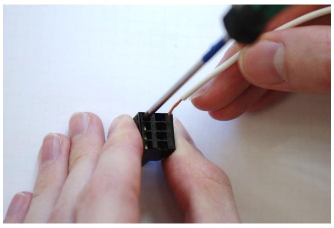


Figure 5 4-pin spring clip

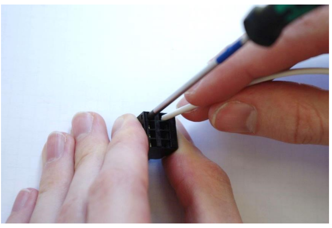
After removing the spring clip from the data logger, the sensor wires are connected in the following way:



Push a 2-mm flat-head screwdriver into the spring slot to open the connection terminal.

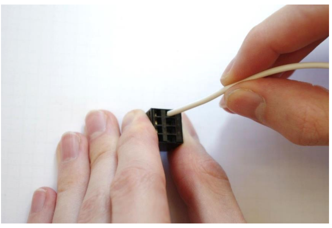


Insert the wire into the connection terminal.



Make sure the wire is inserted down to the bottom of the connection terminal.

ATTENTION Make sure the spring clip connects on the bare wire and not on the wire insulation!



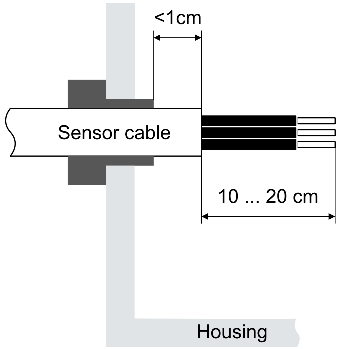
Pull out the screwdriver and verify that the wire is fixed firmly.

9.4 How to connect a sensor

To connect a sensor to the MRL-6.1 follow the steps described below:

1. Open the housing as describes in How to open the data logger housing
   Feed the sensor cable through the cable gland.
2. Strip 10 ... 20 cm of the cable insulation. The insulated cable should protrude max. 1 cm into

the housing.



3. Connect the cable wires to the specified terminals (see Terminals). For handling the spring clips see How to use the spring clips.
4. After closing the data logger, carefully tighten the cable glands.

9.5 How to wire analog outputs

Only applicable to MRL-6.1a and MRL-6.1abt. The 4 ... 20 mA outputs can be wired to any data acquisition device that accepts current or voltage inputs. The latter may require a precision shunt resistor – 100 Ω is generally adequate – to convert the current into a voltage signal. The diagram below shows an example of the wiring between the MRL-6.1a and a data logger. See Analog outputs (MRL-6.1a and MRL-6.1abt only) for configuration of the analog outputs.

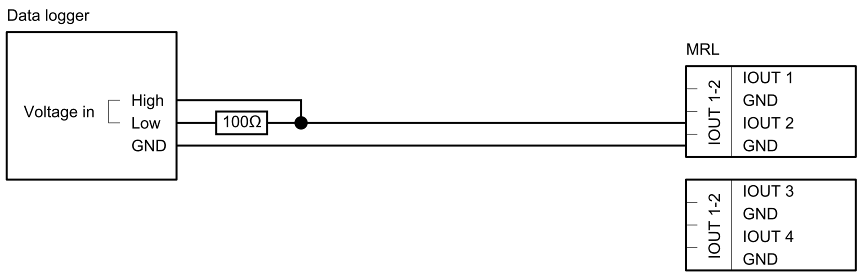


Figure 6 Wiring of an analog output to a data logger

9.6 How to wire digital outputs

Only applicable to MRL-6.1a and MRL-6.1abt. The digital outputs can be wired to any data acquisition device that accepts voltage and/or counter inputs. The diagram below shows an example of the wiring between the MRL-6.1a and a data logger. See Digital output settings (MRL-6.1a and MRL-6.1abt only) for configuration of the digital outputs.

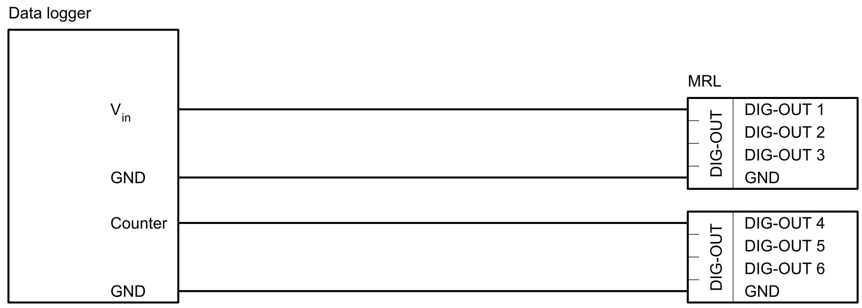


Figure 7 Wiring of a digital output to a data logger

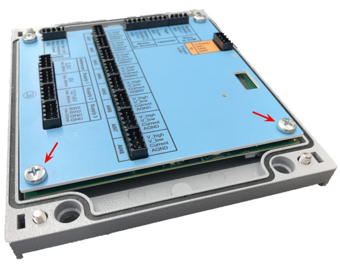
9.7 How to set the clock

The time of the MRL-6.1 can also be synchronized manually by clicking Set device time in the Commander Parameters (F2) tab.

> **ATTENTION** If the internal lithium button cell battery is replaced, the current device time is lost and needs to be re-synchronized!

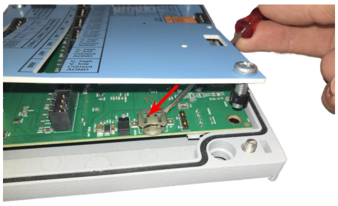
9.8 How to replace the internal lithium battery

The 3V lithium button cell battery of type CR1225 supplies the internal clock if the MRL-6.1 is not powered. Perform the following steps to replace the battery:

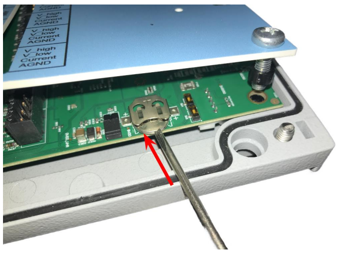


Unpower the device, open it and loosen the two bolts on the lithium battery side of the print.

Gently lift the label-sheet with your fingertips.



Push the lithium button cell battery with a small screwdriver out of its clip.



Insert the new battery, + is facing upwards, with your finger tips or a small screwdriver into its clip.
Gently tighten the bolts of the prints and close the device housing.

10 Maintenance

The MRL-6.1 does not require any special maintenance other than the occasional replacement of the supply battery of the MRL-6.1. The lithium button cell battery lasts approx. 10 years if the MRL-6.1 is not powered, and generally does not require replacement with a powered device.

10.1 Calibration

Re-calibration of the AD-converters strongly depends on the handling of the data logger, its duty time and the demands on accuracy of the acquired measurements. Generally, re-calibration is required after approx. 10 years of operation. Please contact Sommer Messtechnik for this service.

11 Support software Commander

11.1 Software features

The Commander is a multipurpose software tool to configure and operate any Sommer Messtechnik device. It offers the following functions:

- Communication with Sommer Messtechnik sensors and data loggers via serial connection, modem, socket, IP-call and Bluetooth®
- Management of connections and stations
- Configurations of sensors and data loggers
- Live data monitoring and storage
- Data management including download from data loggers and transmission to MDS (Measurement Data server)
- Terminal window to check data transfer and to access device settings directly

11.2 System requirements

The Commander software supports 32- and 64-bit versions of Windows 7 SP1, Windows 8, Windows 8.1, Windows 10 and Windows 11.

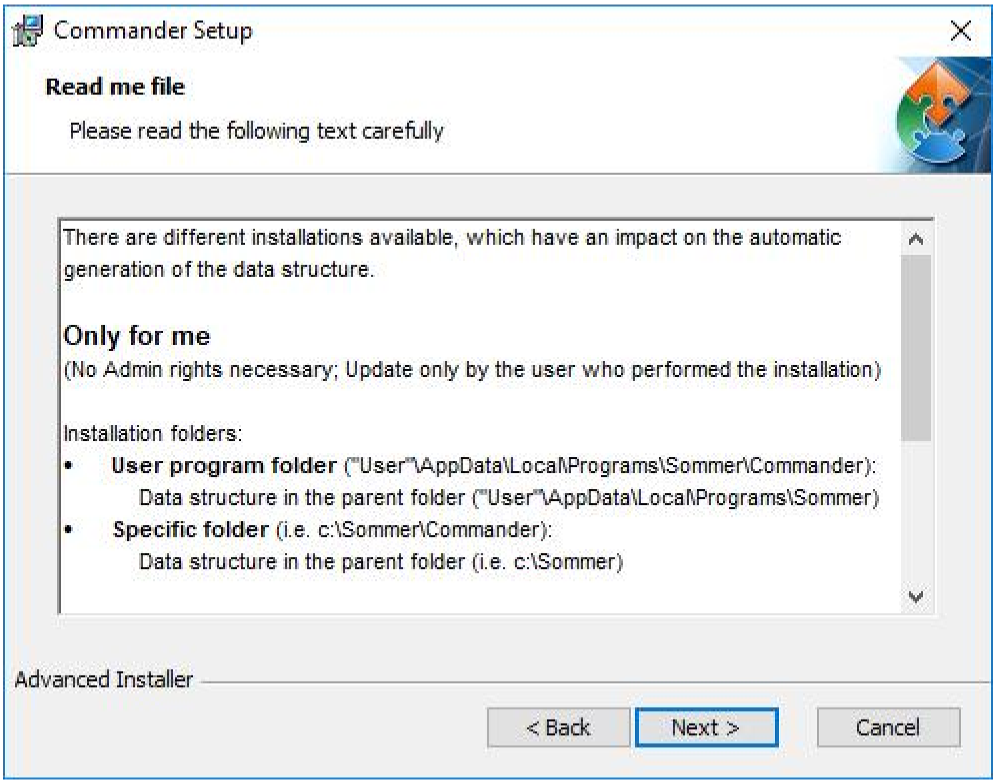
For correct operation Microsoft® .NET Framework 4.5 or later must be installed.

11.3 Installation of Commander

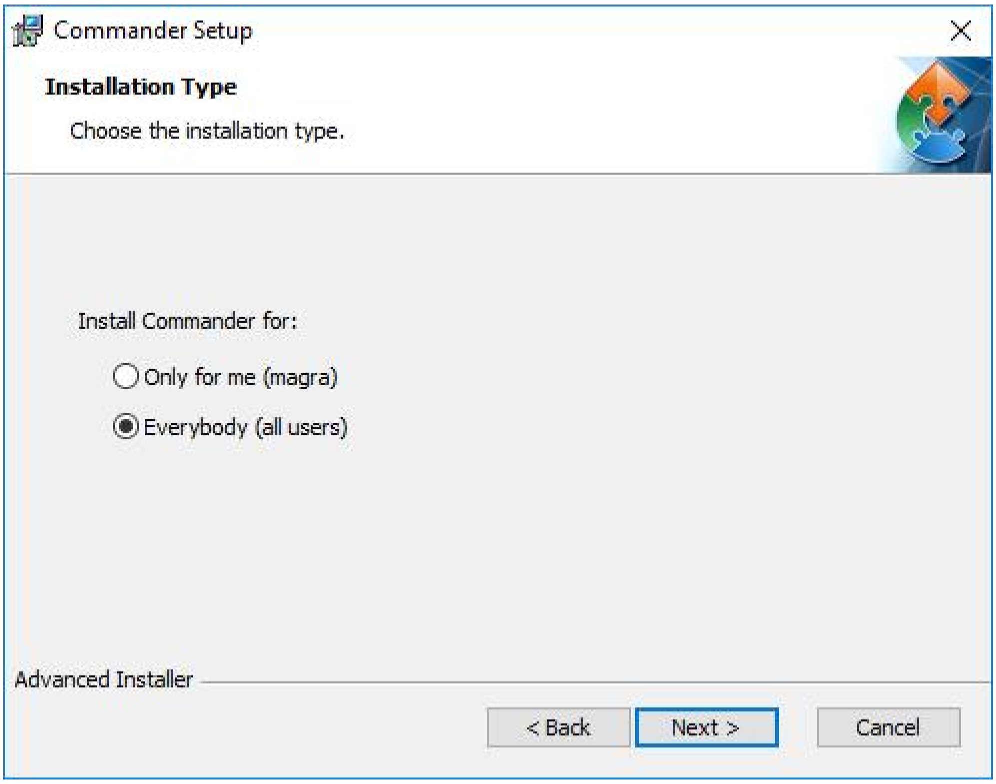
Follow the steps below to install the Commander software:

1. Plug the USB stick shipped with the device into your PC.
2. Double-click the commander.msi installer file on the USB drive.
3. Click Next on the pop-up window

4. Read the instructions and click Next



5. Select the installation type and click Next



NOTE

Two installation types are available. Depending on the selection, the access rights and the folder structure differ:

Only for me

No admin rights are required. Updates are only available to the user who installed the software.

Installation folders:

- User program folder:
  Users\User\AppData\Local\Programs\Sommer\Commander
  Data structure:
  Users\User\AppData\Local\Programs\Sommer
- Specific folder (default):
  C:\Sommer\Commander
  Data structure (default):
  C:\Sommer

Everybody

Admin rights are required. Updates may only be performed by system administrators.

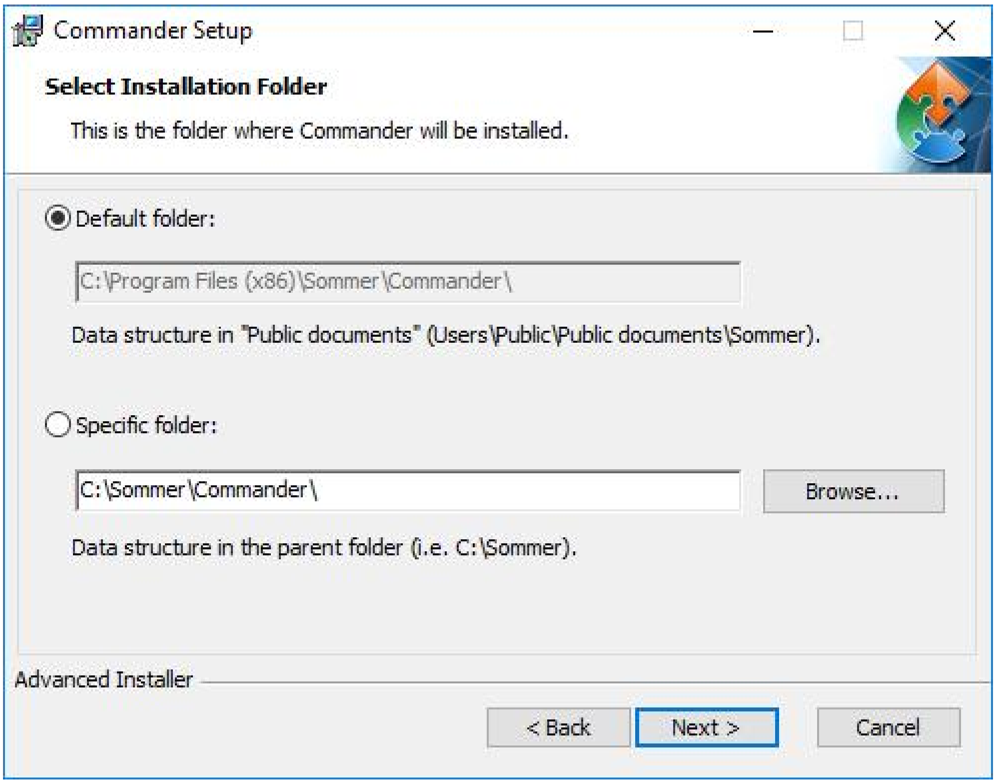
Installation folders:

- Standard program folder:
  Program Files (x86)\Sommer\Commander

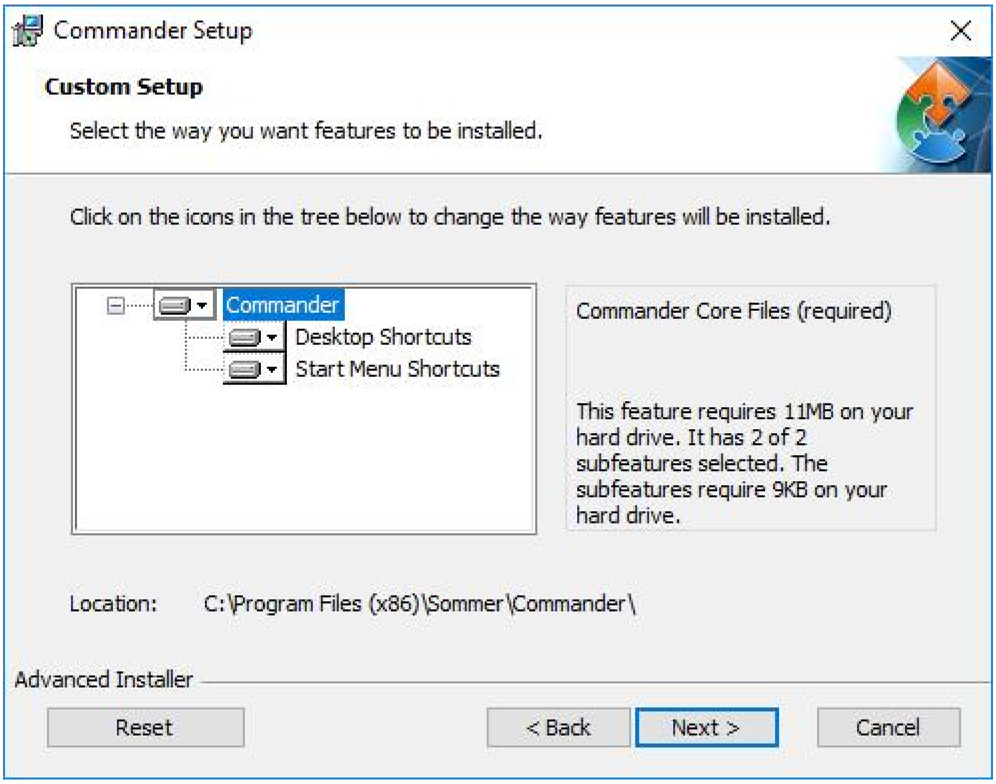
Data structure:
Users\Public\Public documents\Sommer

- Specific folder (default):
  C:\Sommer\Commander
  Data structure (default):
  C:\Sommer

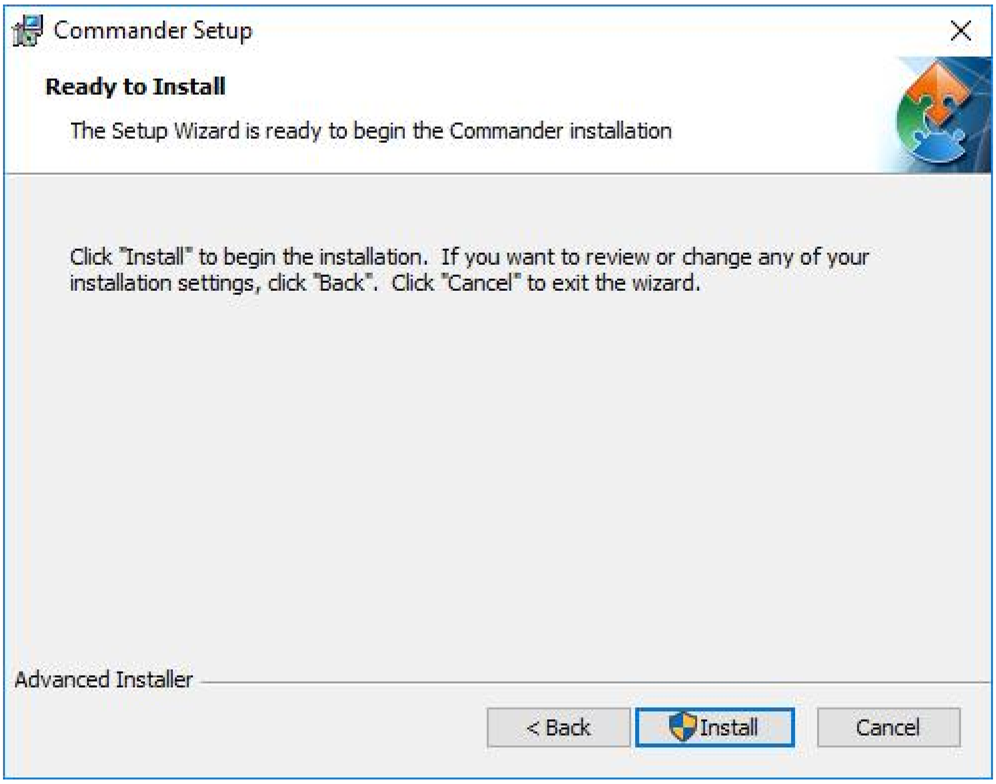
6. Select the installation directory and click Next.



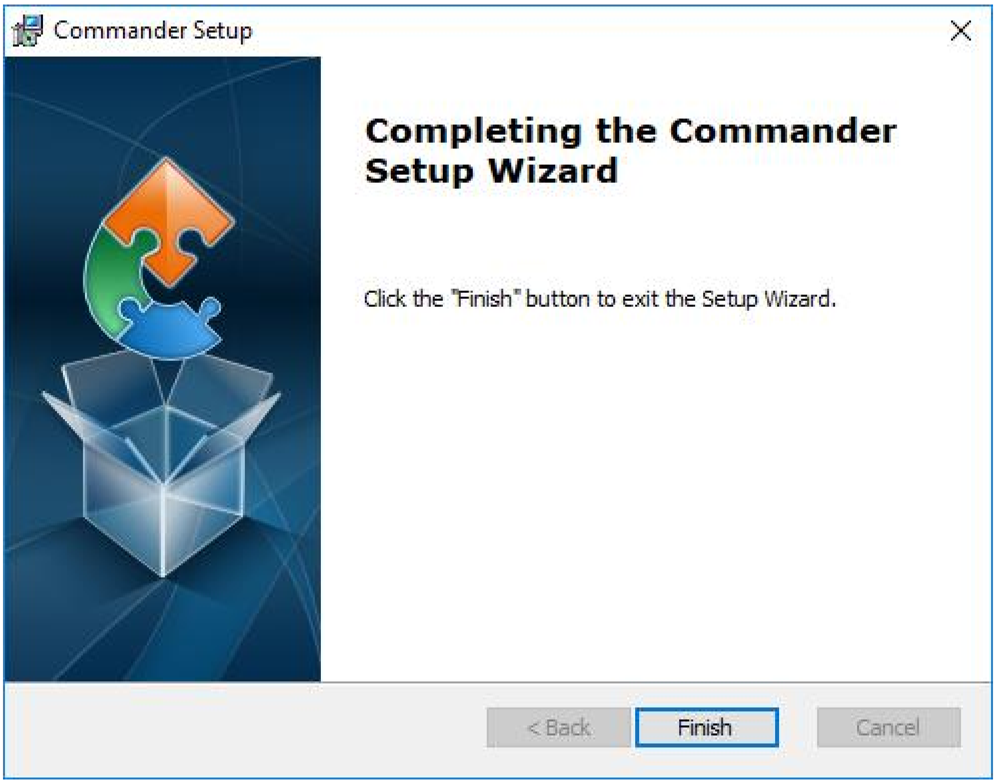
7. Select the features to be installed and click Next.



8. Click Install to start the installation.



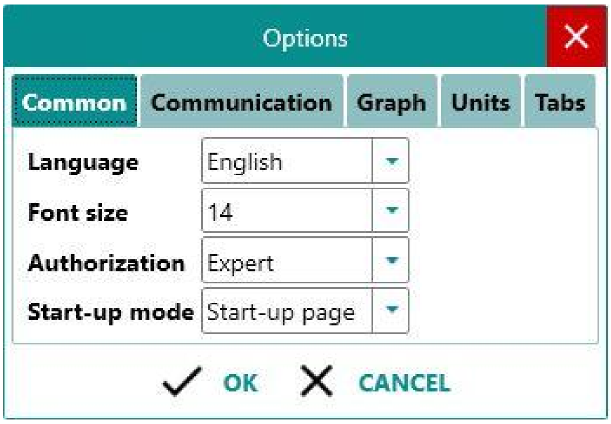
9. Click Finish to complete the installation.



11.4 Change authorization

To prevent unintended changes of parameters in the Technics menu authorization is generally set to *Normal*. Parameter modifications in Technics are enabled by switching the authorization level to *Expert* as described below:

1. On the upper tab bar click on Options and select Common.
2. In the Options window select authorization *Expert* and click OK.



11.5 Working with connections

11.5.1 Establish a connection with the Communication assistant

1. Install the Commander support software as described in Installation of Commander.
2. Connect the device to your PC.
3. Start the Commander software on your PC.
4. Click on Communication assistant on the right-hand side of the Commander window and follow the instructions. During this procedure the communication assistant will search for connected devices. Upon successful completion, the new connection is added to the connections list (tab Connections (F8)).
5. In the Communication section at the right-hand side of the Commander window select Mode Connection and the previously created connection from the drop-down list.
6. Click Connect to establish a connection with the MRL-6.1. If the connection was successful a green icon is displayed at the top-right corner of the Commander window.

To view the settings of the connected device or to read the current measurements, follow the steps described in Download setup and Record measurements.

11.5.2 Establish a connection manually

1. Install the Commander support software as described in Installation of Commander.
2. Connect the device to your PC.
3. Start the Commander software on your PC.
4. Select the required connection in the Connections list of the Connections (F8) tab and click Connect. If the connection was successful a green icon is displayed at the top-right corner of the Commander window.
   If you don't have the required connection available in the Connections list, create a new connection as described in Create a new connection.

To view the settings of the connected device or to read the current measurements, follow the steps described in Download setup and Record measurements.

11.5.3 Create a new connection

1. Select the Connections (F8) tab in the Commander.
2. Click New connection.
3. In the section Connection settings enter a name of the new connection, e.g. *Serial-com1-9600*, and the connection type, e.g. *Serial connection*.

4. Enter the required information for the selected connection type.
   If your MRL-6.1 is wired to your PC with a RS-232 to USB converter cable, select the port where the device is connected and select a Baud rate of 115200.

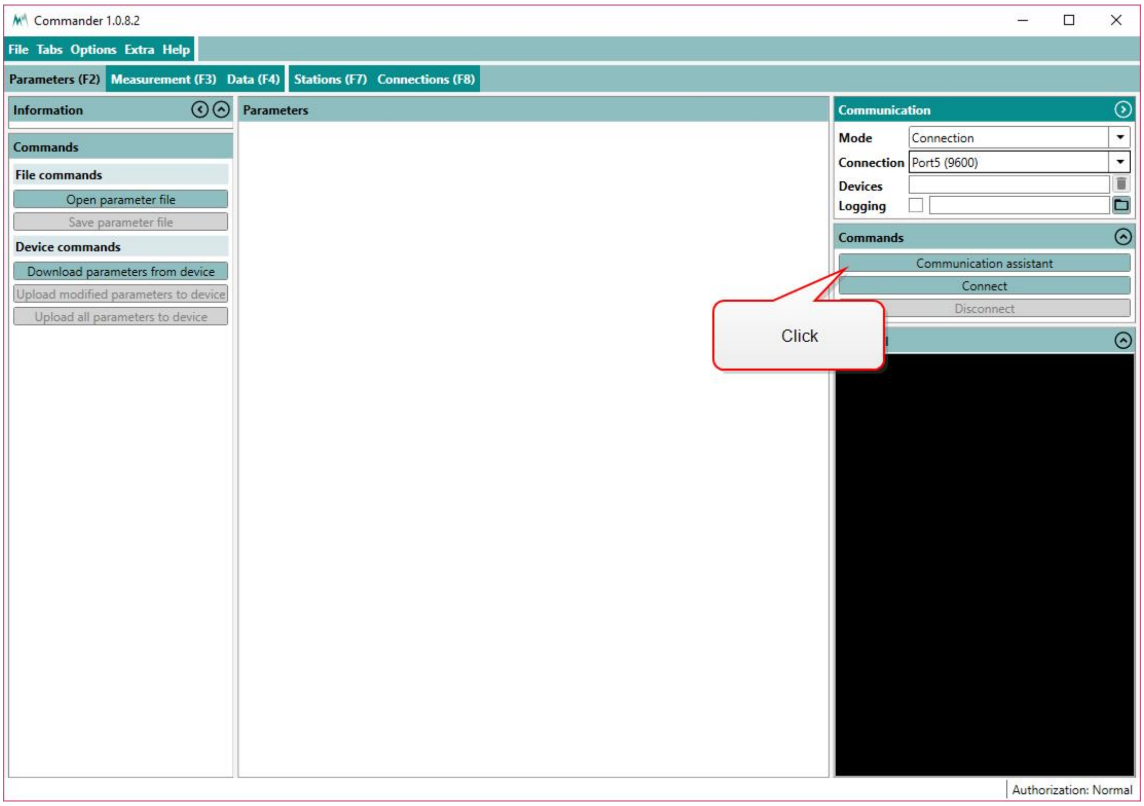
11.6 Working with stations

11.6.1 Create a station with the Communication assistant

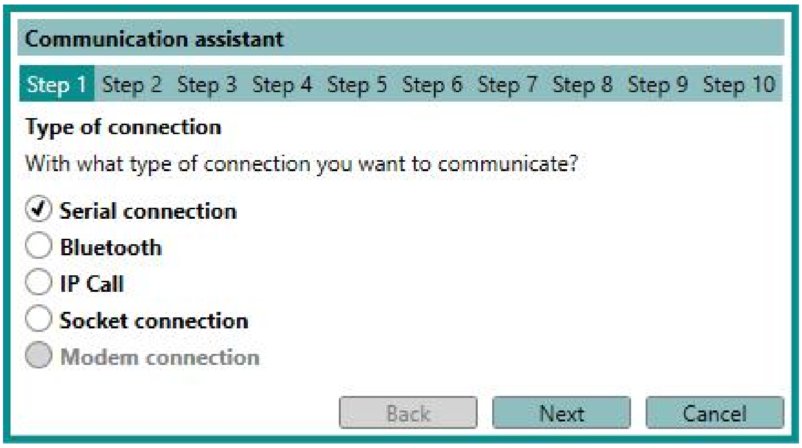
In order to manage several data loggers, to connect to a data logger via IP-call and to download data, stations can be created in the Commander software. To view a list of all stations select the tab Stations (F7).

Perform the following steps to create a new station with the Communication assistant:

1. Click on Communication assistant in the Commander-window

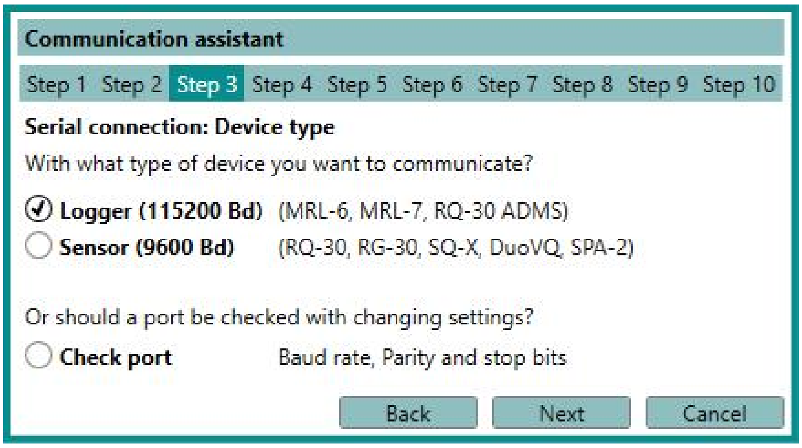


2. In the pop-up window choose the required connection and click Next.

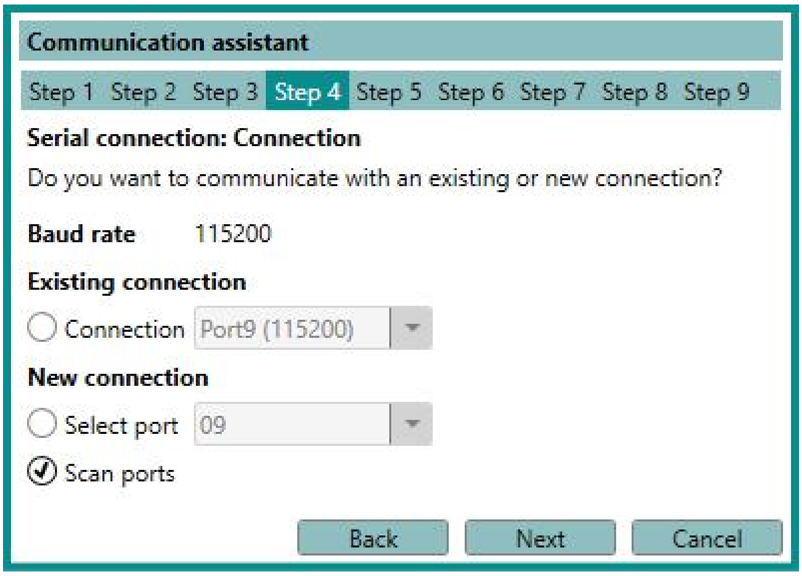


3. Verify that the MRL-6.1 is connected to your PC and a power supply. Click Next.

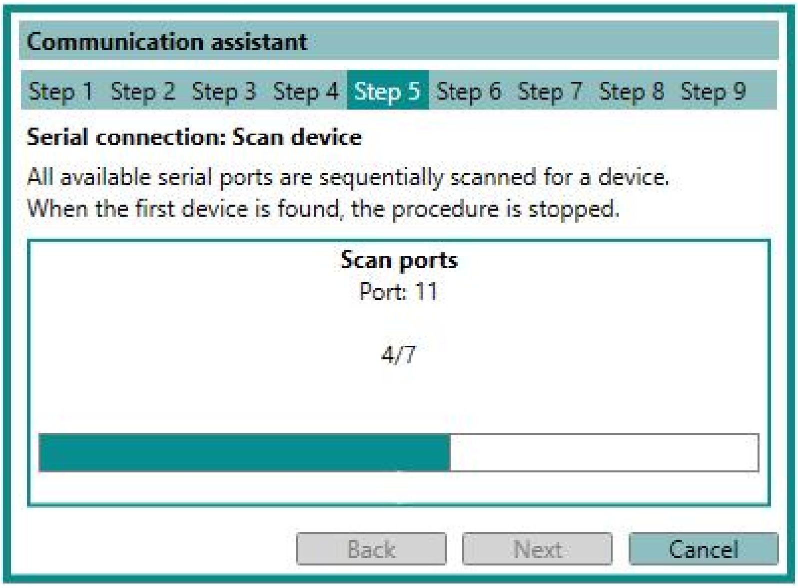
4. Select *Logger (115200 Bd)* and click Next.



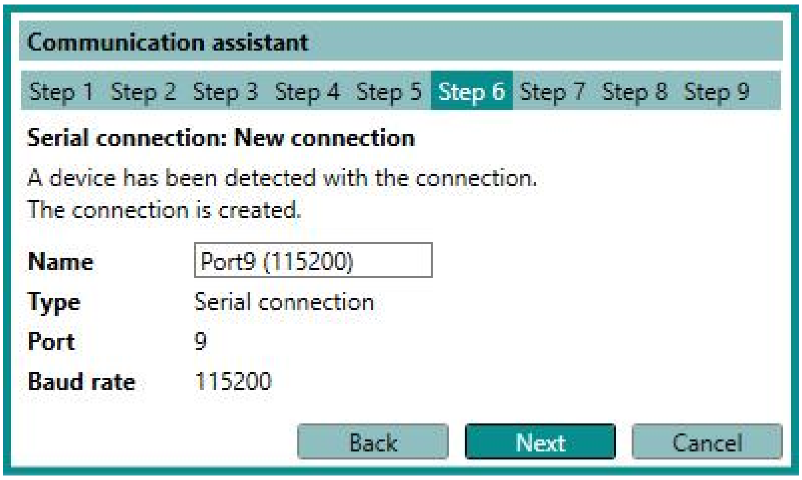
5. Select *Scan ports* and click Next.



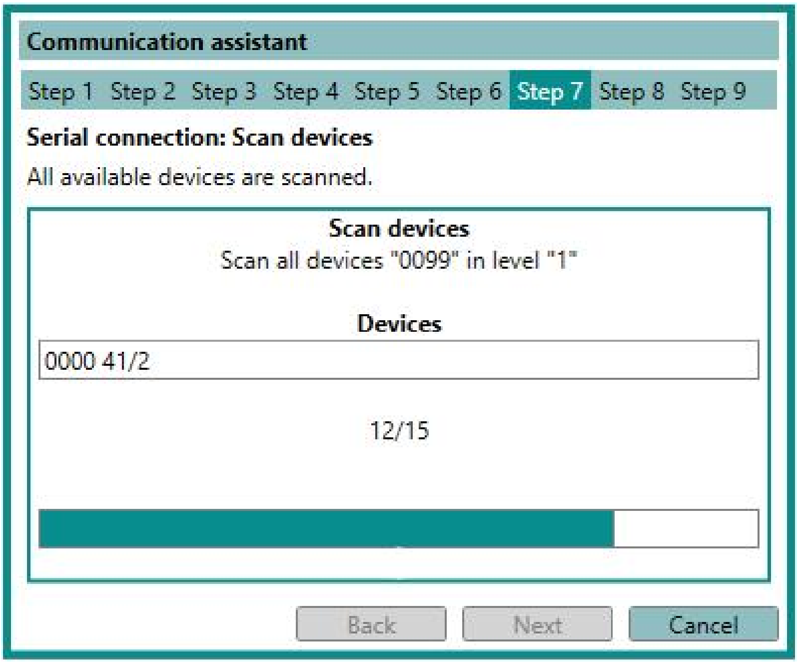
6. The Commander now scans all available ports.



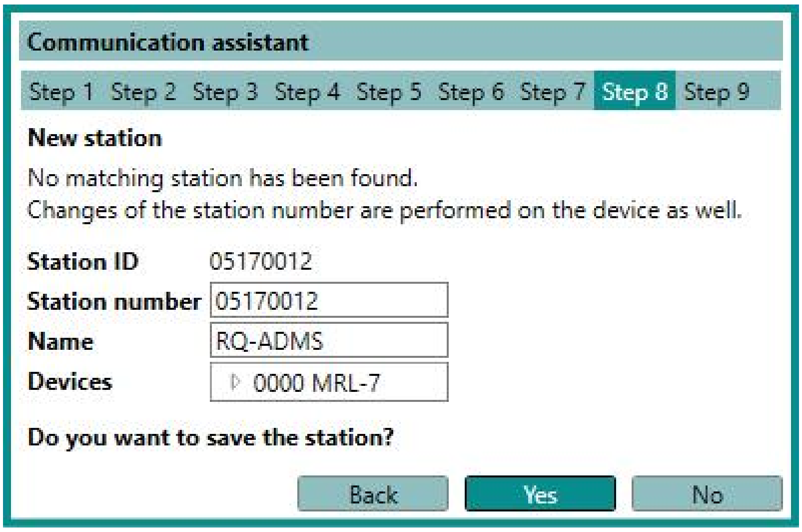
7. Adopt the *Name* provided by the communication assistant. Click Next.



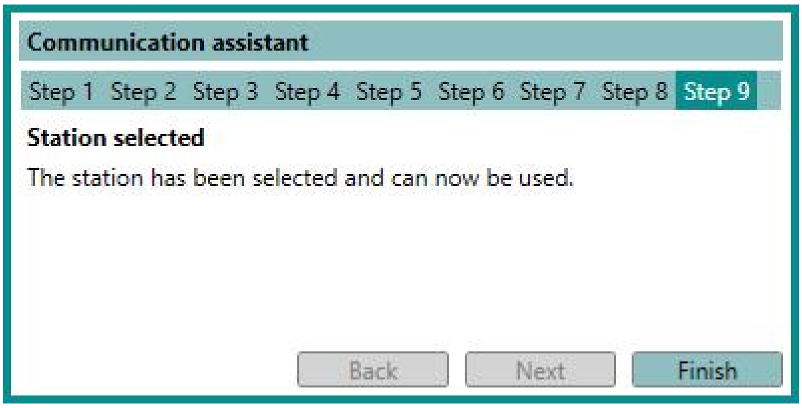
8. The Commander now scans the selected port for connected devices.



9. Adopt the *Name* of the new station or enter a new name. Click Next.



10. A new station has now been created. Click Finish.



11. The newly created station can now be selected in the Communication section of the Commander. Click Connect to activate the connection to your device.

11.6.2 Create a station manually

In order to manage several data loggers, to connect to a data logger via IP-call and to download data, stations can be created in the Commander software. To view a list of all stations select the tab Stations (F7).

Perform the following steps to create a new station:

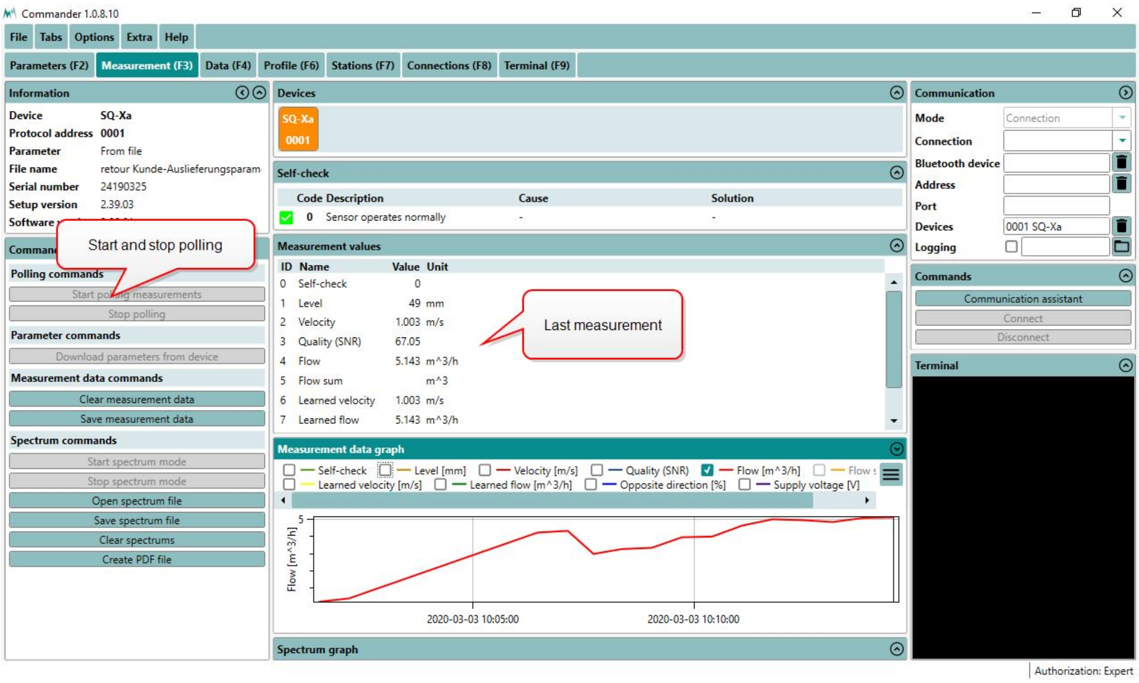
1. In the tab-menu Stations (F7) click New station.
2. Under Station settings enter the Station number and Sommer ID. By default both settings are set to the device's serial number (visible on the MRL-6.1 housing).
3. Select the Connections used for the station. Multiple selections are possible; the default connection can be selected by ticking the circular field.
4. Depending on the connection type, enter the additional information, e.g. Address for a Bluetooth connection or IMSI number for an IP call.

5. Enter the settings for Data management.When data are downloaded from a connected MRL-6.1 they are stored in an archive-file by default. Each archive-file contains the data of a year or month, as selected in Archive type. Selection *None* will save all data in one file.The default location for data files is C:\Users\Public\Documents\Sommer\Data\.
6. Save the newly created station with the button Save station.

11.7 Working with measurements

11.7.1 Poll continuous measurements

1. Establish a connection to your device as described in Working with connections.
2. Download the setup of your device as described in Download setup.
3. Select the Measurement (F3) tab.
4. In the Commandssection click Start polling measurement.
5. Select the option Polling with measurements. Now, the Commander will trigger measurements of the MRL-6.1 without any delays between measurements. The results are displayed Measurement values and plotted in the Measurement data graph.
6. To finish polling mode click Stop polling.



NOTE The polling mode stops automatically after 30 minutes.

11.7.2 Record measurements

1. Establish a connection to your device as described in Working with connections.
2. Download the setup of your device as described in Download setup.
3. Select the Measurement (F3) tab.
4. Make sure that Measurement output is set to *Measured values push* or *Storage values push*.
5. If the connection with your device is active, the data will now be displayed in the measurement table and updated at the interval specified in the setup. Also, the incoming data strings are displayed in the Terminal.
6. Click Save measurement data in the Commands section to save the recorded measurements. The data are saved as a *.csv file in the SommerXF format.

11.8 Working with data

11.8.1 View live data

Follow the steps below to view live data acquired from your device:

1. Establish a direct or remote connection with the MRL-6.1 using the Commander. Use an existing Commander-connection or -station if available.
2. In the Parameters (F2) tab download the parameters of the MRL-6.1.
3. Now, there are two options to view the measurement data:
   1. If Measurement output is set to *Measured values push* or *Storage values push*, data are displayed in the Measurement (F3) tab in the specified measurement interval.
   2. Open the Measurement (F3) tab and click Start polling measurements. With this option measurements are triggered in the fastest possible sequence and the results are displayed instantly. This measurement mode can be stopped by clicking Stop polling, or it is finished automatically after 30 minutes.

11.8.2 Collect measurement data

Follow the steps below to collect data with the Commander software:

1. Establish a direct or remote connection to your Sommer Messtechnik data logger using the Commander. Use an existing Commander-connection or -station if available.
2. If no station has been defined for your data logger, create one as described in Create a station with the Communication assistant.
3. Open the Data (F4) tab and select your station.

4. Click Transfer data manually. In the pop-up window the available data are displayed by the timestamps on the left and right, which correspond to the oldest and most recent data records. Move the slider to the time from which data need to be collected and press OK. Depending on the number of records to be downloaded this may take a few seconds or several minutes.
   The downloaded data are stored as csv- files in the default installation path of the Commandersoftware, generally C:\Users\Public\Documents\Sommer\Data, or in a subfolder as specified in the station (Archive subfolder in Station settings).

   > NOTE If a station has been defined, data since the last transfer can be downloaded.

5. After download is complete, the data are displayed in the graph of the Data (F4) tab. See View collected data for some features of the graph-tool.

11.8.3 View collected data

Follow the steps below to view collected data with Commander:

1. Once measurement data have been collected, open the Data (F4) tab and click Open data file to select the file you want to view. The data are now loaded and displayed in the graph.

Several actions can be used to navigate within the graph:

- Select a data window by pressing the right mouse button and spanning a rectangular box.
- Select a certain time range by moving the mouse over the time axis with the right mouse button pressed.
- Select a certain value range by moving the mouse over the value axis with the right mouse button pressed.
- View all data by pressing the right mouse button within the graph pane.

> NOTE Collected data are stored in the SommerXF format, a semicolon-delimited csv-file, which can be viewed with any text editor or spreadsheet tool.

11.9 Working with setups

11.9.1 Download setup

1. Establish a connection to your device as described in Working with connections.
2. Select the Parameters (F2) tab in the Commander software.

3. In the Commands section click Download parameters from device.
   The Commander now downloads the setup currently active on the MRL-6.1. This may take some time if you are downloading the setup for the first time to your PC. Consecutive downloads of a setup with the same version number will be faster as the parameter structure is already available.

You can now save the setup file by clicking Save parameter file, or edit the settings as described in Edit setup.

> **TIP** Save the setup on your PC before you make any changes!

11.9.2 Open a setup file

1. Start the Commander on your PC and connect to your MRL-6.1 either directly with the USB to RS232 converter cable or the optional Bluetooth connection.
2. Open the Parameters (F2) tab and click Open parameter file. Select the required file (extension .xmld or .xmla).
3. Verify the new settings and click Upload all parameters to device. After completion the new settings are active on your data logger.

11.9.3 Edit setup

1. Open the setup file as described in Open a setup file or download it from your device as described in Download setup.
2. Adapt the values of the settings in question and press Enter after each. After you have changed a value, its text box will turn red.

   > **NOTE** If you have entered a value outside the data range of the setting, it will be forced to the next valid value! The valid range of each setting is listed in the Parameter definitions.

3. After you have adapted all required settings save the setup file and/or upload the setup to your device by clicking Upload modified parameters to device.
   Once the setup has been saved or uploaded, the modified red text boxes will turn white again, indicating that the settings have been saved/applied.

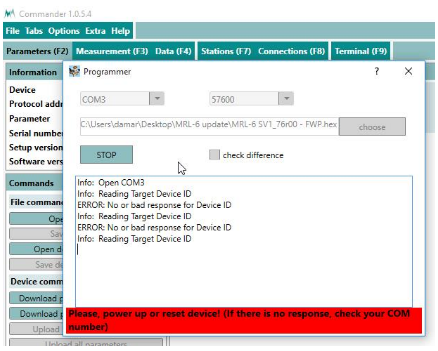
11.9.4 Upload new setup file

1. Establish a connection to your device as described in Working with connections.
2. Select the Parameters (F2) tab.
3. Download the setup currently on the MRL-6.1 as described in Download setup and save it by clicking Save parameter file. This step is recommended to have the latest setup available for documentation.
4. Click Open parameter file and select the required setup file (*.xlmd) on your PC.
5. Click Upload all parameters to device. This transfers the current setup to the MRL-6.1.
6. To verify the correct upload click Dowanload parameters from device. This will display the present setup of the MRL-6.1.

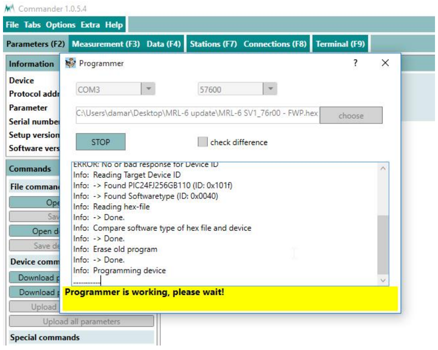
11.10 Update firmware

1. Connect the MRL-6.1 to your PC with the USB to RS232 converter cable.
2. Make sure no connection is active in the Commander (no green icon at the top-right corner).
3. Click on the menu item Extra and select Start Programmer.
4. Select the firmware file (*.hex) provided by SOMMER Messtechnik. Make sure the file is stored on your PC and not on a USB or network drive.
5. Choose the COM-port the data logger is connected to and a Baud-rate of 57'600.
6. Perform the following three steps in short sequence:
   - Click Program
   - Unpower the data logger
   - Wait 3…5 seconds to enable full activation of the bootloader and a correct restart (capacitors must be discharged, and if the device had been in sleep mode, this can take some time)
   - Repower the data logger

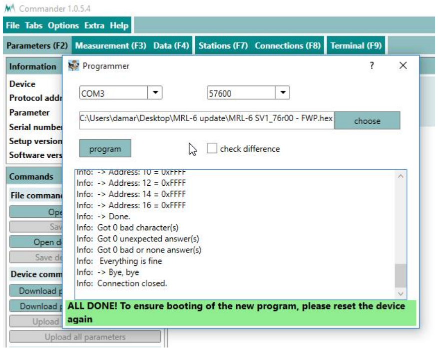
   The firmware currently present on the data logger is now erased and the new one copied to the data logger. During the update process the pop-up window may show the following messages:



The programmer is not ready; power needs to be on.



The programmer is active.



The firmware update has finished.

7. Close the programmer-window as soon as the firmware update has finished.
8. Switch off and repower the data logger again.
9. Open the Parameters (F2) tab.
10. Click Download parameters from device. The download of the new parameter list might take a few minutes as the parameter structure may need to be downloaded as well. After completion the new firmware and setup versions will be displayed in the Information section.

11.11 Set the device time

1. Establish a connection to your device as described in Working with connections.
2. Download the setup of your device as described in Download setup. The current time of the device is displayed in the Information section.
3. Click Set device time to synchronize the time of the device.

12 Communication with the MRL-6.1

12.1 Options

The following options can be used to communicate with the MRL-6.1:

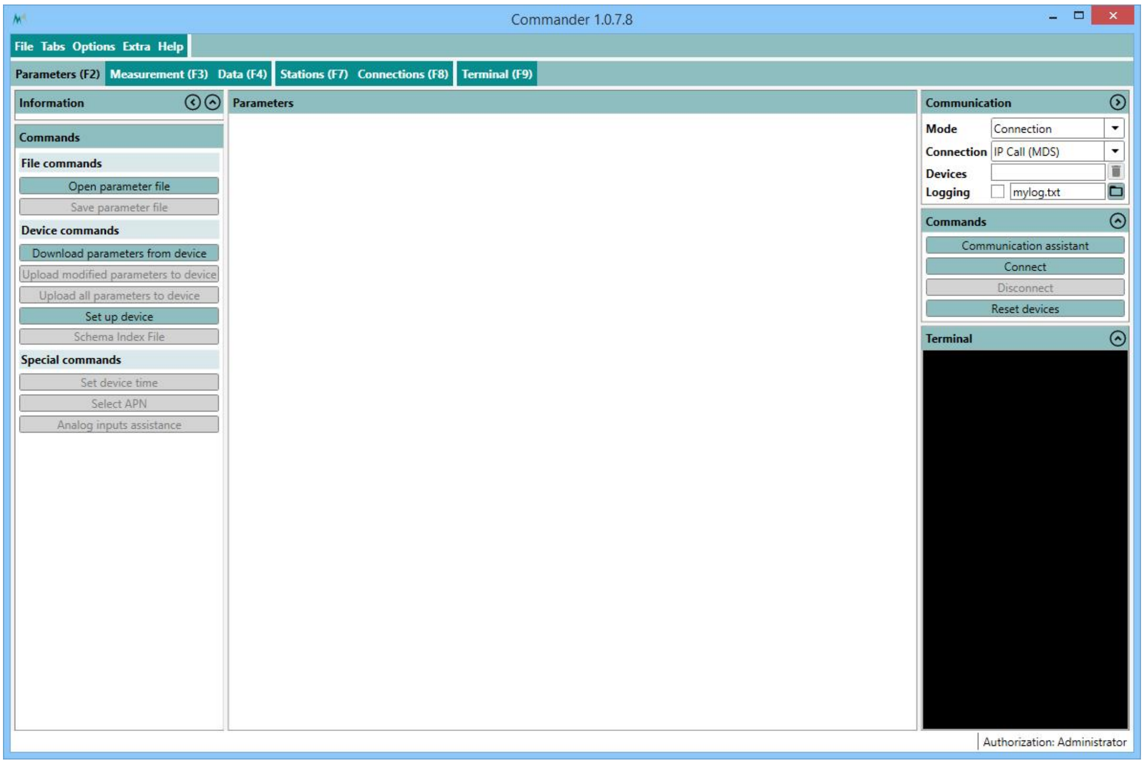
- RS-232 using an USB converter (available as an accessory)
- Bluetooth (MRL-6.1bt and MRL-6.1abt)
- Radio connection

All these options require the Commander software. Alternatively, a terminal editor can used to communicate with the data logger.

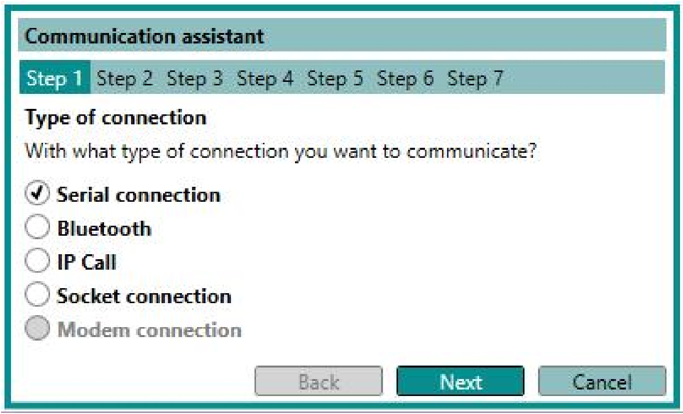
12.1.1 RS-232 using an USB converter

Perform the following steps to set up the communication between the MRL-6.1 and your PC:

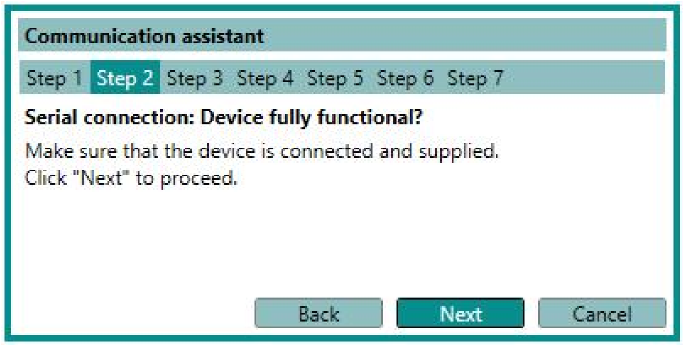
1. Install the Commander software on your PC.
2. Connect the provided USB to RS-232 converter to your PC. If required, install the driver of the USB to RS-232 converter.
3. Start the Commander software.
4. Click on Communication assistant on the right-hand side of the Commander window.



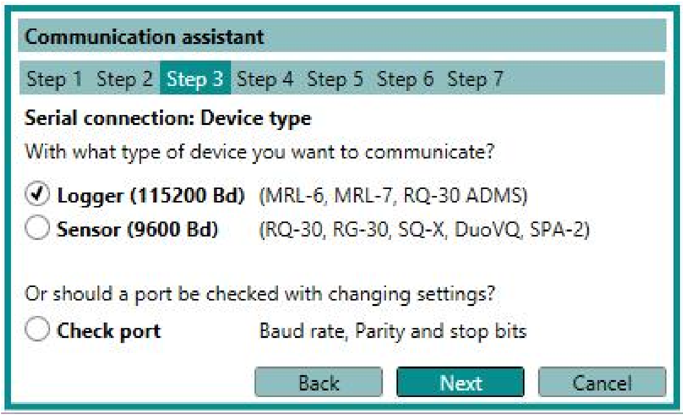
5. Select *Serial Connection* and press Next.



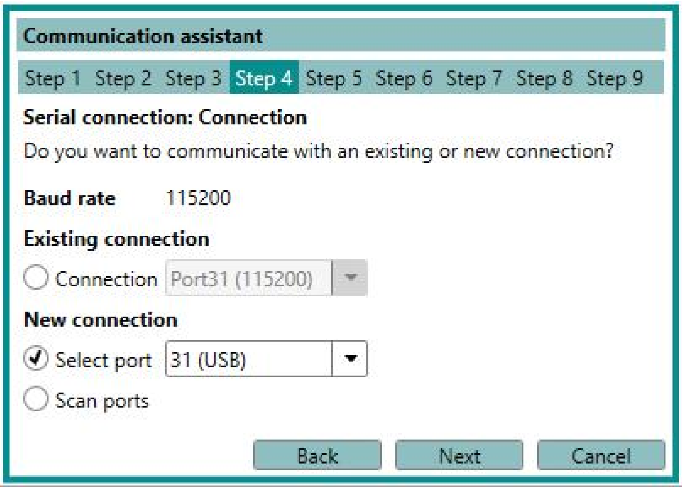
6. Make sure the MRL-6.1 is powered either by internal or external batteries and press Next.



7. Select *Logger (115200 Bd)* and press Next.

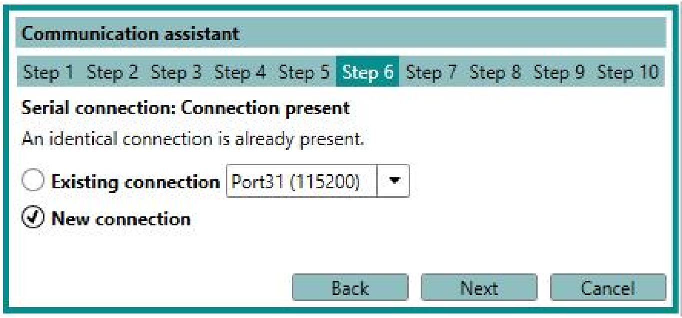


8. Either tick Connection and select a previously configured connection, or tick Select port and select the COM port that was assigned to the USB/RS-232 converter; then click Next.

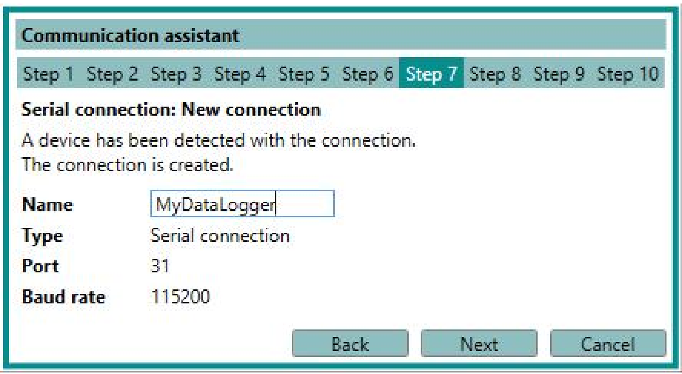


If more than one COM ports are listed and you are not sure which one to select, open the Windows Device Manager (press Windos-key and type *device manager*) and expand the menu Ports (COM & LPT). By unplugging and re-plugging your USB/RS-232 converter you can identify the number of the desired port.

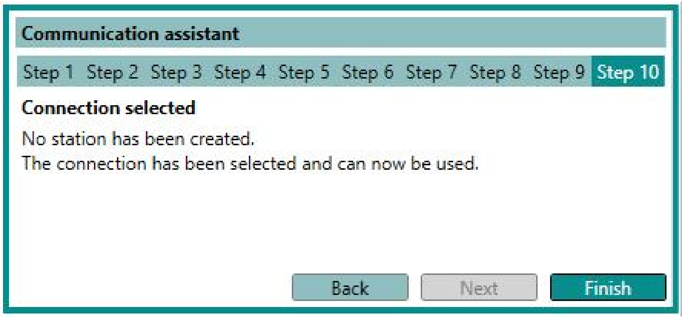
9. Select New connection and click Next.



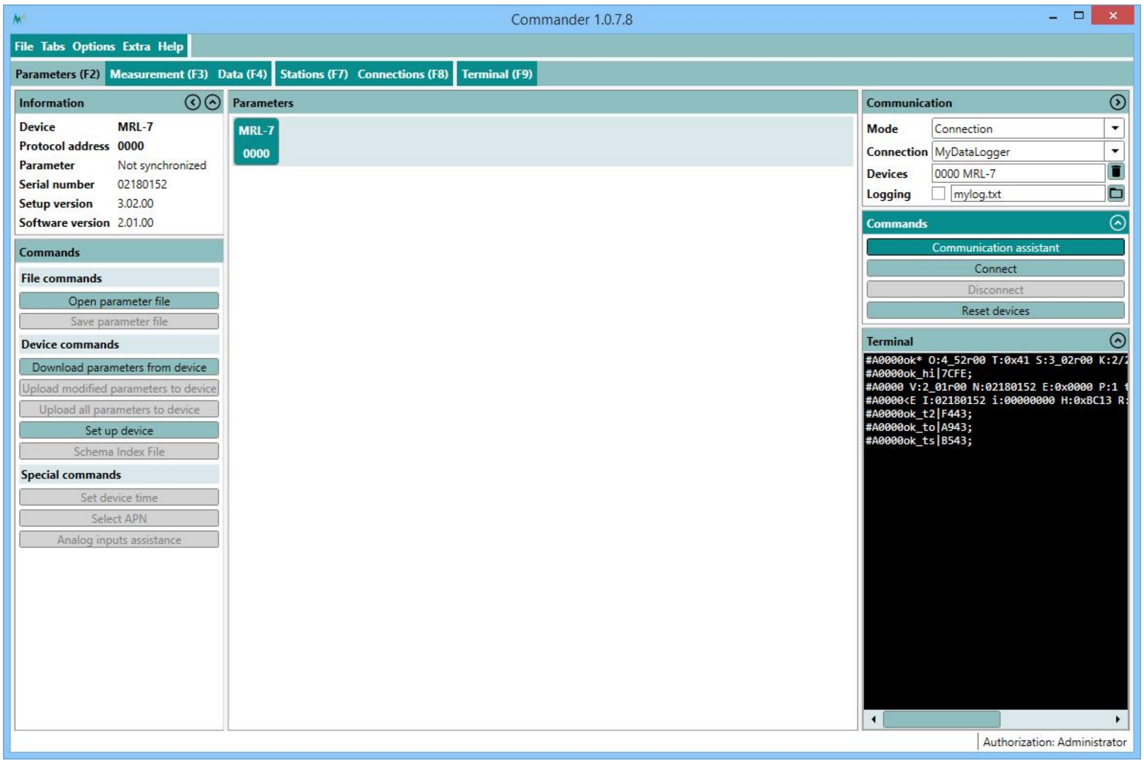
10. Assign a name to the connection and click Next. The software now searches for connected devices. This procedure can take several seconds.



11. Select if you want to create a new station. If yes, assign an appropriate name. If a station already exists, it will be recognized and automatically selected.
12. Click Finish. Upon completion, the newly created connection is displayed in the Communication section of the Commander.



13. Click Connect to open the connection with the data logger. If the connection was successful a green icon is displayed at the top-right corner of the Commander window.



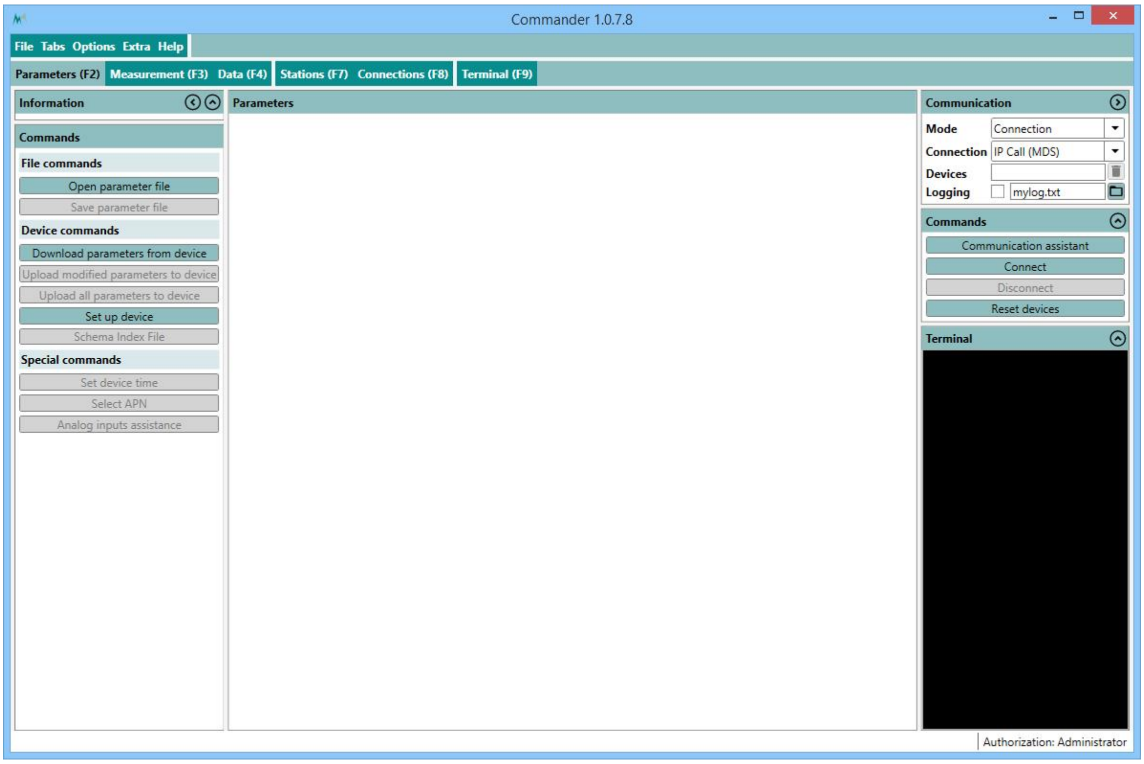
All configured connections can be viewed under the tab Connections (F8).
Alternatively, a connection can be configured manually; please consult the Commander manual for detailed instructions.

12.1.2 Bluetooth (MRL-6.1bt and MRL-6.1abt)

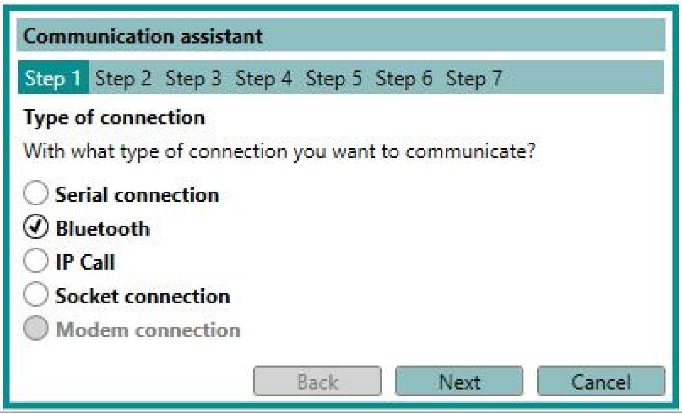
Perform the following steps to set up the communication between the MRL-6.1 and your PC:

1. Install the Commander software on your PC.
2. Make sure your PC has an internal Bluetooth or a Bluetooth dongle is connected.
3. Start the Commander software.
4. Make sure the MRL-6.1 is powered

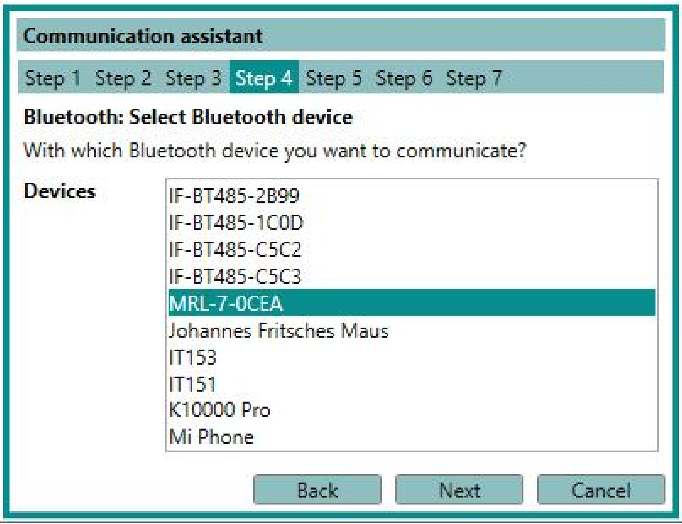
5. On the MRL-6.1 press the button DATA BT until the message `hold for BT` and then `waiting for BT no access` is displayed.
6. Click on Communication assistant on the right-hand side of the Commander window.



7. Select *Bluetooth* and press Next.

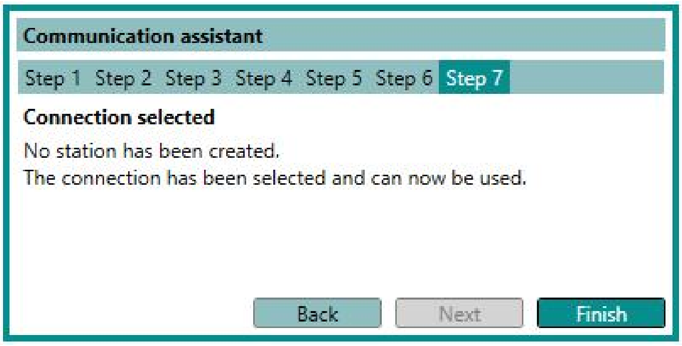


8. Select the device you want to connect to and click Next. The Bluetooth ID of your data logger is printed on a sticker on the housing. The software now searches for devices connected to your data logger. This may take a few seconds.

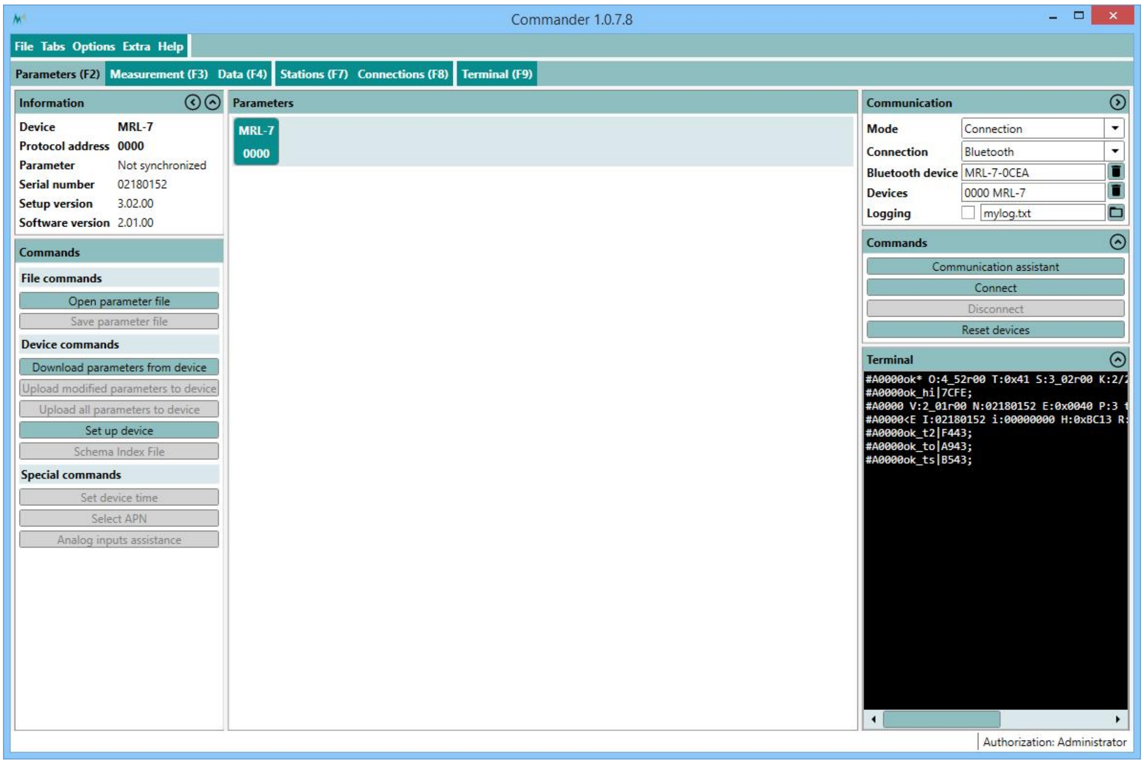


TIP The Bluetooth ID is also displayed in the list returned by the special function Device status.

9. Select if you want to create a new station. If yes, assign an appropriate name. If a station already exists, it will be recognized and automatically selected.
10. Click Finish. Upon completion, the newly created connection is displayed in the Communication section of the Commander.



11. Click Connect to open the connection with the data logger. If the connection was successful a green icon is displayed at the top-right corner of the Commander window.



All configured connections can be viewed under the tab Connections (F8).
Alternatively, a connection can be configured manually; please consult the Commander manual for detailed instructions.

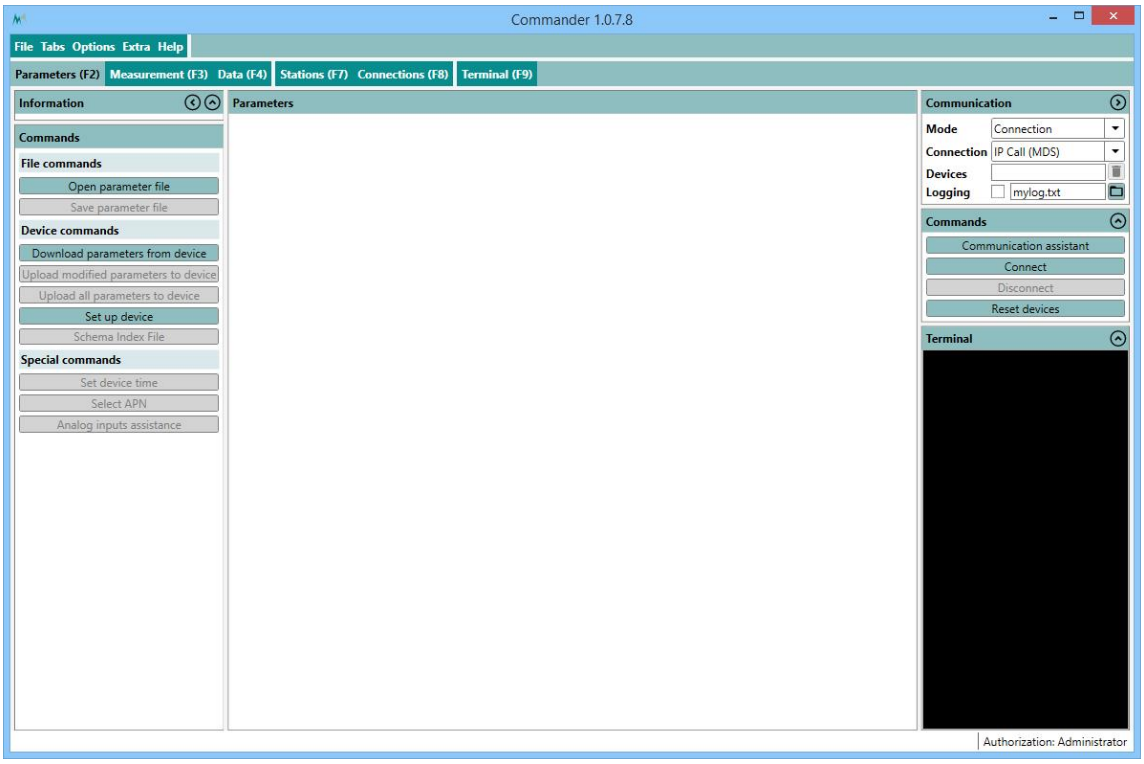
12.1.3 Radio connection

To enable radio communication, the COM interface of the MRL-6.1 must first be enabled to connect with a Sommer Messtechnik radio device. This is done by setting the following parameters in the Port sub-menu of the COM menu:

Parameter	Setting
Baud rate	19200
Flow control	DFM-RC for Sommer Messtechnik DFM point-to-point radios DFM-TM for Sommer Messtechnik DFM Tiny mesh radios

Follow the steps below to connect to a radio-enabled MRL-6.1:

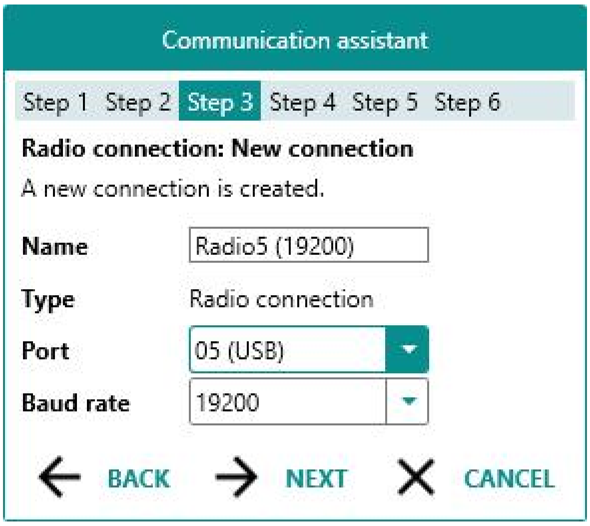
1. Make sure the MRL-6.1 and the radio devices are connected properly. See the DFM manual for details.
2. Start the Commander software.
3. Click on Communication assistant on the right-hand side of the Commander window.



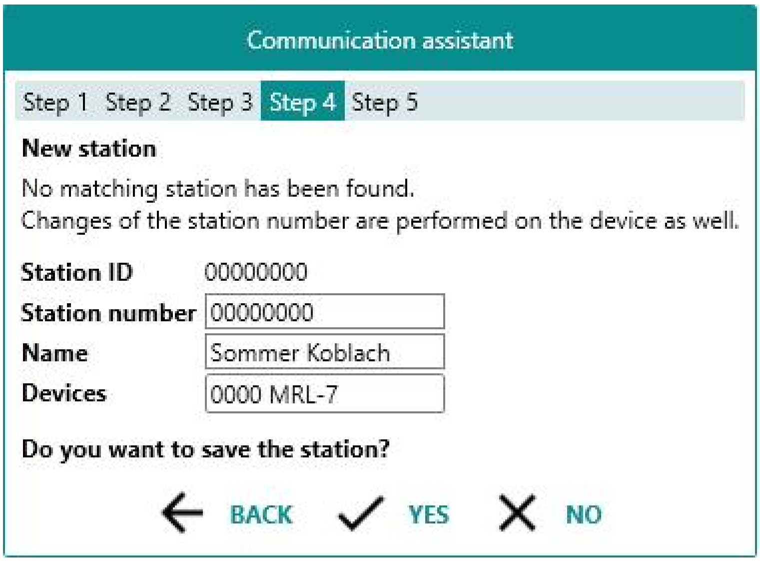
4. Select Radio connection and click NEXT.

5. Select New connection and click NEXT.

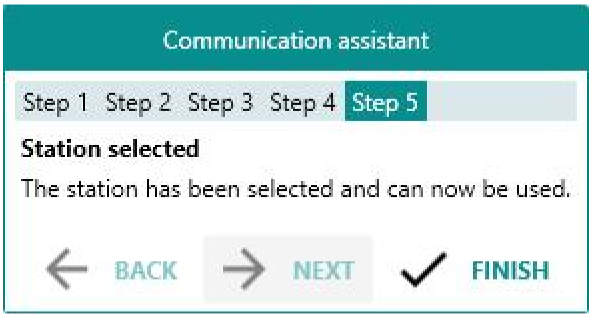
6. Select the COM Port of the connected radio device, set Baud rate to 19200 and enter a Name of the connection. Click NEXT to continue.



7. The Commander is now searching for the MRL-6.1. This may take several seconds. After the communication assistant has completed the search, enter a station Name and click Yes.



8. Click Finish. Upon completion, the newly created station is displayed in the Communication section of the Commander.



9. Now you can click Connect and view the data transmitted by the MRL-6.1 in the terminal, or download the setup of the MRL-6.1 by clicking Download parameters from device in the tab Parameters (F2). To view the data see section View live data.

12.2 Communication protocols

The MRL-6.1 provides the following communication protocols:

- RS-232 communication (Sommer bus protocol)

12.2.1 Data output

The MRL-6.1 includes a RS-232 interface for communication and data output. The measurement values returned over this port are arranged in a fixed sequence and are identified by the index in Measurement table.

Output values

The returned measurement data are indexed according to the entries in the Measurement table. The output format is selected in Protocol type.

Index	Measurement value
1	Variable 01[a]
2	Variable 02[a]
3	Variable 03[a]
...	...
97	Variable 97[a]
98	Variable 98[a]
99	Variable 99[a]

[a]According to the acquired variables

NOTE The variables listed above can also be configured as auxiliary variables. These are configured in the same way as regular variables but are not stored in the loggers memory. See Aux measurements, max. number for details.

Table 1 Output values

Exception values

Measurement data may be returned with the following exception values:

Value	Description
99999998	Initial value: No measurement has been performed yet.
99999997	Conversion error: Caused by a technical problem.
99999999	Positive overflow
-9999999	Negative overflow

Table 2 Exception values

12.2.2 RS-232 communication

Configuration

The MRL-6.1 has serial RS-232 communication enabled by default. If the device is integrated into a data network or connected to a stand-alone data acquisition system, the parameters listed in COM may need to be adapted.

System key and device number

The system key and device number are used to identify a MRL-6.1 in a bus system. This is essential if multiple devices (MRL-6.1 and sensors) are operated within the same system.

System key
: The system key separates different conceptual bus systems. This may be necessary if the remote radio coverage of two measurement systems overlap. In wired setups, the system key should be set to *00*.

Device number
: The device number is a unique number that identifies a device in a bus system.

> ⚠ **ATTENTION** Do not use a device number twice in your bus system! Otherwise communication will fail!

Measurement output

The serial data output can be triggered in the following ways:

ID	Option	Description
1	Just per com-mand	The output is only requested by commands via the RS-485 or SDI-12 interface.
2	Measured values push	Data are returned automatically after each measurement. interval.
3	Storage values push	Data are returned automatically after they have been written to the data logger memory.

Operation modes

The MRL-6.1 supports different modes to acquire data from various digital sensors.

Waking-up a connected data logger

The MRL-6.1 supports wake-up of a connected data logger that is in standby mode. Generally, this feature is only used in pushing mode and can be set under Wake-up sequence.

Sync sequence

The sync sequence is the string `UU~?~?` and is sent directly before a command. It is used to synchronize the receiving UART.

Prefix

The prefix is an arbitrary character; the MRL-6.1 uses a blank. This character is sent prior to any communication. Then the time of the Prefix holdback is waited and the command is sent afterwards. With this procedure the receiving device has time to wake-up.

Output protocols

For data output via RS-232 different protocols are available, which can be selected under Protocol type.

Data output options

Data are returned in two different formats, selectable in Protocol type:

- Sommer bus protocol (SBP)
- Standard protocol

Sommer bus protocol (SBP)

The data string of the Sommer protocol has the following format:

> **EXAMPLE** `#M0001G01se01     1461|02     1539|03    25.25|04     0|3883;`

A data string contains max. 8 values and is max. 105 characters long.

Header

The header (`#M0001G00se`) identifies the data by system key, device number and string number.

Parameter	Format	Description
Start character	`#`	
Identifier	`M`	`M` identifies an output string
System key	`dd`	
Device number	`dd`	
Command ID	`G`	`G` defines an output string with string number
String number	`dd`	`01` Output values `dd` increments until all values are returned
Command	`se`	`se` identifies automatically sent values

Table 3 Header of the Sommer protocol

Measurement value

A measurement value (`02     1539|`) has a length of 8 digits and is returned together with its index. If the measurement value is a floating point number, one digit is reserved for the decimal character. Values are returned right-aligned, so blanks may occur between index and value.

Parameter	Format	Description
Index	`dd`	2 numbers
Value	`xxxxxxxx`	8 character right-aligned
Separator	`|`	

Table 4 Values in Sommer protocol

End sequence

The data string is terminated with a CRC-16 in hex format (3883) followed by an end character and <CR><LF>. The CRC-16 is described in Sommer CRC-16.

Parameter	Format	Description
CRC-16	Hhhh	4-digit hex number
End character	;	
Control characters	<CR><LF>	Carriage return and Line feed

Table 5 End sequence of the Sommer protocol

Example Sommer protocol

Output values

The acquired data are returned as in the following example:

EXAMPLE #M0001G 01se01 1461|02 1539|03 25.25|04 0|3883;

#M0001G01se	Header with system key 00, device number 01 and string number 01
01 1461|	Level
02 1539|	Distance
03 25.25|	Temperature
04 0|	Status
3883;	Closing sequence

Table 6 Output values in Sommer protocol

Standard protocol

The data string of the Standard protocol has the following format:

EXAMPLE M_0001   1461   1359   25.38   0

Header

The header (M_0001) identifies the data by system key and device number.

Parameter	Format	Description
Identifier	X_	M_ Measurement values
System key	Dd	
Device number	Dd	

Table 7 Header of the Standard protocol

Measurement values

Measurement values are returned in sequence and are separated by a blank. A measurement value has a length of 8 digits. If the measurement value is a decimal number, one digit is reserved for the decimal character. Values are returned right-aligned, so additional blanks may be returned between values.

Parameter	Format	Description
Separator	[blank]	blank
Value	xxxxxxxx	8 character right-aligned

Table 8 Values in Standard protocol

NOTE With the standard protocol the data strings can be very long. In contrast, the strings of the Sommer protocol are max. 105 characters long.

End sequence

The data string is terminated with <CR><LF>.

Example Standard protocol

Output values

The acquired data are returned as in the following example:

EXAMPLE `M_0001 1461 1359 25.38 0`

M_0001	Header with identifier for measurement values
1461	Level
1359	Distance
25.38	Temperature
0	Status

Table 9 Output values in Standard protocol

Serial commands

Command structure

The structure of serial commands and answers is described in the following table:

Parameter	Format	Description
Start character	#	
Identifier	X	W Write: MRL-6.1 returns a confirmation on receipt. This command type demands a closing sequence with a valid CRC-16. S Silent: MRL-6.1 does not acknowledge the receipt of the command. This command type demands no closing sequence and therefore no CRC-16. R Read: MRL-6.1 returns the requested measurement value or parameter. This command type demands a closing sequence with a valid CRC-16. T Temporary: Write a volatile, temporary setting and receive a confirmation. A Answer: Answer of device to read or write command.
System key	dd	
Device number	dd	
Command	xxx	See table in section Commands.
Separator	|	
CRC-16	hhhh	4-digit hex number
End character	;	

Table 10 Structure of Sommer bus commands and answers

Commands

The following commands can be used with the MRL-6.1:

Command	Description
$pt	Return measurement values
XX	Read a parameter with identifier XX
XX=xxxx	Write a parameter with identifier XX and the value xxx

Table 11 List of Sommer bus commands

Read a parameter value

Read measurement interval (in the example below the menu item B):

EXAMPLE `#R0001B|228E;` Answer: `#A0001B=300|F8B3;`

Request a complete data string

The command `$pt` requests a data string as in the following example:

EXAMPLE

Option 1

`#W0001$pt|7D19;` Answer: `#A0001ok$pt|8C35;`

Option 2

`#S0001$pt|` Answer: none

The measurement data string is returned as soon as the MRL-6.1 has processed the command.

NOTE If Measurement output is set to *Measured values push*, the data strings are returned automatically after the measurements have been completed.

Request a single measurement value

The reading command `R` together with the index of the requested measurement returns a single measurement value. In the following example the measurement value with index `01` (in this example a water level) is requested:

EXAMPLE

`#R0001_010cv|EA62;`

Answer: `#A0001ok_010cv1461     |07EB;`

Sommer CRC-16

The CRC-16 (cyclic redundancy check) used in data transmission of Sommer devices is based on the ZMODEM protocol. When data are exchanged between two devices the receiving device calculates the CRC-value. This value is compared to the CRC value sent by the other device to check if the data were transmitted correctly. Please refer to technical literature or contact Sommer for calculation of CRC-16 values.

You can here calculate the CRC of a command online .

If you need to compute CRCs automatically, you can implement the following procedure in your data logger or controller software.

The CRC-16 is calculated character by character. The start value for the initial CRC-16 calculation is always 0.

The following procedure returns the CRC-16 of a single character:

`byte1 = CRC-16 right shift by 8 bits`	upper byte disappears
`uint1 = c`	new character, upper byte = 0
`uint2 = CRC-16 left shift by 8 bits`	lower byte = 0
`uint3 = crc16tab[byte1]`	Table value from the CRC-16 table

`Crc16 = uint3 (excl. or) uint2 (excl. or) uint1`

Computation CRC-16 in C/C++

```
crc16 = crc16tab[(unsigned char)(crc16>>8)] ^ (crc16<<8) ^ (unsigned int)(c);
```

The `crc16tab` array is listed in CRC-16 array.

EXAMPLE

Command to request measurement data `#W0001$pt|7D19;`

The first character is `#`, the last `|`. The CRC-16 of the command is `7D19` and its end character is `;`.

The CRC-16 is calculated sequentially with the start value `0` for the initial CRC-16 calculation:

Position	String	CRC-16
Start		0000
0	#	0023
1	#W	2357
2	#W0	4331
3	#W00	4997
4	#W000	4EDD
5	#W0001	743B
6	#W0001$	0537
7	#W0001$p	67D5
8	#W0001$pt	C935
9	#W0001$pt|	7D19

13 Configuration of the MRL-6.1

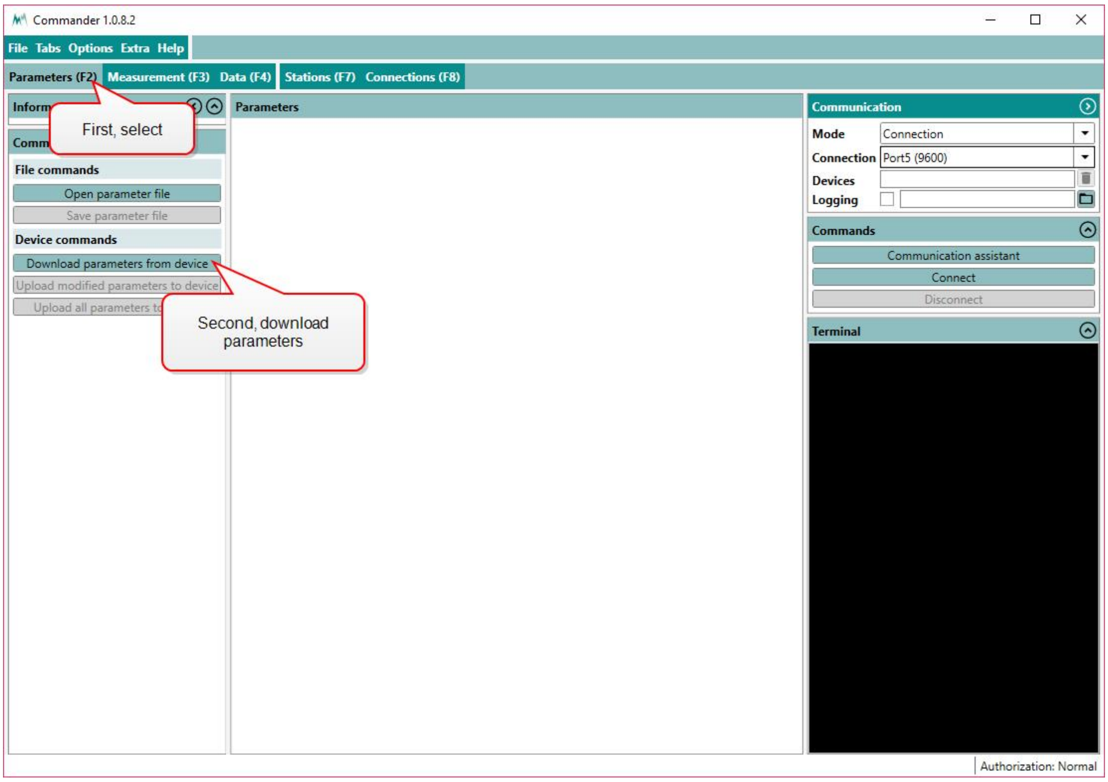
The MRL-6.1 can be configured with one of the following tools:

- Configuration with Commander support software
- Configuration with a terminal program

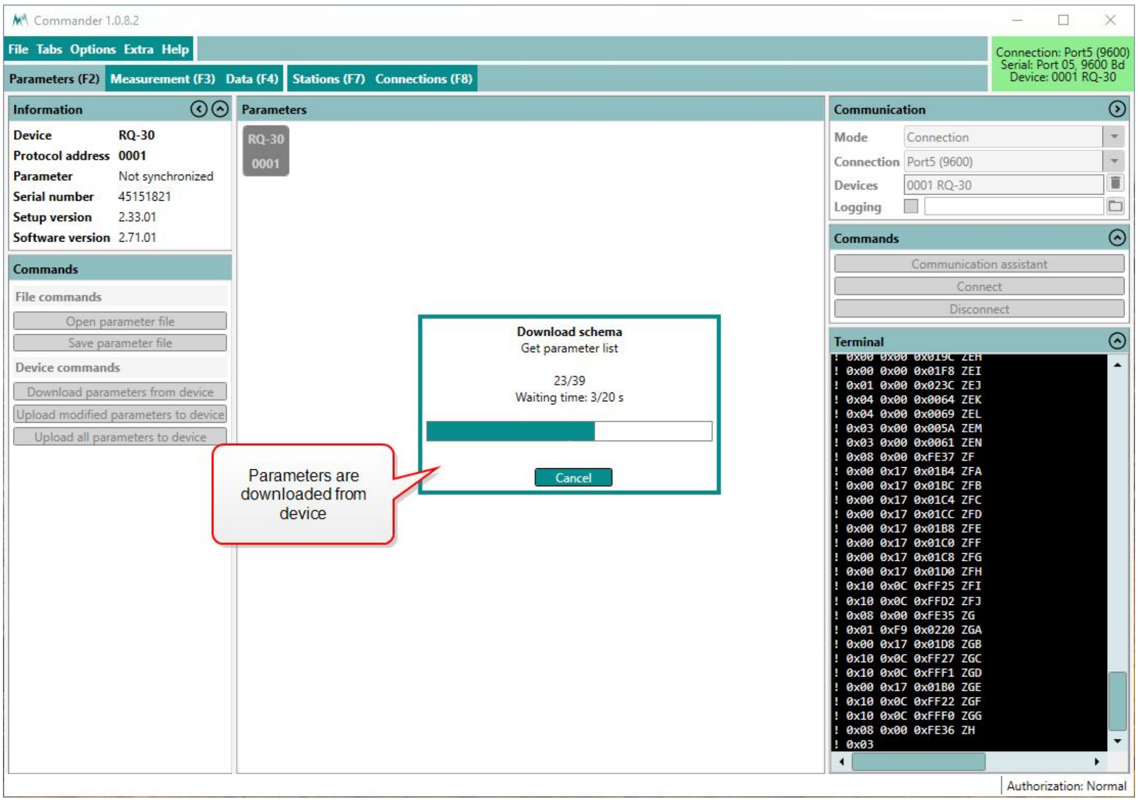
13.1 Configuration with Commander support software

Follow the steps below to modify the configuration parameters of the MRL-6.1:

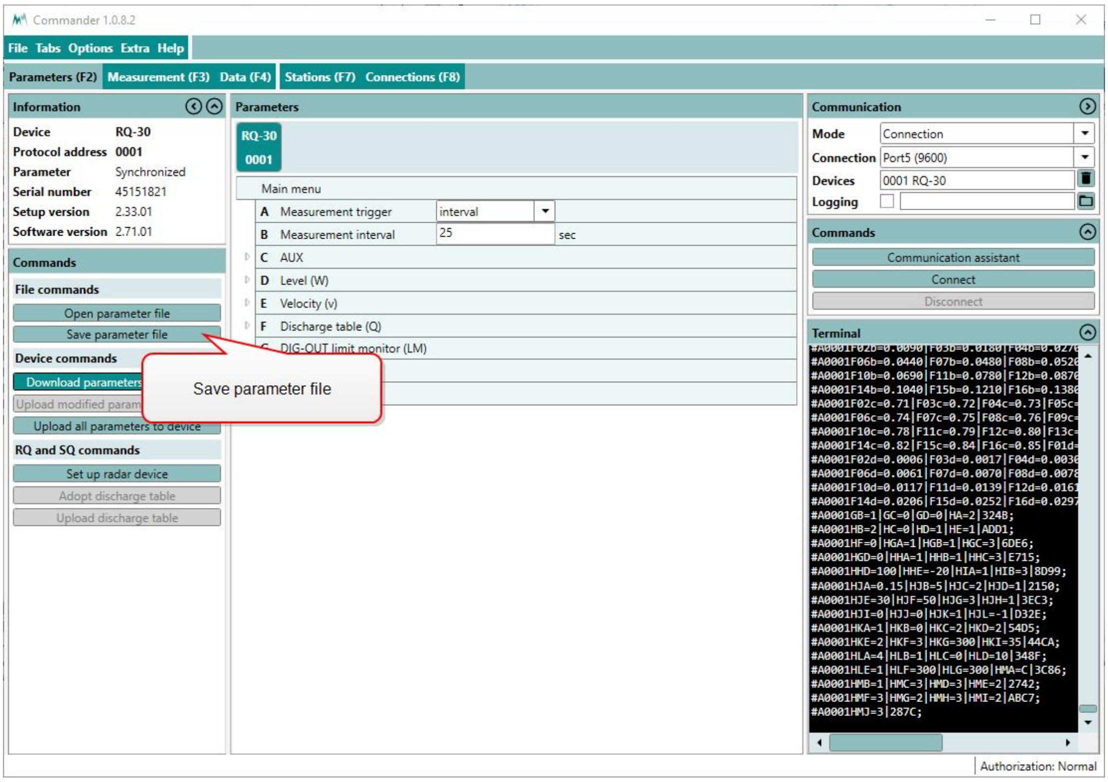
1. Establish a connection between your PC and the MRL-6.1.
2. Select the tab Parameters (F2) and click Download parameters from device. The complete parameter list is transferred from the sensor to your PC and displayed in the Parameter window.



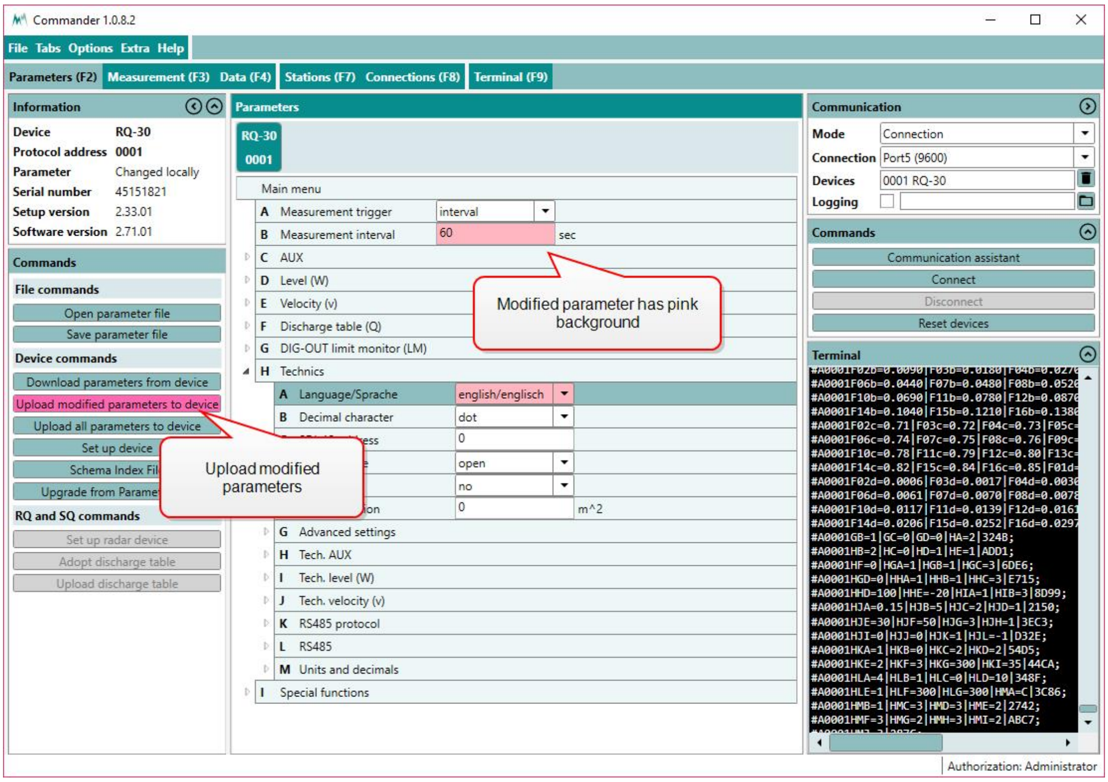
> **NOTE** The first download of the parameter list may take a few minutes. After that the device is known to the PC and consecutive downloads are much faster.



3. Save the parameter file to your PC by clicking Save parameter file. This step is recommended to track any configuration changes.



4. Adapt the parameters required for your application. Changed values are displayed with a pink background.



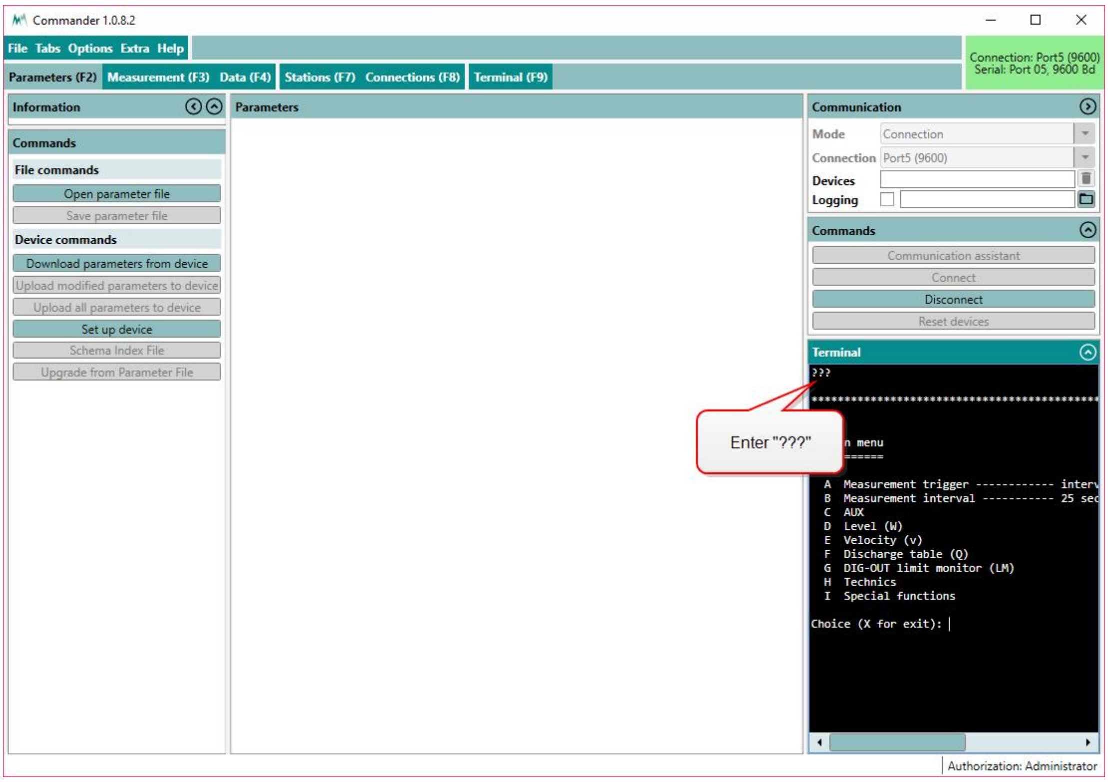
5. Send the modifications to the MRL-6.1 by clicking Upload modified parameters to device. Upon successful upload the pink backgrounds disappear again.

13.2 Configuration with a terminal program

The Commander software ships with an integrated terminal program. However, communication with the MRL-6.1 can be performed with any terminal program.

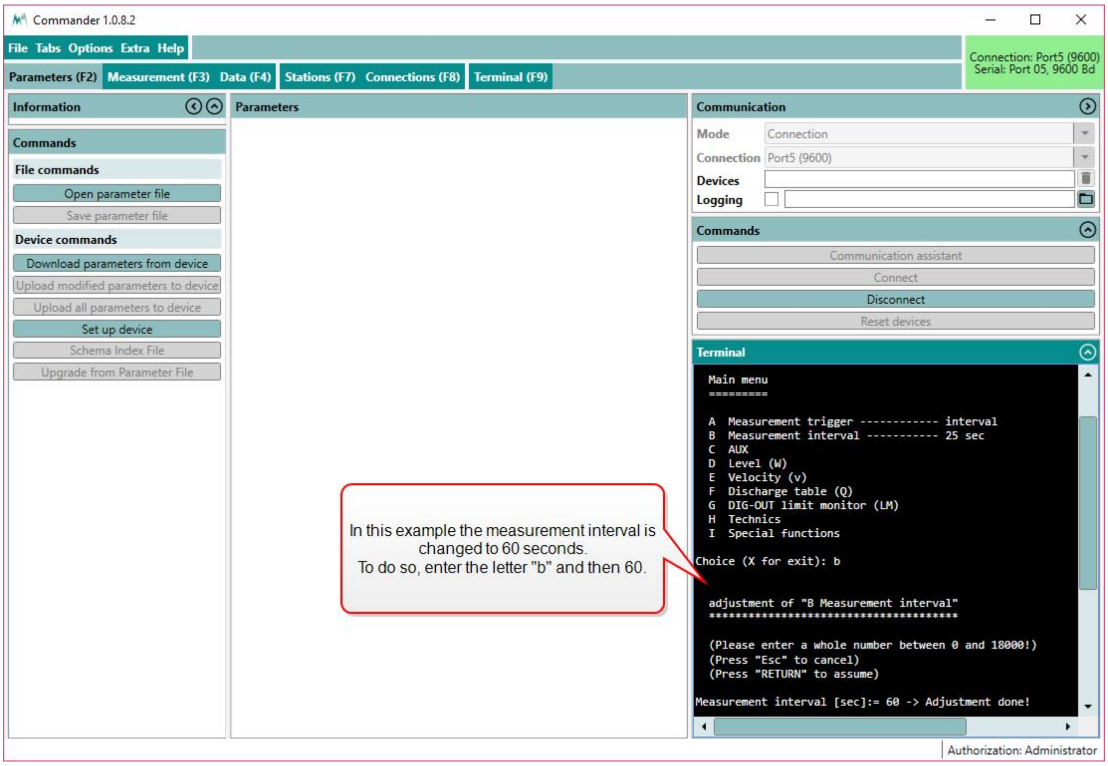
Follow the steps below to modify the configuration parameters of the MRL-6.1:

1. Establish a connection between your PC and the MRL-6.1.
2. In the terminal window enter three question marks (`???`) in quick succession. The main parameter menu is displayed in response.



NOTE As an unwanted switching into the menu mode must be avoided the timing of the three question marks ??? is very restrictive and must never be finished with Return/Enter. This is especially important for command line tools, which automatically send a closing "Carriage return". Before and after sending ??? no communication must occur for 1 second.

3. Read or modify the required parameters: The menu items can be selected by entering the letter assigned to each item. Upon selection a submenu is opened or the selected parameter is displayed with its unit. Changes to values are confirmed with Return/Enter or discarded with Esc. Menus are closed with X or Esc. After closing the main menu with X the device performs an initialization.



13.3 Configuration errors

13.3.1 Conflict messages

During configuration with the Commander software, the MRL-6.1 may return conflict messages after one or more parameters have been changed and uploaded to the device. An example is shown in Figure 8.

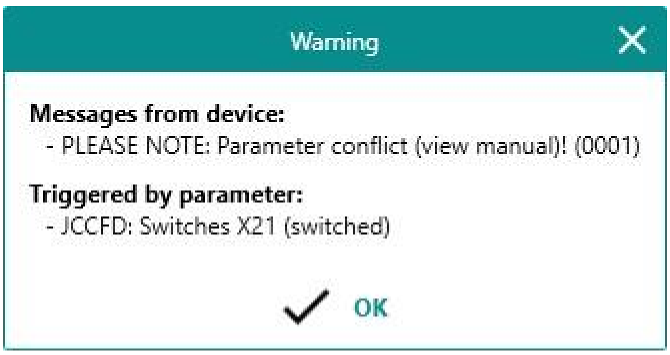


Figure 8 Example of a conflict message

The pop-up window lists the parameters and their indices which have triggered the warning. See Parameter conflicts for details.

ATTENTION If a conflict occurs, invalid settings are replaced automatically with valid values. Verify the values of the conflicting parameters and adapt them if needed!

13.3.2 Parameter conflicts

A parameter conflict message as listed below is returned if the value of a parameter conflicts with another parameter setting.

Changed parameter	Comment
Measurement channel nr. in Overview (MRL-6.1a and MRL-6.1abt only)	If the value of Measurement channel nr. is higher than Measurements, max. number, Measurement channel nr. is set to Measurements, max. number.
Measurement channel nr. in Digital outputs (MRL-6.1a and MRL-6.1abt only)	If the value of Measurement channel nr. is higher than Measurements, max. number, Measurement channel nr. is set to Measurements, max. number.

Table 12 Parameter conflict messages

13.3.3 Setup conflicts

A setup conflict message as listed below is returned if a modified setup with conflicting parameters is loaded onto the MRL-6.1.

Conflict code	Parameter	Comment
0001	Measurement Interval	If the interval is shorter than the sum of all individual measurement times, it is set to this sum. This internally calculated sum depends on the number and type of measurements, and the settings of Warm-up time, ADC - conv. Rate, ADC filter and others.

Table 13 Setup conflict messages

13.4 What do I need to configure?

When first setting-up a MRL-6.1 at a measurement site, the parameters described below may need to be adapted.

13.4.1 General settings

Station ID

By default, the station ID is set to the MRL-6.1 serial number. Adjust to your requirements if needed.

Station name

The name of the Station (max. 32 characters long).

Language/Sprache

The menu language.

Decimal character

The character used as decimal separator in the values of the settings, in serial data strings and in .csv files.

Measurement Interval

The MRL-6.1 can perform analog, impulse counter and digital measurements at an interval between 2 s and 12 h.

Storage interval

Measurement data can be stored at a primary interval between 10 s and 12 h, specified in Storage interval , or a secondary interval between 1 s and 12 h, specified in Storage interval asynchronous. By default, all variables specified in the measurement table are stored in the primary interval. An exception are counter variables, manual entries and some system variables which are stored by default in the secondary interval. By adding the command `SY` or `AS` to the field S-ADD of the measurement table, a variable can be forced to be stored in the primary or secondary interval.

In the Function field of the measurement table you can specify whether the last measurement value or an aggregated value, e.g. mean, shall be stored.

13.4.2 Measurement table

The data acquired by the MRL-6.1 are configured in the measurement table. The screenshot below shows an example of a measurement table for an automatic weather station equipped with a combined temperature/humidity sensor, wind speed/direction sensor and a tipping bucket rain gauge.

	Function	Identifier	Unit	Decimals	Scale	Offset			S-TYP	S-NUM	S-MEA	S-ADD
01	Actual	Air temperature	°C	2	100	-40	Adjustment	Test	AIN		An1	
02	Actual	Rel. humidity	%	1	100	0	Adjustment	Test	AIN		An2	
03	Meanval	Wind speed	m/s	2	0,098	0	Adjustment	Test	WIND		Speed	
04	Maximum	Wind speed	m/s	2	0,098	0	Adjustment	Test	WIND		Speed	
05	Meanval	Wind direction	°	1	1,0	0	Adjustment	Test	WIND		Direct.	
06	Actual	Precipitation	mm/h	1	6,0	0	Adjustment	Test	COUNT		Counter 1	
07	Sum	Precip. daily	mm	1	1,0	0	Adjustment	Test	COUNT		Counter 1	SY
08	Actual	Battery voltage	V	1	1,0	0	Adjustment	Test	SYS	0	+Bat V	

Please refer to Measurement table for a detailed description of the fields and their options. The configuration of different sensor types is described in Section Data acquisition examples.

NOTE

Summed values

Summing up a measurement value eventually leads to data overflow. The table below shows the maximum of summed variables.

Summarized value	Digits	Max./min. value
Positive integer	8	99 999 999
Negative integer	7	-9 999 999
Positive floating point	7	999 999.9 / 99 999.99 / 9 999.999 / ...
Negative floating point	6	-99 999.9 / -9 999.99 / -999.999 / ...

13.4.3 Analog inputs

The signal type of up to eight analog input terminals can be set. The terminals are then referenced in S-TYP of the Measurement table. In the sub-menu Sensor supply the required supply voltages can be selected.

13.4.4 Analog output settings (MRL-6.1a and MRL-6.1abt only)

Up to four variables listed in Measurement table can be allocated to the analog outputs by specifying their index in Measurement channel nr. of Overview (MRL-6.1a and MRL-6.1abt only).

The value corresponding to 4 mA is set in 4 mA value and the value range corresponding to 4 ... 20 mA is specified in 4-20 mA span.

EXAMPLE A water level sensor with an SDI-12 output is connected to the MRL-6.1a. It measures the level between 0 and 500 cm. This translates to a 4 mA value of 0 and a 4-20 mA span of 500 cm.

13.4.5 Digital output settings (MRL-6.1a and MRL-6.1abt only)

Up to six variables listed in Measurement table can be allocated to the digital outputs by specifying their index in Measurement channel nr. of Digital outputs (MRL-6.1a and MRL-6.1abt only). Each output can be configured to either indicate the status of a variable, or return the value of the variable as pulses. The following examples illustrate these two options.

EXAMPLE

A water level sensor with an SDI-12 output is connected to the MRL-6.1a. If the water level exceeds 3.5 m, it shall switch the digital output DIG-OUT 3 to its high state to trigger an alarm.

For this task the Output status of Digital outputs (MRL-6.1a and MRL-6.1abt only) is set to *Limit monitor*, Limit type to *above* and Limit value to *3.5*.

EXAMPLE

A digital flow meter that measures the discharge of a water irrigation channel is connected to the MRL-6.1a. The total discharge shall be displayed by an analog water meter.

For this task the Output status of Digital outputs (MRL-6.1a and MRL-6.1abt only) is set to *Impulse output* and min. impulse width to, e.g., *100 ms*.

The min. impulse width depends on the discharge volume and the response-speed of the water meter.

13.4.6 Totalizer reset options

Precipitation and discharge measurements, among others, require a totalizer function. For example, in water management it is common to report water discharge as daily totals.

To configure a summed variable with a daily reset, the Function field in the measurement table has to be set to *sum* and the Sum, reset time has to be set to the required time.

13.4.7 Device clock

The clock of the MRL-6.1 requires regular synchronization. After connection with the Commander software, the time can be set by clicking Set device time in the Parameters (F2) tab.

14 Data acquisition examples

As listed in What can I do with it? the MRL-6.1 accepts a wide range of sensor inputs. In this section the data acquisition of the most common sensor types is described.

TIP See Sensor connections for a complete list of sensor connections.

14.1 Power considerations

The MRL-6.1 provides analog sensor supplies of 500 mA at 5 V, 12/14 V and at SW2 each, totaling 1.5 A at 12 V supply voltage.

NOTE Some digital sensors may require a supply current >500 mA. If such sensors are connected to the MRL-6.1, they need to be powered by an external power supply with a sufficient source current.

14.2 Analog measurements

With the MRL-6.1 the following signal types can be measured:

ID	Setting	Description
1	Voltage 2.5 V	Single ended voltage input 0 ... 2.5 V
2	Diff volt. 2.5 V	Differential voltage input 0 ... 2.5 V
3	Diff volt. 1.25 V	Differential voltage input 0 ... 1.25 V
4	Diff volt. 0.311 V	Differential voltage input 0 ... 0.311 V
5	Diff volt. 0.032 V	Differential voltage input 0 ... 0.032 V
6	R meas < 100k	Measures a resistance <100 kΩ
7	R meas < 3k	Measures a resistance <3 kΩ
8	R meas < 300	Measures a resistance <300 Ω
9	4...20 mA	Current input 4 ... 20 mA
10	PT1000	Measures the temperature of a PT1000 temperature sensor

ID	Setting	Description
11	NTC (2k2)	Measures the temperature of a 2k2 NTC-thermistor
12	AD592	Measures the temperature of an AD592 temperature sensor
13	PT100	Measures the temperature of a PT100 temperature sensor

The signals received from a sensor are wired in the MRL-6.1 as illustrated in Figure 9.

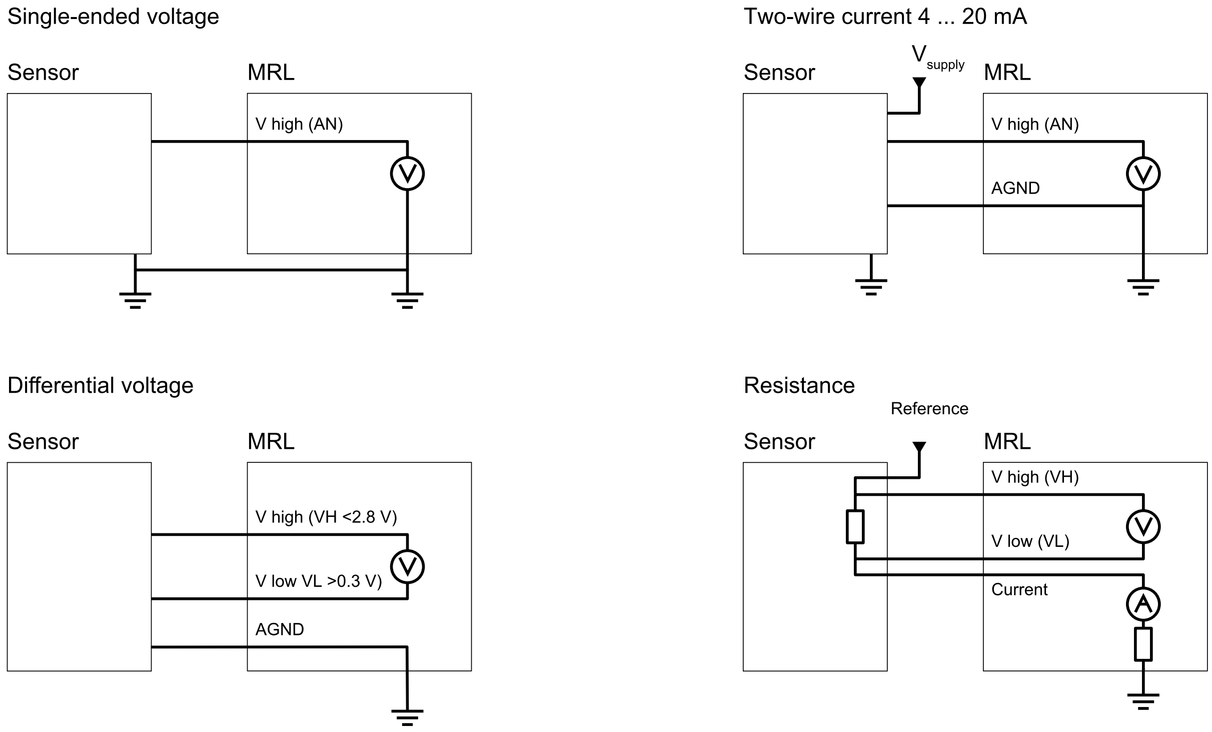


Figure 9 Internal wiring of analog MRL-6.1 inputs

14.2.1 Principals

The illustration below shows a sequence of two measurement cycles of three analog inputs (AN1, AN2 and AN3) and switched power supply.

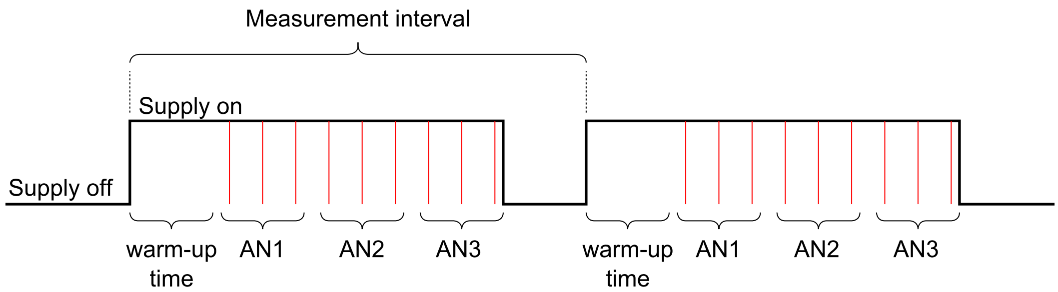


Figure 10 Principal of analog measurements

At the start of each measurement interval the sensor power supply is switched on. After the specified Warm-up time each of the three analog inputs is measured sequentially 3x at the sampling rate defined in ADC - conv. Rate. After each measurement has been completed, the sensor power supply is switched off.

The speed of the analog measurements can be set in ADC - conv. Rate. If ADC filter is activ the input is measured 3x and the data logger returns the statistic specified in ADC filter.

The measurement interval of all sensors is specified in Measurement Interval.

14.2.2 Single ended voltage measurement

A total of eight single ended voltages can be measured with the MRL-6.1. Figure 11 illustrates the wiring of a temperature and relative humidity sensor for single ended measurements with two analog inputs.

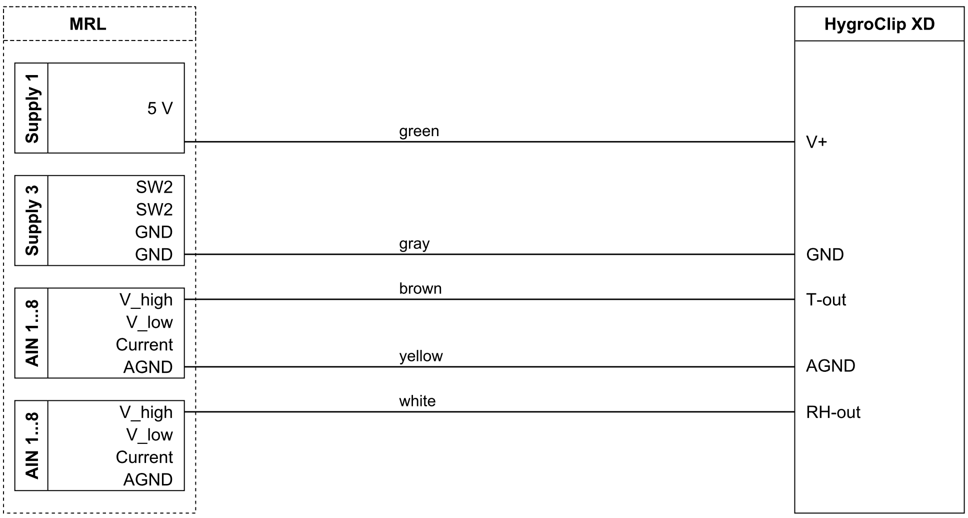


Figure 11 Wiring of a single ended voltage measurement (T/rH-sensor)

In this example, the AIN 1 signal type in the Analog inputs menu has to be set to Voltage 2.5 V.

The T/rH-sensor in this example can be configured in Measurement table as follows:

	Function	Identifier	Unit	Decimals	Scale	Offset			S-TYP	S-NUM	S-MEA	S-ADD
01	actual	Air Temperature	°C	2	100	-40	Adjustment	Test	AIN		AIN 1	
02	actual	Humidity	%	1	100	0	Adjustment	Test	AIN		AIN 2	

14.2.3 Differential voltage measurement

All analog inputs AIN1 ... AIN8 can also be configured as differential voltage inputs. The wiring of a pyranometer with a 0…100 mV output is illustrated in Figure 12.

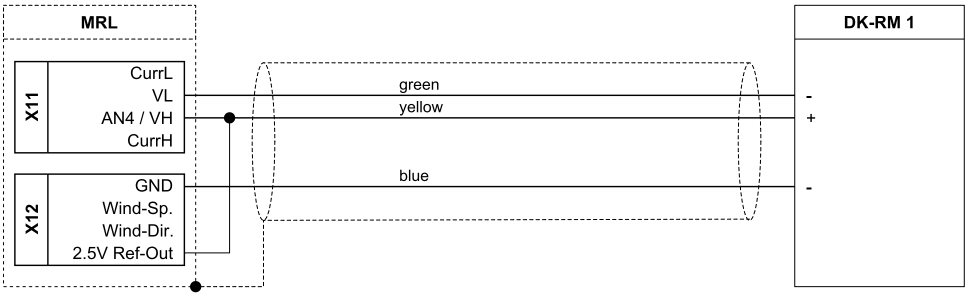


Figure 12 Wiring of differential voltage measurement (pyranometer)

In this example, the AIN 1 signal type in the Analog inputs menu has to be set to Diff volt. 0.311 V.

The pyranometer in this example is configured in Measurement table as follows:

	Function	Identifier	Unit	Decimals	Scale	Offset			S-TYP	S-NUM	S-MEA	S-ADD
01	actual	Global radiation	W/m²	2	125000	0	Adjustment	Test	AIN		AIN 1	

14.2.4 Current measurement

All analog inputs AIN1 ... AIN8 can also be configured as current inputs. As an example, the wiring of a infrared temperature sensor with an output of 4…20 mA and a measurement range of -50…50 °C is illustrated in Figure 13.

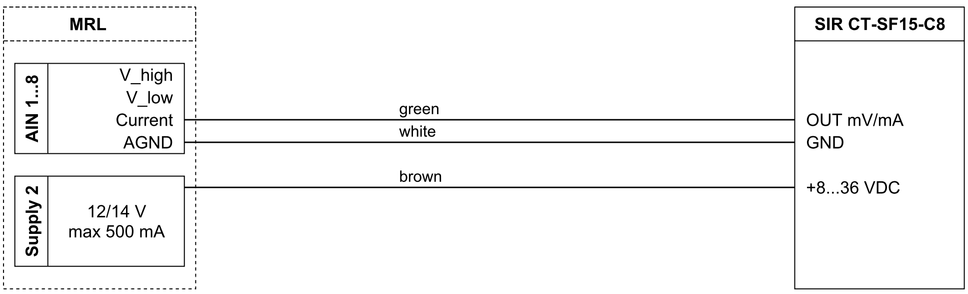


Figure 13 Wiring of sensor with current output (infrared temperature sensor)

In this example, the AIN 1 signal type in the Analog inputs menu has to be set to 4...20 mA.

The infrared temperature sensor in this example is configured in Measurement table as follows:

	Function	Identifier	Unit	Decimals	Scale	Offset			S-TYP	S-NUM	S-MEA	S-ADD
01	actual	Temperature	°C	2	6,25	-75	Adjustment	Test	AIN		AIN 1	

The given Scale and Offset values result from the 4...20 mA sensor output, the measurement range of the sensor and the chosen 100 Ω shunt resistor.

14.2.5 Resistance measurement

All analog inputs AIN1 to AIN8 can be used to measure resistances. As an example, the wiring of a 4-wire PT1000 temperature sensor is illustrated in Figure 14.

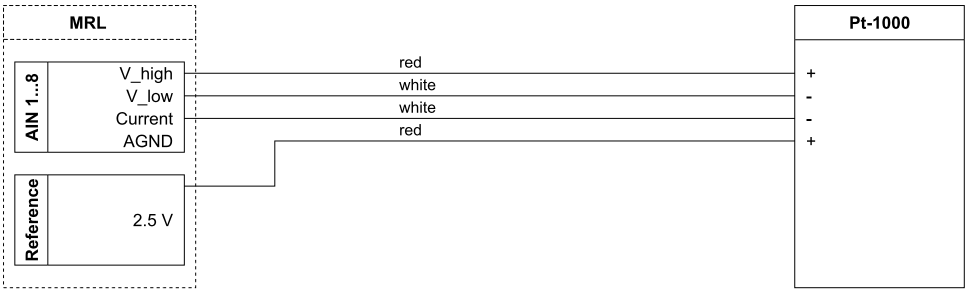


Figure 14 Wiring of resistance measurement (4-wire PT1000)

In this example, the AIN 1 signal type in the Analog inputs menu has to be set to PT1000.

The PT1000 in this example is configured in Measurement table as follows:

	Function	Identifier	Unit	Decimals	Scale	Offset			S-TYP	S-NUM	S-MEA	S-ADD
01	actual	Temperature	°C	2	1	0	Adjustment	Test	AIN		AIN 1	

As a Pt1000 sensor is already linearized, Scale and Offset need not to be changed.

14.3 Counter & frequency measurements

The MRL-6.1 is equipped with one universal counter input and one counter input dedicated to wind speed measurements with an anemometer.

14.3.1 Counting events

The counter input can be used to record counts of different devices.

As an example, the wiring of a tipping bucket rain gauge is illustrated in Figure 15.

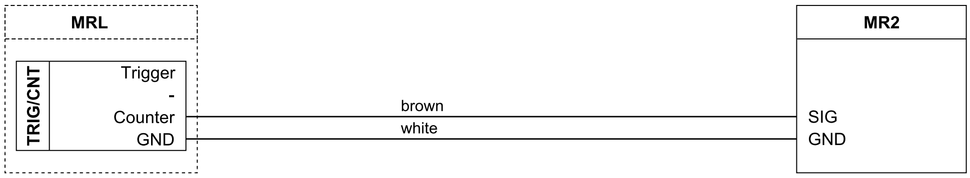


Figure 15 Wiring of a counter input (tipping bucket rain gauge)

The rain gauge in this example is configured in Measurement table as follows:

	Function	Identifier	Unit	Decimals	Scale	Offset			S-TYP	S-NUM	S-MEA	S-ADD
01	intens.	Precipitation	mm	2	0,2	0	Adjustment	Test	COUNT			

NOTE The acquired counter value is stored in the Storage interval asynchronous.

14.3.2 Frequency measurement

The wind speed input of the MRL-6.1 – generally used for wind speed measurements – measures the frequency of an incoming signal. Figure 16 illustrates the wiring of a combined wind speed/direction sensor.

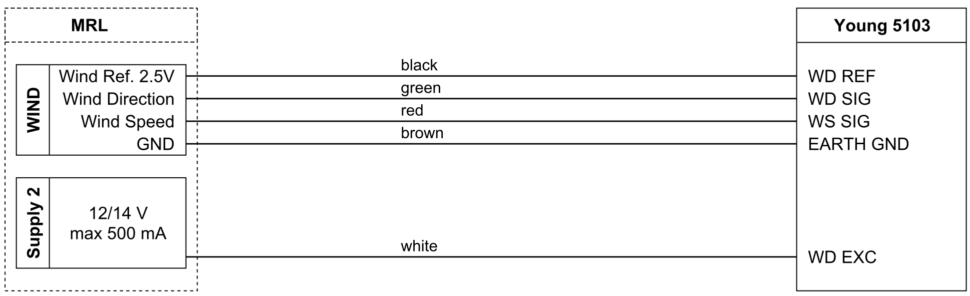


Figure 16 Wiring of a frequency input (combined wind speed/direction sensor)

The wind sensor in this example is configured in Measurement table as follows:

03	meanval	Wind Speed	m/s	2	0.098	0	Adjustment	Test	WIND		speed	
04	maximum	Wind Speed	m/s	2	0.098	0	Adjustment	Test	WIND		speed	
05	meanval	Wind Direction	°	1	1.44	0	Adjustment	Test	WIND		direct.	

14.4 RS-485

The MRL-6.1 is equipped with a RS-485 port to acquire sensor measurements.

14.4.1 Principles

The example below illustrates the acquisition of measurement values from three digital sensors with the same measurement duration.

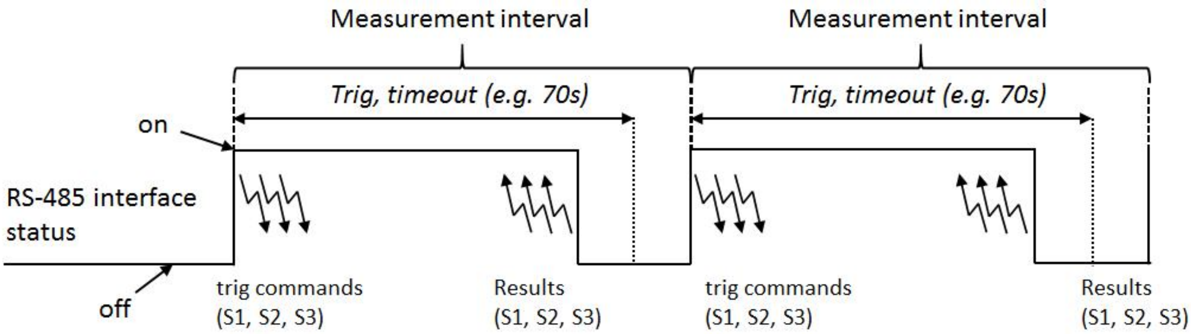


Figure 17 Principal of data acquisition by RS-485

In polling mode the MRL-6.1 activates the RS-485 interface at the beginning of each measurement interval and sends a measurement command to the addressed sensors. If this command is not confirmed by a sensor it is re-sent a 2nd or 3rd time. As soon as all measurements have been completed and the requested results have been received within Timeout, the RS-485 interface is switched off automatically and remains idle until the next measurement interval.

NOTE

If multiple sensors are connected to a MRL-6.1, the measurement values must be polled in sequence to avoid data transmission conflicts. To do so, set Polling delay to a few seconds. As a result, the MRL-6.1 waits for the duration of Polling delay before it requests the data of the next sensor.

The Polling delay and the measurement duration of every sensor must match the duration of Timeout. If Timeout is too short, the MRL-6.1 may not receive all measurement values.

For example, sensor one has a measurement duration of 10 seconds, sensor two has a measurement duration of 30 seconds and Polling delay is 2 seconds, Timeout should be at least 10 + 2 + 30 = 42 seconds, plus a few seconds for processing delays.

14.4.2 Multiple RS-485 devices

Multiple Sommer-sensors can be connected to the RS-485 port of the MRL-6.1, provided each digital sensor has a unique address.

ATTENTION If multiple Sommer-sensors need to be connected, assign a unique address to each device! To do so, connect each sensor individually and set its address.

14.4.3 Find RS-485 devices with Commander

The Commander can be used to connect and manage Sommer RS-485 devices connected to the MRL-6.1 data logger. Follow the steps below to do this:

1. Connect your RS-485 devices to the +RS485A/-RS485B ports of the MRL-6.1 and make sure all devices are powered.
2. Establish a connection with the MRL-6.1 as explained in Connect the MRL-6.1 to a PC.
3. Define a station as describes in Create a station manually.
4. In the Parameters (F2) tab download the parameters of the MRL-6.1.
5. Set Enable network scan to *on*.
6. Make sure the connection to the MRL-6.1 is not active (no green icon in the top-right corner). In the Stations (F7) tab click Scan devices. The Commander will now search for all RS-485 devices connected to the data logger and will add them to the station information.

Now, the parameter lists of all devices can be downloaded and the configurations be adapted.

14.4.4 Reading data from a Sommer RS-485 device

Various sensing devices perform measurements autonomously and send out the results on request. The SOMMER IDS-20 Ice detection system is an example of such a device. It detects icing of a surface with a capacitive transducer and is used, for example, in the wind industry and in aviation to detect ice loads and icing events.

The IDS-20 performs measurements autonomously at an interval of 60 seconds. The acquired data can be read with the MRL-6.1 by wiring the data logger according to Figure 18.

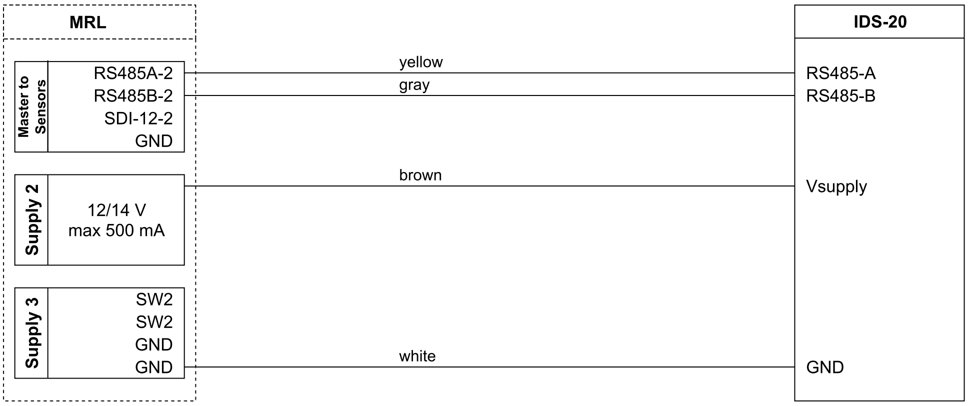


Figure 18 Wiring of IDS-20 ice detection sensor with RS-485 interface

The IDS-20 in this example is configured in Measurement table as follows:

	Function	Identifier	Unit	Decimals	Scale	Offset			S-TYP	S-NUM	S-MEA	S-ADD
01	actual	Ice	mm	as S		0	Adjustment	Test	SBP	1	7	TD
02	actual	Ice rate	mm/h	as S		0	Adjustment	Test	SBP	1	9	
03	actual	Dep point	°C	as S		0	Adjustment	Test	SBP	1	3	

To poll the data of the sensor, Polling must be *Off*. Also, note the command `TD` (trigger data) in the S-ADD field: this command requests the data from the IDS-20 device and needs to be set in the first variable acquired from the sensor.

To match this setup, the Measurement trigger of the sensor must be set to *Interval* (if this settings is available), and the output time (in sub-menu RS485 protocol) to *Just per command*.

Note that in this example only three variables of the IDS-20 are recorded. The device provides an extended list of variables that can be polled by the data logger.

> **ATTENTION** The measurement time of different digital sensors varies considerably. Please consult the sensor manual and adjust Timeout accordingly! See also Note in RS-485 above.

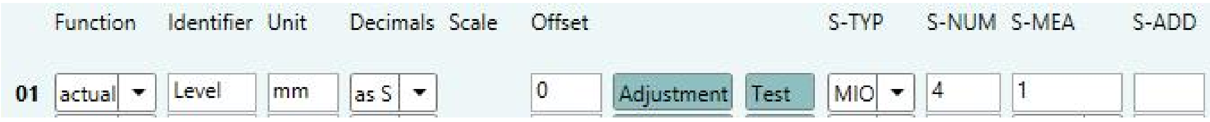
14.4.5 Reading data in MIO-format

Some older Sommer sensors like the USH-8 send data in the MIO-format (multi-in-out) which is structured as in the following example:

```
I04124874-011350148960519;
```

	Format	Description
Identifier	I	I identifies an output string
Device number	04	
System key	12	
Measurement value 1	4874	Level in mm (4 digits)
…	…	Measurement values 2…4 (4 digits each)
Checksum	0519	
End character	;	

To read data strings in MIO-format Measurement table has to be configured as follows:



In this example the first measurement value (level) is read from the sensor with device number 04.

ATTENTION The system keys of the sensor and the MRL-6.1 must be the same! In the example above the system key is 12. Set System key of the MRL-6.1 to 12 as well, or adapt the key of the sensor.

14.4.6 Trigger measurements of a Sommer RS-485 device

In many applications it is preferred that the MRL-6.1 triggers the sensor measurements. As an example, the SOMMER SQ-U water discharge sensor can be set into triggered mode. Once it has received the trigger command, the sensor performs the measurement and returns the acquired data to the MRL-6.1. The wiring for this example is shown in Figure 19.

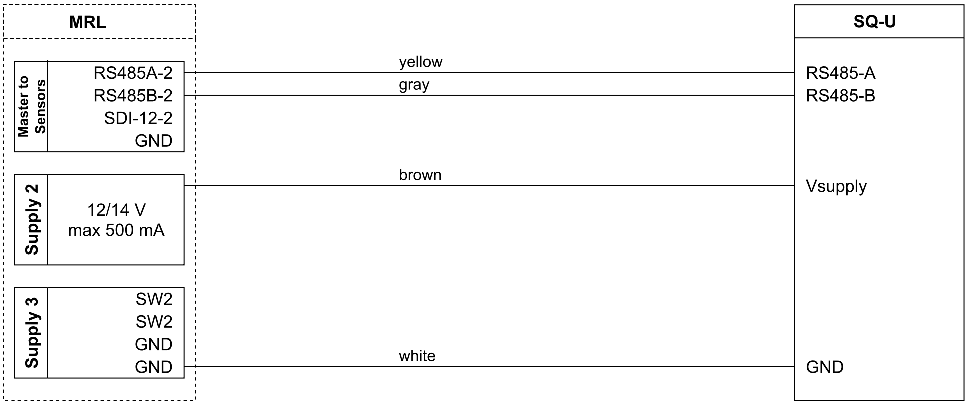


Figure 19 Wiring of SQ-X water discharge sensor with RS-485 interface

The SQ-U in this example is configured in Measurement table as follows:

	Function	Identifier	Unit	Decimals	Scale	Offset			S-TYP	S-NUM	S-MEA	S-ADD
01	actual	Water level	m	as S		0	Adjustment	Test	SBP	1	2	
02	actual	Velocity	m/s	as S		0	Adjustment	Test	SBP	1	3	
03	actual	Discharge	m^3/s	as S		0	Adjustment	Test	SBP	1	5	

Additionally, Polling must be set to *On*!

To match this setup, the Measurement trigger of the sensor must be set to *SDI-12/RS485*, and the output time (in sub-menu RS485 protocol) to *After measurement*.

Note that in this example only three variables of the SQ-U are recorded. The device provides an extended list of variables that can be read by the data logger.

> NOTE Alternatively, the SQ-U can be set to acquire measurements in its own interval. See Reading data from a Sommer RS-485 device for configuration.

14.5 SDI-12

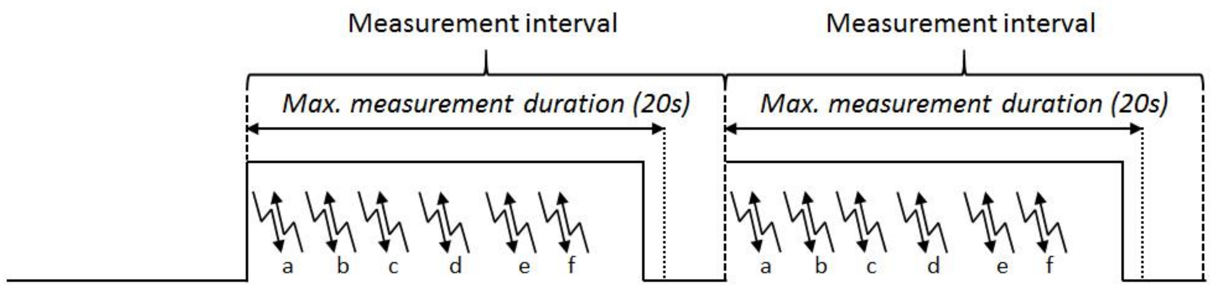
SDI-12 (Serial Data Interface at 1200 Baud) is a serial data communication standard for interfacing multiple sensors with a single data recorder. The MRL-6.1 complies with SDI-12 Version 1.3.

The MRL-6.1 is equipped with two SDI-12 ports. The port on terminal Masters to Sensors operates as an SDI-12 master, and the port on terminal Slave to COM as an SDI-12 slave.

The functions in the parameter menu SDI-12 Master offers some helpful functions to query SDI-12 sensor addresses, to test communication and to handle extended SDI-12 commands..

14.5.1 Principles

The example below illustrates how the MRL-6.1 triggers the measurements and requests the results from three SDI-12 sensors.



The commands and the received responses are as follows:

1. `0M!` Response: `00013<CR><LF>` 3 values are available in 1 second
2. `0D0!` Response: `0+1.1+2.2+3.3><CR><LF>` 3 values: `1.1`, `2.2`, `3.3`
3. `1M!` Response: `10022<CR><LF>` 2 values are available in 2 seconds
4. `1D0!` Response: `1+4.4+5.5<CR><LF>` 2 values: `4.4`, `5.5`
5. `2M!` Response: `20031<CR><LF>` 1 value is available in 3 seconds
6. `2D0!` Response: `2+6.6<CR><LF>` 1 value: `6.6`

At the beginning of each measurement interval the MRL-6.1 sends an `M!` command to the first sensor. The sensor answers by returning the number of available measurements and the measurement duration. After the required measurement time the MRL-6.1 sends a `D!` command to request the measurement results. This sequence is repeated for the other two sensors before the next measurement interval starts.

The MRL-6.1 supports all standard SDI-12 commands. See S-ADD in Measurement table for a full list of these commands. For a detailed description on SDI-12 communication please refer to www.sdi-12.org.

> **TIP** If you need to know more about how to program multiple M! and D! commands please see the example in Send multiple SDI-12 requests.

14.5.2 Measurements with an SDI-12 sensor

An SDI-12 sensor is wired to the MRL-6.1 as shown in Figure 20.

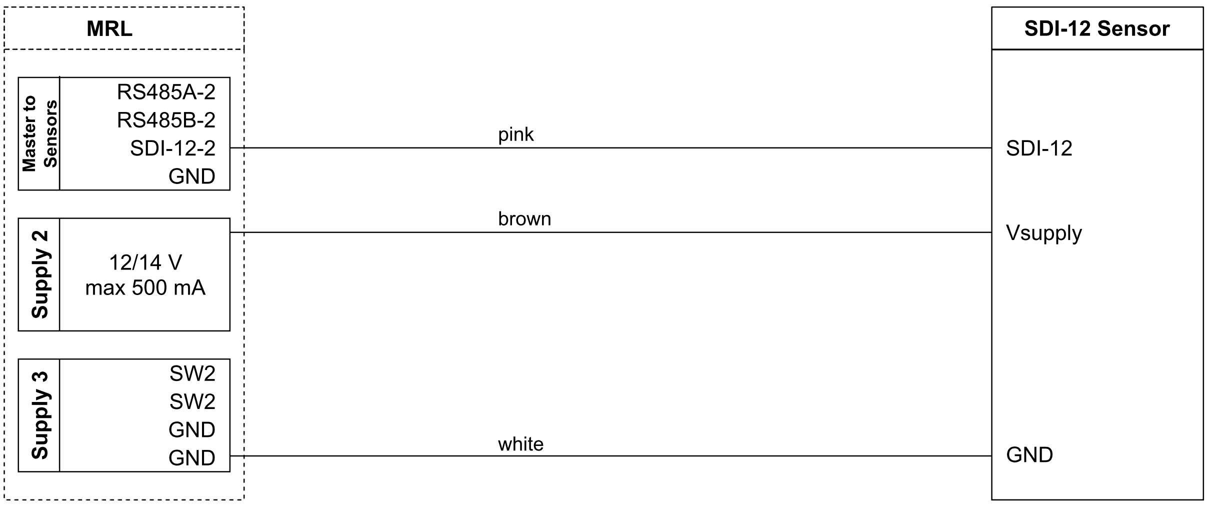


Figure 20 Wiring of a SDI-12 sensor

An SDI-12 sensor is configured in Measurement table as in the following example:

	Function	Identifier	Unit	Decimals	Scale	Offset			S-TYP	S-NUM	S-MEA	S-ADD
01	actual	Water Level	m	as S		0	Adjustment	Test	SDI12	1	2	
02	actual	Velocity	m/s	as S		0	Adjustment	Test	SDI12	1	3	
03	actual	Discharge	m^3/s	as S		0	Adjustment	Test	SDI12	1	5	

To enable data acquisition via SDI-12, S-TYP has to be set to *SDI12*, S-NUM to the SDI-12 address of the sensor and S-MEA to the position of the required measurement value in the data string.

To check the correct wiring between the MRL-6.1 and SDI-12 sensors, and to request the addresses of these sensors click on Sensor search in the SDI-12 Master menu. This function then searches for any connected SDI-12 sensors and lists their addresses and identifications. To change a sensor address click Change sensor address.

NOTE

Please consider that SDI-12 measurements of multiple sensors are performed sequentially. To determine the total measurement time, add the measurement times of all sensors!

Make sure Max. measurement duration is long enough to capture the SDI-12 measurements. Be aware that some sensors need long warm-up times, which requires adequate Max. measurement duration and an appropriate Measurement Interval.

NOTE The parameter Max. measurement duration is important to allow the MRL-6.1 to switch into power saving mode in case a sensor has a failure.

15 Signal output examples

As listed in What can I do with it? the MRL-6.1a and MRL-6.1abt provide multiple signal output options. The most common are described in this section.

15.1 Current output

In this example the measurement values of a temperature and humidity sensor is applied to the 4 ... 20 mA outputs of the MRL-6.1a. The settings of Measurement table and Overview (MRL-6.1a and MRL-6.1abt only) are shown below.

	Function	Identifier	Unit	Decimals	Scale	Offset			S-TYP	S-NUM	S-MEA	S-ADD
01	actual	Air Temperature	°C	2	100	-40	Adjustment	Test	AIN		AIN 1	
02	actual	Humidity	%	1	100	0	Adjustment	Test	AIN		AIN 2	

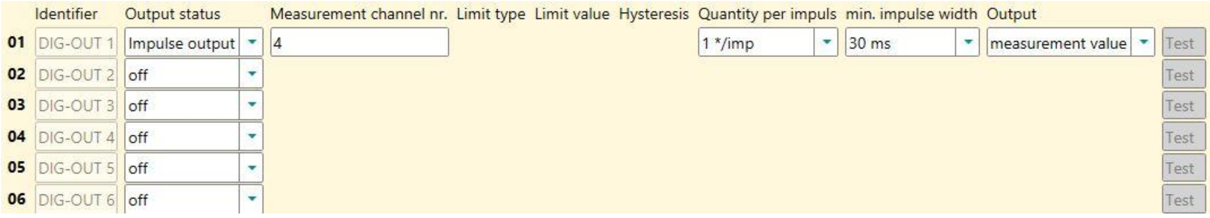
	Identifier	Output status	Channel allocation	4 mA value	4-20 mA span
01	IOUT 1	always on	1	-30	90
02	IOUT 2	always on	2	0	100
03	IOUT 3	off			
04	IOUT 4	off			

NOTE The range of the 4 ... 20 mA output is specified in 4-20 mA span. In the example above, the current output ranges from -30 to +60 °C, which corresponds to a span of 90°C.

15.2 Pulse output

In this example the water flow of a canal is recorded with a SOMMER SQ-U discharge sensor. To display the total volume with an analog meter the MRL-6.1a converts the flow value to a corresponding number of pulses that are applied to the digital output.

	Function	Identifier	Unit	Decimals	Scale	Offset			S-TYP	S-NUM	S-MEA	S-ADD
01	actual	Water level	m	as S		0.0	Adjustment	Test	SBP	1	2	
02	actual	Velocity	m/s	as S		0.0	Adjustment	Test	SBP	1	3	
03	actual	Flow rate	m^3/s	as S		0.0	Adjustment	Test	SBP	1	5	
04	actual	Flow	m^3	as S		0.0	Adjustment	Test	RECYC	3		PS



The water volume that passes the discharge sensor in one measurement interval is specified in the measurement table with index *4* and has the unit m³ (the command *PS* in S-ADD returns the number of seconds of one measurement interval).

After each measurement interval the flow is returned on DIG-OUT 1 with *1 m³/impulse*. For example, a flow of 12.3 m³ generates 12 impulses. The remaining volume of 0.3 m³ is added to the next interval.

If Quantity per impulse would be set to *10 */imp*, only one impulse would be generated and the remaining 2.3 m³ would be added to the next interval.

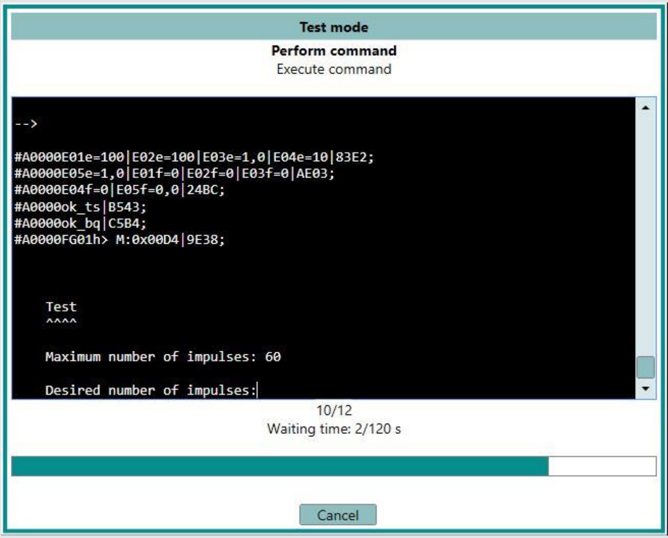
15.2.1 How to simulate pulse output

Each entry in Digital outputs (MRL-6.1a and MRL-6.1abt only) has a Test button to simulate the specified pulse output. This allows testing of a connected display or data acquisition system.

By clicking Test, a window opens and the maximum number of pulses the MRL-6.1a can return with the present settings are displayed.

EXAMPLE

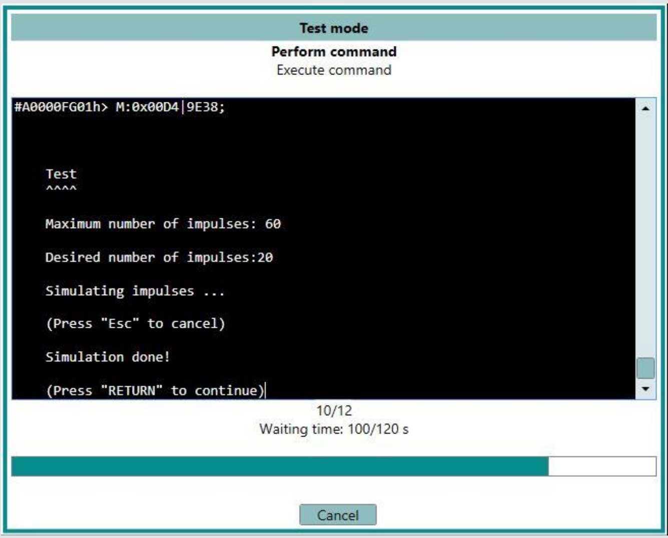
In this example the Measurement Interval is set to *1* minute and the min. impulse width in Digital outputs (MRL-6.1a and MRL-6.1abt only) to *500 ms*. As each impulse of high voltage is followed by a low-voltage lapse of the same length, 60 s·min^{-1} / (2 x 0.500 s) = 60 pulses can be applied to the digital output every minute.



In the pop-up window you can now enter the desired number of pulses that are applied to the digital output.

EXAMPLE

Following the example above, by entering a desired number of 20 impulses the digital output of the MRL-6.1a is activated and the pulses are applied. After all pulses have been sent `Simulation done!` is displayed.



15.3 Limit monitoring

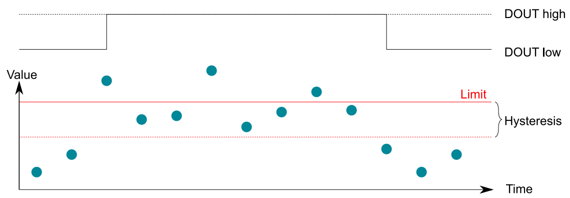
The MRL-6.1a can be used to monitor a variable with respect to a limit value. In this example the discharge of a river is monitored with a Sommer SQ-U water discharge sensor. The MRL-6.1a shall return a high-voltage signal as soon as the discharge exceeds 9 m^3/s.

To implement this task, the Limit value in Digital outputs (MRL-6.1a and MRL-6.1abt only) is set to *9* and Hysteresis to *0.5*. As soon as the water discharge exceeds 9 m^3/s the digital output DIG-OUT 1 is set to *high*. This status remains until the water discharge drops below 9.0 m^3/s – 0.5 m^3/s = 8.5 m^3/s again.

	Function	Identifier	Unit	Decimals	Scale	Offset			S-TYP	S-NUM	S-MEA	S-ADD
01	actual	Water level	m	as S		0	Adjustment	Test	SBP	1	2	
02	actual	Velocity	m/s	as S		0	Adjustment	Test	SBP	1	2	
03	actual	Discharge	m^3/s	as S		0	Adjustment	Test	SBP	1	5	

	Identifier	Output status	Channel allocation	Limit type	Limit value	Hysteresis	min. impulse width	
01	DIG-OUT 1	Limit monitor	3	Limit overrun	9	0,5		Test
02	DIG-OUT 2	off						
03	DIG_OUT 3	off						
04	DIG-OUT 4	off						
05	DIG-OUT 5	off						
06	DIG-OUT 6	off						

The hysteresis prevents frequent switching of the digital output when the monitored variable fluctuates around the limit value. The graph below illustrates this situation.



16 Parameter definitions

A Station ID

`mrl-station-id`

By default, the station ID is set to the MRL-6.1 serial number. Adjust to your requirements if needed.

Value range	Default	Unit
0...99'999'999	xxxxxxxx	-

B Station name

`mrl-station-name`

The name of the Station (max. 32 characters long).

C Measurement Interval

`generic-measurement-interval`

The interval at which measurements are acquired.

Value range	Default	Units
00:00:02 ... 12:00:00	00:05:00	-

D Storage interval

`mrl-storage-interval`

The interval at which acquired measurements are stored in internal memory.

Value range	Default	Unit
00:00:02 … 12:00:00	00:05:00	-

E Measurements, max. number

mrl-measurements-max-number

The number of variables the MRL-6.1 records. If the MRL-6.1 is shipped with additional instruments, SOMMER Messtechnik pre-configures the required variables. The variables are configured in Measurement table and their number can be increased to 99 (including Aux measurements, max. number) .

Value range	Default	Unit
0 … 99	4	-

F Aux measurements, max. number

mrl-aux-measurements-max-number

The number of auxiliary variables the MRL-6.1 records. Auxiliary variables are configured like regular variables, except that they are not stored in memory and are only visible in the Commander Measurement tab, the terminal window or the logger display. In Measurement table they are numbered downwards from 99.

Auxiliary variables may be used to monitor limit violations, trigger messages or to display a variable with a second, different unit or a different offset. They are also used to combine different variables to a new one.

Value range	Default	Units
1 … 99	0	-

G Measurement table

generic-measurement-table

In the measurement table the required variables and any auxiliary variables are configured. The measurement table can have up to 99 entries. Each entry is configured by the parameters described below.

The measurement table is a powerful tool to configure a wide range of measurement inputs. The controls S-TYP, S-NUM and S-MEA are used to select the input type and the measurement source. Scale and Offset convert the acquired signal to a readable quantity and Function applies a statistical transformation. Finally, S-ADD is used to apply a special property to the measurement variable, e.g. *MR1* to reset a summed variable at the 1st of the month.

Function

`generic-measurement-table-function`

Defines the output type of the variable. The following options are available:

ID	Function	Description
1	Off	The variable is not recorded and stored.
2	Actual	The last value acquired within the storage interval is recorded and saved.
3	Meanval	The average of all values acquired within the storage interval is recorded and saved.
4	Minimum	The minimum of all values acquired within the storage interval is recorded and saved.
5	Maximum	The maximum of all values acquired within the storage interval is recorded and saved.
6	Sum	The sum of all values acquired within the storage interval is recorded and saved.
7	Intens.	The difference of the last two stored values is saved. If the difference is negative, *0* is returned. Often used for rain intensity measurements.
8	Diff.	The difference of the last two stored values is saved.
9	Custom1	not generally available
10	Custom2	not generally available

Identifier

`generic-measurement-table-identifier`

User defined variable name. Max. 17 characters long.

Unit

`generic-measurement-table-unit`

The unit of the selected variable. Max. 7 characters long.

Decimals

`generic-measurement-table-decimals`

The number of decimal places assigned to the selected variable. The following options are available:

ID	Decimals	Description
1…5	1…5	number of decimal places assigned to the selected variable
6	none	no decimal places
7	as S	For a connected serial sensor the number of decimal places of the sensor output is adopted. For a connected analog sensor the following rules apply: Input type — Decimal places Voltage, resistance — 4 Frequency of wind sensor — 1 Direction of wind sensor — 1

Scale

`generic-measurement-table-scale`

The slope applied to the selected variable. Only available if Decimals is set to 1…5 or none. If Decimals is set as S (as source), no scaling is applied.

Offset

`generic-measurement-table-offset`

The offset applied to the selected variable.

Adjustment

`generic-measurement-table-adjustment`

A measurement of the selected variable is triggered and the result displayed in a terminal window. If the measured value deviates from the correct value, the correct value can be entered. This adjusts the value in Offset. The factor in Scale is not affected by this correction.

Test

`generic-measurement-table-test`

A measurement of the selected variable is triggered and the result displayed in a terminal window.

S-TYP

`generic-measurement-table-s-typ`

One of the following sensor (or source) types:

S-TYP	Description and S-MEA options
AIN	Analog input The input port is set in S-MEA with the following options: `AN 1 ... AN 8` Analog input 1 ... 8
WIND	Wind sensor The input is set in S-MEA with the following options: `Speed` Wind speed `Direct.` Wind direction
COUNT	Counter input See Counter & frequency measurements for details.
SDI12	SDI-12 input The sensor address is set in S-NUM, and the position of the measurement value within the output string is assigned in S-MEA. See SDI-12 for details.
SBP	SOMMER sensor that supports the SBP-protocol (via RS-485) The sensor address is set in S-NUM, and the position of the measurement value within the output string is assigned in S-MEA. See RS-485 for details.
MIO	SOMMER sensor that supports the MIO-protocol (via RS-485) The sensor address is set in S-NUM, and the position of the measurement value within the output string is assigned in S-MEA. See Reading data in MIO-format for details.
SYS	System variable The variable is set in S-MEA with the following options: `Status A` Number of triggers received on the TRIG- input within the Measurement Interval `Status B` not assigned `Exep. A` Diagnostic variable `Exep. B` Diagnostic variable `HB` Heartbeat (diagnostic variable) `+Sup V` Supply voltage `12V | 14V` Voltage of internal 12V / 14V power supply `5V` Voltage of internal 5V power supply `2.5V` Voltage of internal 2.5V power supply
RECYC	Performs an operation on the variable referenced in S-NUM and returns its result. See S-ADD for available operations.
RECYCM	Performs a mathematical operation between two variables referenced in S-NUM and S-MES, and returns its result. See S-ADD for available functions.

S-NUM

`generic-measurement-table-s-num`

This setting depends on the selection of S-TYP. For example, if S-TYP is set to *SDI12*, *S-NUM* sets the SDI-12 address of the connected sensor.

S-MEA

`generic-measurement-table-s-mea`

This setting depends on the selection of S-TYP. For example, if S-TYP is set to *SDI12*, *S-MEA* sets the position of the measurement variable within the SDI-12 string. See S-TYP for all available options.

S-TYP	S-NUM	S-MEA	Usage
SBP	Sensor address (*0...99*)	Position of variable in received data string (*0...99*).	Read value of digital sensor using SBP protocol.
MIO	Sensor address (*0...99*)	Position of variable in received data string (*0...99*).	Read value of digital sensor using MIO protocol.
SDI12	Sensor address (*0...62*)	Position of variable in received data string (*0...99*).	Read value of SDI-12 sensor.
RECYC	Measurement ID (*0...99*)	-	See table in S-ADD.
RECYCM	Measurement ID (*0...99*)	Measurement ID (*0...99*)	See table in S-ADD.

S-ADD

`generic-measurement-table-s-add`

Contains additional commands which are sent with a standard request to a sensor (or source), or which provide additional options for controlling measurements and handling results. The available commands depend on the settings of Function, S-TYP and S-ADD.

Function	S-TYP	S-ADD	Description
SUM	all	`NR`	No reset of summed variables at defined reset event.
SUM	all	`MRx`	Monthly reset of summed variables at day x, e.g *MR1* for reset at 1st of month.
SUM	all	`DD`	Double data for summed variables at reset event; old and new values are stored.
all	SDI12	`_Cn`	Concurrent measurement command for measurements `n` (`_C1` .... `_C9`).

Function	S-TYP	S-ADD	Description
all	SDI12	CCn	Concurrent measurement command with CRC for measurements n (_CC1 .... _CC9).
all	SDI12	_Mn	Measurement command for measurements n, (_M1 .... _M9).
all	SDI12	MCn	Measurement command with CRC for measurements n, (_MC1 .... _MC9).
all	SDI12	_Rn	Read command for measurements n, (_R0 .... _R9).
all	SDI12	RCn	Read command with CRC for data n, (_RC0 .... _RC9).
all	SDI12	RD	Rain disdrometer data of Sommer Messtechnik RHD sensor.
all	SDI12	HD	Hail disdrometer data of Sommer Messtechnik HDI sensor.
all	SBP, MIO	SCx	Sub-channel x for MDL compatibility.
all	SBP, MIO	TD	Trigger data of a SBP or MIO device.
all	MIO	TF	Trigger fake. In MIO protocol ID's are often only string ID's and not real device ID's. TF marks the real device ID's.
all	all	SY	Synchronous storage: variable that is normally stored asynchronously is stored in the main storage interval, e.g. a counter intput.
all	all	AS	Asynchronous storage: variable that is normally stored synchronously is stored in the Storage interval asynchronous, i.e. it is only stored if the variable changes its value.
all	all	PV	Values are returned on serial port RS-485-2 immediately after measurement. This may be used to send measurement values to another serial sensor as input. **ATTENTION** Make sure to use proper timing if data are also received over the RS-485-2 port.

Function	S-TYP	S-ADD	Description
all	all	`MAxx`	Moving average of `xx` values, where `xx` is 5, 12, 24, 48, 96. Note: Each command can only be applied once, i.e. one MA5, one MA12, ...!
all	all	`PS`	Converts the measurement interval into seconds (`PS`), minutes (`PM`), hours (`PH`) and days (`PD`) and multiplies the it with the value of the variable. Generally used to calculate differences and intensities. For example, a sensor returns a flow rate with the unit m^3/s. To return the total flow, set Function to *Sum*, the Unit to *m^3* and S-ADD to *PS*. Here, the measurement interval is converted into seconds, multiplied with the measurement value and added to the flow. ATTENTION: Select the time unit that matches the unit of the variable!
all	all	`PM`	
all	all	`PH`	
all	all	`PD`	
all	RECYC	`GS`	Returns the limit status of the variable referenced in S-NUM. If a limit has been violated *1* is returned.
all	RECYCM	`D+`	Adds variables referenced in S-NUM and S-MEA.
all	RECYCM	`D-`	Subtracts variable referenced in S-MEA from S-NUM.
all	RECYCM	`D*`	Multiplies variables referenced in S-NUM and S-MEA.
all	RECYCM	`D/`	Divides variable referenced in S-NUM by S-MEA.
all	RECYCM	`EX`	Returns exponential of variable referenced in S-NUM (power to basis `e`).
all	RECYCM	`PTy.y`	Returns potential of variable referenced in S-NUM to the power of `y.y`, e.g. a value of *2* with function `PT3.0` returns *$2^3 = 8$*.
all	RECYCM	`DM`	Returns the value of the variable referenced in S-MEA at the maximum or minimum of the variable referenced in S-NUM. Generally used to record the wind directions of wind gusts (direction maximum).

> **TIP** Multiple commands can be entered by separating them with a space, e.g. `D+ SY`.

H Technics

H-A SBP device addressing

H-A-A Device number

`generic-rs-485-protocol-device-number`

The device number is used for the unique identification of the device in a bus system.

Value range	Default	Units
0...98	0 (default)	-

H-A-B System key

`generic-rs-485-protocol-system-key`

The system key defines the bus system of the device. Thus, different conceptual bus systems can be separated. Interfering bus systems occur if the remote radio coverage of two measurement systems overlap. In general, the system key should be set to 00.

Value range	Default	Units
0...99	0	-

H-A-C Enable network scan

`generic-rs-485-port-network-scan-extension`

Optional detection of connected SOMMER sensors with the Commander software.

ID	Setting	Description
1	No	Detection of SOMMER devices connected to RS485-2 is deactivated.
2	Yes (default)	Detection of SOMMER devices connected to RS485-2 is activated.

H-B COM

H-B-A Output protocol

H-B-A-A Protocol type

`generic-rs-485-protocol-output-protocol`

The type of the serial output protocol. The following options are available:

ID	Option	Description
1	Sommer (SBP) (default)	Sommer protocol; data values are returned with an index starting at 1. Multiple strings may be returned.
2	Standard	Standard protocol; data values are returned without an index in one string.

H-B-A-B Measurement output

`generic-rs-485-protocol-measurement-output`

Specifies the timing of the serial data output.

ID	Option	Description
1	Just per command	The output is only requested by commands via the RS-485 or SDI-12 interface.
2	Measured values push	Data are returned automatically after each measurement. interval.
3	Storage values push	Data are returned automatically after they have been written to the data logger memory.

H-B-A-C Information

`generic-rs-485-protocol-information`

The main measurement values are always included in the data output string. Additionally, the auxiliary values can be included.

ID	Option	Description
1	Main values	Only the main values are returned.
2	& Aux values	Main values and auxiliary values are returned.

H-B-A-D Wake-up sequence

`generic-rs-485-protocol-wake-up-sequence`

Serial data can be transmitted to a recording device automatically without a request. However, many devices demand a wake-up sequence before they can receive and process data. The MRL-6.1 has the option to send a sync sequence and a prefix before data are transmitted (see Waking-up a connected data logger). The following options are available:

ID	Option	Description
1	Off	No wake-up sequence
2	Sync	The sync sequence UU~?~? is sent before the output string.
3	Prefix (default)	A blank with a time delay is sent before the output string.
4	Prefix & Sync	A blank with a time delay and the sync sequence UU~?~? is sent before the output string.

H-B-A-E Prefix holdback

`generic-rs-485-protocol-prefix-holdback`

The hold-back time defines the time delay between the prefix and the data string.

Value range	Default	Units
0...5'000	300	ms

H-B-B Port

H-B-B-A Baud rate

`generic-rs-485-port-baud-rate`

The following transmission rates in bps (baud) can be selected:

ID	Option	Description
1	1'200	-
2	2'400	-
3	4'800	-
4	9'600 (default for sensors and data logger inputs)	-
5	19'200 (default if used with radio communication)	-
6	38'400	-
7	57'600	-
8	115'200 (default for data loggers)	-

H-B-B-B Parity, stop bits

`generic-rs-485-port-parity-stop-bits`

The following combinations of parity and stop bits can be selected:

ID	Option	Description
1	No par, 1 stop (default)	No parity and 1 stop bit
2	No par, 2 stop	No parity and 2 stop bits
3	Even par, 1 stop	Even parity and 1 stop bit
4	Odd par, 1 stop	Odd parity and 1 stop bit

H-B-B-C Minimum response time

`generic-rs-485-port-minimum-response-time`

This setting avoids failures of half-duplex interfaces. For this purpose the response to a command is delayed by the selected time. Additionally, the response is also kept temporally compact.

Value range	Default	Units
0...2'000	10	ms

H-B-B-D Flow control

`mrl-com-port-flow-control`

ID	Option	Description
1	Off	no flow control
2	XOFF-XON	XOFF-XON flow control, especially adapted for half-duplex systems
3	RTS-CTS (default)	RTS-CTS flow control
4	DFM-RC	Flowcontrol for Sommer Messtechnik DFM point-to-point radios.
5	DFM-TM	Flowcontrol for Sommer Messtechnik DFM tiny-mesh radios.

H-C Inputs

H-C-A RS485-2

H-C-A-A Sensor supply (always on)

`mrl-12v-sensor-supply-always-on`

Sets the 12V sensor supply.

ID	Setting	Description
1	Off (default)	The sensor supplies 12V / 14V and SW2 are off.
2	SW2	The sensor supply SW2 is active.
3	12V / 14V	The sensor supply 12V / 14V is active.
4	12V / 14V & SW2	Both sensor supplies 12V / 14V and SW2 are active.

NOTE If one of the listed sensor supplies has been selected, it also remains active during the sleep mode of the MRL-6.1.

H-C-A-B SBP sensor feedback

The parameters in this menu define the transmission of measurement data to serial RS-485 sensors operating with the Sommer bus protocol (SBP).

H-C-A-B-A Measurement output

`generic-rs-485-protocol-measurement-output`

Specifies the timing of the serial data output.

ID	Option	Description
1	Just per com- mand	The output is only requested by commands via the RS-485 or SDI-12 interface.
2	Measured values push	Data are returned automatically after each measurement. interval.
3	Storage values push	Data are returned automatically after they have been written to the data logger memory.

H-C-A-B-B Information

`generic-rs-485-protocol-information`

The main measurement values are always included in the data output string. Additionally, the auxiliary values can be included.

ID	Option	Description
1	Main values	Only the main values are returned.
2	& Aux values	Main values and auxiliary values are returned.

H-C-A-B-C Wake-up sequence

`generic-rs-485-protocol-wake-up-sequence`

Serial data can be transmitted to a recording device automatically without a request. However, many devices demand a wake-up sequence before they can receive and process data. The MRL-6.1 has the option to send a sync sequence and a prefix before data are transmitted (see Waking-up a connected data logger). The following options are available:

ID	Option	Description
1	Off	No wake-up sequence
2	Sync	The sync sequence UU~?~? is sent before the output string.
3	Prefix (default)	A blank with a time delay is sent before the output string.
4	Prefix & Sync	A blank with a time delay and the sync sequence UU~?~? is sent before the output string.

H-C-A-B-D Prefix holdback

`generic-rs-485-protocol-prefix-holdback`

The hold-back time defines the time delay between the prefix and the data string.

Value range	Default	Units
0...5'000	300	ms

H-C-A-C Port

H-C-A-C-A Baud rate

`generic-rs-485-port-baud-rate`

The following transmission rates in bps (baud) can be selected:

ID	Option	Description
1	1'200	-
2	2'400	-
3	4'800	-
4	9'600 (default for sensors and data logger inputs)	-
5	19'200 (default if used with radio communication)	-
6	38'400	-
7	57'600	-
8	115'200 (default for data loggers)	-

H-C-A-C-B Parity, stop bits

`generic-rs-485-port-parity-stop-bits`

The following combinations of parity and stop bits can be selected:

ID	Option	Description
1	No par, 1 stop (default)	No parity and 1 stop bit
2	No par, 2 stop	No parity and 2 stop bits
3	Even par, 1 stop	Even parity and 1 stop bit
4	Odd par, 1 stop	Odd parity and 1 stop bit

H-C-A-C-C Minimum response time

`generic-rs-485-port-minimum-response-time`

This setting avoids failures of half-duplex interfaces. For this purpose the response to a command is delayed by the selected time. Additionally, the response is also kept temporally compact.

Value range	Default	Units
0...2'000	10	ms

H-C-A-C-D Transmitter warm-up time

`generic-rs-485-port-transmitter-warm-up-time`

The transmitter warm-up time defines the time before data is sent.

Value range	Default	Units
0...2'000	10	ms

H-C-A-C-E Flow control

`generic-rs-485-port-flow-control`

Flow control for the defined application.

ID	Option	Description
1	Off	no flow control
2	XOFF-XON blocking (default)	XOFF-XON flow control, especially adapted for half-duplex systems
4	DFM-RC	Flowcontrol for Sommer Messtechnik DFM point-to-point radios.
5	DFM-TM	Flowcontrol for Sommer Messtechnik DFM tiny-mesh radios.

H-C-A-C-F Sending window

`generic-rs-485-port-sending-window`

If XON-XOFF flow control is activated data are transmitted in blocks with the defined length.

Value range	Default	Units
200...5'000	300	ms

H-C-A-C-G Receiving window

`generic-rs-485-port-receiving-window`

If XON-XOFF flow control is activated transmission of blocks is delayed by the specified time.

Value range	Default	Units
200...5'000	300	ms

H-C-A-C-H Transparency to RS485 A/B

`generic-rs-485-port-transparency-rs-485-2`

Only required in terminal mode. After activation, direct communication with a connected sensor is enabled, i.e. commands and theirs answers are exchanged over the RS485-2 interface of the MRL-6.1. With this mode the settings of a connected digital sensor can be read or changed.

The transparency mode has some restrictions:

- Data logger polling is inactive.
- You can only access a connected sensor with `???` if no other sensor is connected to the RS-485 bus.
- If a sensor in the RS-485 bus pushes data, it will interfere with any parametrization effort unless it is switched off.

H-C-A-D Trigger

H-C-A-D-A Polling

`generic-rs-485-port-trig-polling`

Sets the polling of connected digital sensors.

ID	Setting	Description
1	Off (default)	Regular polling is inactive.
2	On	Regular polling is active. This settings allows the interface to switch into sleep mode between pollings.

H-C-A-D-B Timeout

`generic-rs-485-port-trig-timeout`

The time the MRL-6.1 is waiting until expected commands/answers are received via the RS485-2 interface.

Value range	Default	Units
3 … 250	60	s

H-C-A-D-C Sleep while timeout

`generic-rs-485-port-trig-sleep-timeout`

To reduce power consumption the MRL-6.1 can switch to a sleep mode between measurements.

ID	Setting	Description
1	Off (default)	MRL-6.1 remains activated between measurements, i.e. during Timeout
2	On	MRL-6.1 is inactive between initialization of measurement and reception of measurement data. The connected sensor must send a Prefix command to wake up the MRL-6.1 for data transmission.

H-C-A-D-D Polling delay

`generic-rs-485-polling-delay`

Time by which polling of multiple digital sensors is delayed. Used to poll sensors in sequence to avoid communication conflicts during subsequent measurement data transmission.

Value range	Default	Unit
0 … 20	2	sec

H-C-B SDI-12 Master

H-C-B-A Max. measurement duration

`generic-sdi-12-max-measurement-duration`

The timeout for commands sent to SDI-12 devices connected to the MRL-6.1. After the MRL-6.1 has received a response, it goes back into sleep mode. If a SDI-12 device does not respond within this time the MRL-6.1 returns a measurement error.

Value range	Default	Units
0...255	20	sec

H-C-B-B Sensor supply (always on)

`mrl-12v-sensor-supply-always-on`

Sets the 12V sensor supply.

ID	Setting	Description
1	Off (default)	The sensor supplies 12V / 14V and SW2 are off.
2	SW2	The sensor supply SW2 is active.
3	12V / 14V	The sensor supply 12V / 14V is active.
4	12V / 14V & SW2	Both sensor supplies 12V / 14V and SW2 are active.

NOTE If one of the listed sensor supplies has been selected, it also remains active during the sleep mode of the MRL-6.1.

H-C-B-C Sensor search

`generic-sdi-12-sensor-search`

Searches for connected SDI-12 sensors and lists their identification and sensor address in the terminal window.

H-C-B-D Change sensor address

`generic-sdi-12-change-sensor-address`

Changes the SDI-12 address of a connected sensor.

H-C-B-E SDI-12 address

`generic-sdi-12-address`

The address is a unique identifier of the sensor within a SDI-12 bus system.

Value range	Default	Units
0...9, a...z, A...Z	0	-

H-C-B-F Transparency to SDI-12

`mrl-sdi-12-transparency`

Enables direct communication with a connected device, i.e. commands and theirs answers are exchanged over the SDI-12 interface of the MRL-6.1. Requires knowledge about SDI-12 communication.

H-C-C Analog inputs

H-C-C-A AIN signal type

`mrl-ain-signal-type`

Measurement type of analog input channels.

ID	Setting	Description
1	Voltage 2.5 V	Single ended voltage input 0 ... 2.5 V
2	Diff volt. 2.5 V	Differential voltage input 0 ... 2.5 V
3	Diff volt. 1.25 V	Differential voltage input 0 ... 1.25 V
4	Diff volt. 0.311 V	Differential voltage input 0 ... 0.311 V
5	Diff volt. 0.032 V	Differential voltage input 0 ... 0.032 V
6	R meas < 100k	Measures a resistance <100 kΩ
7	R meas < 3k	Measures a resistance <3 kΩ
8	R meas < 300	Measures a resistance <300 Ω
9	4...20 mA	Current input 4 ... 20 mA
10	PT1000	Measures the temperature of a PT1000 temperature sensor
11	NTC (2k2)	Measures the temperature of a 2k2 NTC-thermistor
12	AD592	Measures the temperature of an AD592 temperature sensor
13	PT100	Measures the temperature of a PT100 temperature sensor

H-C-C-B Warm-up time

`generic-warm-up-time`

The time required to return valid measurements, e.g., if an analog sensor requires warm-up to perform properly.

Value range	Default	Units
0…255	0	sec

H-C-C-C ADC - conv. Rate

`mrl-adc-conversion-rate`

The sampling rate of the analog inputs.

ID	Setting	Description
1	2 Hz	Sampling rate of 2 Hz
2	3 Hz	Sampling rate of 3 Hz
3	5 Hz	Sampling rate of 5 Hz
4	8 Hz	Sampling rate of 8 Hz
5	25 Hz	Sampling rate of 25 Hz
6	62 Hz (default)	Sampling rate of 62 Hz
7	125 Hz	Sampling rate of 125 Hz
8	250 Hz	Sampling rate of 250 Hz

H-C-C-D ADC filter

`mrl-adc-filter`

Filter for analog data acquisition.

ID	Setting	Description
1	Off (default)	Each analog channel is sampled once and no filter is applied.
2	Minimum of 3	Each analog channel is sampled three times per measurement cycle and the minimum value is returned.
3	Median of 3	Each analog channel is sampled three times per measurement cycle and the median value is returned.
4	Mean of 3	Each analog channel is sampled three times per measurement cycle and the mean value is returned.

H-C-C-E Sensor supply

H-C-C-E-A SW2

`mrl-sensor-supply-sw2`

Sets the switched sensor supply (terminal Supply 3).

ID	Setting	Description
1	off (default)	Switched supply is inactive.
2	Switched	Switched supply is active, i.e. power is supplied only during warm-up and measurement.
3	Always on	Switched supply is always on.

H-C-C-E-B 12 V / 14 V

`mrl-sensor-supply-12v-14v`

Sets the 12/14 V sensor supply (terminal Supply 2).

ID	Setting	Description
1	off (default)	12/14 V sensor supply is inactive
2	Switched	12/14 V sensor supply is active
3	Always on	12/14 V sensor supply is always on

H-C-C-E-C 5V

`mrl-5v-sensor-supply`

Sets the 5V analog sensor supply.

ID	Setting	Description
1	Off (default)	5V sensor supply is inactive
2	Switched	5V sensor supply is active during analog measurements
3	Always on	5V sensor supply is always on

H-C-C-E-D 2.5 V

`mrl-2.5v-sensor-supply`

Sets the 2.5 V sensor supply.

ID	Setting	Description
1	Off (default)	The 2.5V sensor supply is inactive
2	Switched	The 2.5V sensor supply is active during analog measurements
3	Always on	2.5V sensor supply is always on

H-C-C-E-E External sensor supply

`mrl-external-sensor-supply`

Switch to select between internal and external power supply. This setting enables optimized power management by timely switching the links to the internal shunt resistors. In general, this setting must be *on* if a sensor is not powered by the MRL-6.1.

ATTENTION If a connected analog sensor is operated with an external power supply, this parameter must be set to *on*.

ID	Setting	Description
1	Used (default)	At least one analog sensor is powered by an external source.
2	Not used	All connected analog sensors are powered internally

H-C-D Additional meas. settings

H-C-D-A 12V / 14V output voltage

`mrl-12v-or-14v`

Selects 12 or 14 V sensor supply (terminal Supply 2).

ID	Setting	Description
1	12 Volt (default)	12V / 14V sensor supply is set to 12 V
2	14 Volt	12V / 14V sensor supply is set to 14 V

H-C-D-B Wind speed measurement duration

`mrl-wind-speed-measurement-duration`

The time for measuring the wind speed with a connected anemometer. With longer measurement times lower velocities can be accurately determined. However, longer measurement times also increase power consumption.

Value range	Default	Unit
500...2000	1000	ms

H-C-D-C Storage interval asynchronous

`mrl-occasional-storage-interval`

Storage interval of variables which are only stored at the time when their value changes.

Variables with the following S-TYP and S-MEA settings are stored by default in the asynchronous storage interval:

S-TYP	S-MEA
`COUNT`	–

`SYS`	`Status A`
	`Status B`
	`Exep. A`
	`Exep. B`

By adding the command `SY` in Measurement table, the variable can be forced to be stored in the primary storage interval.

Value range	Default	Unit
00:00:00 ... 23:59:59	00:01:00	-

H-C-D-D Sum, reset time

`mrl-sum-reset-time`

Time at which the sums of summed variables defined in Measurement table are reset to zero.

Value range	Default	Unit
00:00:00 ... 23:59:59	07:00:00	-

H-C-D-E Conversion table A

`mrl-A-table`

X-Y look-up table with up to 32 data-pairs. For a variable in Measurement table with the function *VA* in S-ADD the referenced variable of S-NUM is passed as X to the look-up table and the corresponding interpolated value of Y is returned. Up to 6 decimal places are supported.

H-C-D-F Conversion table B

`mrl-B-table`

X-Y look-up table with up to 32 data-pairs. For a variable in Measurement table with the function *VB* in S-ADD the referenced variable of S-NUM is passed as X to the look-up table and the corresponding interpolated value of Y is returned. Up to 6 decimal places are supported.

H-D Additional settings

H-D-A Sommer ID

`generic-sommer-id`

The Sommer ID is used to define stations within the Commander software. The ID is preset in the device and corresponds to its serial number.SOMMER suggests to change the ID only, if a MRL-6.1 device is replaced. In such a case it can be practical to change the ID of the new device to the ID of the replaced device to guarantee data consistency. It is important that two devices that have the same combination of Sommer ID and Station ID, do NOT access the IP-Call server or MDS!

H-D-B Block size, data load

`mrl-block-size-data-load`

The maximum amount of data transferred with one communication block requested by a data acquisition software.

Value range	Default	Units
50...250	250	-

H-D-C Internal low volt. disconnect

`mrl-internal-low-volt-disconnect`

To prevent deep discharge of the MRL-6.1 batteries, the device switches off if the battery voltage drops below the specified limit. It then checks every hour if the battery has recuperated again and eventually switches back to normal measurement mode. The limit depends on the battery and the duration the battery has to supply the station without any recharge; consult the battery datasheet for more information.

Value range	Default	Unit
0...11	11	V

NOTE If set to *0*, deep discharge is not monitored! This may be applied when using an external charger with an external battery (no battery is connected to terminal X1).

ATTENTION Inappropriate setting of the voltage limit can seriously impair the continuous operation of the MRL-6.1 or even lead to a complete failure of the station! Once the battery voltage drops to Internal low volt. Disconnect, all power outputs of the MRL-6.1 incl. X20 are switched off.

H-D-D SommerXF starts with BOM

`mrl-sommerxf-starts-with-bom`

The BOM (Byte Order Mark) labels the downloaded data file to indicate that special characters within the file are coded.

ID	Setting	Description
1	On (default)	BOM is is included in the data file.
2	Off	BOM is not included in the data file.

H-E Analog outputs (MRL-6.1a and MRL-6.1abt only)

H-E-A Overview (MRL-6.1a and MRL-6.1abt only)

`mrl-analog-output-overview`

Defines the behavior and scaling of the analog outputs. The available options are described in the table below.

Identifier	The name of the analog output, *IOUT 1* ... *IOUT 4*
Output status	The behavior of the analog output: *off* — Analog output is inactive *just during TRIG* — Analog output is only active when TRIG input is high *always on* — Analog output is always active
Measurement channel nr.	The index of the variable in Measurement table for which the analog output is generated.
4 mA value	The value of the variable specified in Measurement table that corresponds to 4 mA.
4.20 mA span	The value range of the variable specified in Measurement table that corresponds to the 4 ... 20 mA span.

NOTE The analog value corresponds to the Function specified in Measurement table, i.e., if Function is set to *actual*, the measurement value is returned, if Function is set to one of the aggregation options, the aggregated value is returned.

NOTE Measurement values as well as auxiliary values can be converted to analog outputs.

H-E-B Simulate current output

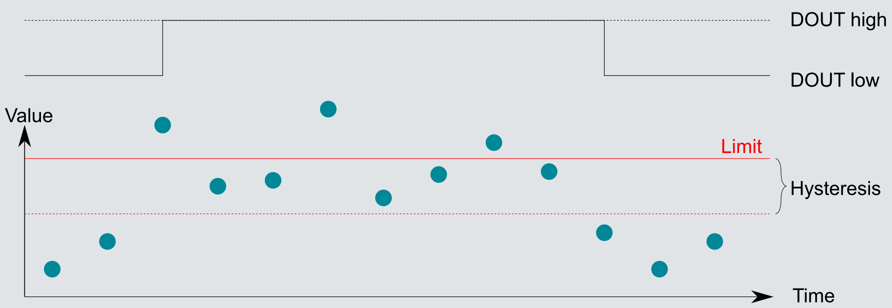
`generic-analog-out-simulate-current`

With this function the analog outputs can be simulated. Upon submission of a current value between 4 and 20 mA the corresponding values of the selected variable are displayed. The selected current is also applied to the active analog outputs and can be read with a connected data logger or multimeter. By pressing Return/Enter again the simulation stops.

H-F Digital outputs (MRL-6.1a and MRL-6.1abt only)

`mrl-digital-output-settings`

Defines the type of the digital outputs. The available options are described in the table below.

Identifier	The name of the digital output, *DIG-OUT 1* ... *DIG-OUT 2*
Output status	The type of the digital output: *off* — The digital output is inactive. *Limit monitor* — If the Limit value of the variable specified in Channel allocation is violated, the digital output is set to high. *Impulse output* — The value of the variable specified in Channel allocation is translated to an equivalent number of impulses and applied to the digital output. A comma is ignored. For example, a value of *12.6* returns *126* impulses.
Measurement channel nr.	The variable listed in Measurement table whose value is monitored. This can be a regular or an auxiliary variable.
Limit type	*above* — If the recorded value exceeds the Limit value the digital output is activated. *below* — If the recorded value falls below the Limit value the digital output is activated.
Limit value	The limit value of the variable specified in Channel allocation.
Hysteresis	Setting a hysteresis value suppresses multiple violations if the measurement value closely fluctuates around the threshold. After a violation the output state is preserved until the measured value exceeds or falls below the specified hysteresis value. The hysteresis is an absolute value and is added with the correct sign to the threshold. The figure below illustrates an example. 

Quantity per impuls	The quantity that represents one impuls. 0.01 */imp 0.1 */imp 1 */imp 10 */imp 100 */imp 1000 */imp	* ... unit of variable referenced in Measurement channel nr.
Min. impulse width	The minimum duration of the voltage impulse: *500 ms*, *100 ms*, *30 ms*	
Output	*measurement value*	The measured value is returned.
	statistic value	The aggregated statistic value is returned.
Test	Function to test the digital output.	

I Region format

I-A Language/Sprache

`generic-language`

The menu language.

ID	Option	Description
1	German/Deutsch	German language
2	English/Englisch (default)	English language

I-B Decimal character

`generic-decimals-character`

The character used as decimal separator in the values of the settings, in serial data strings and in .csv files.

ID	Option	Description
1	Comma	-
2	Dot (default)	-

J Special functions

J-A Device status

`generic-special-functions-device-status`

Displays information about the device and the software version.

J-B Last date sync.

`mrl-sync-date-last`

The date at which the MRL-6.1 has been last synchronized; read only.

J-C Last time sync.

`mrl-sync-time-last`

The time at which the MRL-6.1 has been last synchronized; read only.

J-D View setup

`generic-special-functions-view-setup`

All parameters of the MRL-6.1 are listed in the terminal window.

J-E Continuous meas. mode (temp).

`generic-special-functions-continuous-meas-mode`

Inactive in the Commander menu. This feature can be triggered in the Commander under the Measurement (F3) tab with the command Start polling measurements and then Start polling WITH measurements . When active, measurements are performed continuously, ignoring the specified measurement interval.

J-F Set factory default

`generic-special-functions-set-factory-default`

All parameters are reset to factory defaults. Only available in terminal-mode.

J-G Temp. load factory default

`generic-special-functions-temp-load-factory-default`

Loads factory default values temporarily. Only available in terminal mode.

J-H Relaunch program

`generic-special-functions-relaunch-program`

The device is restarted. Powering the sensor off and on again is equivalent.

J-I Replace program

`generic-special-functions-replace-program`

The sensor is set into a "Boot Loader" mode for three minutes to upload new software remotely. Not required for local firmware update.

Appendix A Troubleshooting

1.1 Configuration errors

1.1.1 Conflict messages

During configuration with the Commander software, the MRL-6.1 may return conflict messages after one or more parameters have been changed and uploaded to the device. An example is shown in Figure 1.

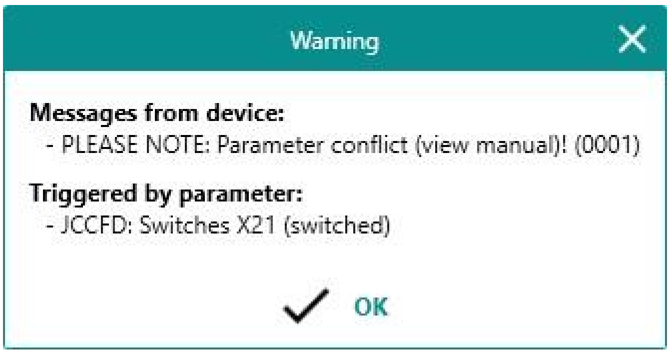


Figure 1 Example of a conflict message

The pop-up window lists the parameters and their indices which have triggered the warning. See Parameter conflicts for details.

ATTENTION If a conflict occurs, invalid settings are replaced automatically with valid values. Verify the values of the conflicting parameters and adapt them if needed!

1.1.2 Parameter conflicts

A parameter conflict message as listed below is returned if the value of a parameter conflicts with another parameter setting.

Changed parameter	Comment
Measurement channel nr. in Overview (MRL-6.1a and MRL-6.1abt only)	If the value of Measurement channel nr. is higher than Measurements, max. number, Measurement channel nr. is set to Measurements, max. number.
Measurement channel nr. in Digital outputs (MRL-6.1a and MRL-6.1abt only)	If the value of Measurement channel nr. is higher than Measurements, max. number, Measurement channel nr. is set to Measurements, max. number.

Table 1 Parameter conflict messages

1.1.3 Setup conflicts

A setup conflict message as listed below is returned if a modified setup with conflicting parameters is loaded onto the MRL-6.1.

Conflict code	Parameter	Comment
0001	Measurement Interval	If the interval is shorter than the sum of all individual measurement times, it is set to this sum. This internally calculated sum depends on the number and type of measurements, and the settings of Warm-up time, ADC - conv. Rate, ADC filter and others.

Table 2 Setup conflict messages

A.2 Devices

A.2.1 The MRL-6.1 is not responding or returns unreadable characters

Reason	Solution
The power supply is not connected or turned off.	Check if the power supply is connected and on.
The polarity of connected power supply wires is wrong.	Check the polarity of connected wires.
The power supply does not provide enough current.	Use a power supply that provides more current than listed in the Specifications.
The power supply voltage is out of range.	Adjust the power supply to match the specified voltage range.
A pin of the connector plug is bent or broken.	Verify that all connector pins are straight.
The COM-port has not been assigned correctly to the USB converter.	1. Make sure to use a Sommer Messtechnik USB converter. Third party converters are not supported. 2. Check the COM-port number using Windows Device Manager. 3. Plug in the USB converter first, then start Commander.
The USB converter is faulty.	Replace the USB converter.
The USB port on your PC is not working.	Use another USB port.
The driver of the USB converter was incorrectly installed	Reinstall the driver of the USB converter.

A.2.2 The MRL-6.1 reboots repeatedly

Reason	Solution
The power supply has not enough current to start the MRL-6.1.	Verify that the power supply provides enough current. A MRL-6.1 consumes up to 140 mA @ 12 V. If required, power the MRL-6.1 by an additional or alternative supply.

A.3 Measurement data

A.3.1 Measurement data are not updated

The device is connected to the Commander, but the data are not updated.

Cause	Solution
The MRL-6.1 triggers measurements (Polling is *On*) and triggers data (command *TD* added in S-ADD in Measurement table) of a sensor.	If the MRL-6.1 triggers measurements, remove the *TD* command and set the sensor to push data after measurements. See also Trigger measurements of a Sommer RS-485 device and Reading data from a Sommer RS-485 device.

A.4 Firmware & software

A.4.1 Commander loads wrong setup

If the setup is reloaded from the device the Commander seems to display an old version.

Cause	Solution
The device has been connected to the same PC before and several different setup files have been loaded.	● In the Communication section of the Commander, select Mode *Connection* and click on the trash can icon on the right edge. Then, reload the setup from the device. ● Delete the setup files of the device that have been downloaded by Commander to the folder *C:\Users\Public\Documents\Sommer\Setup*. The respective files can be identified by the serial number in the file name and the file date.

A.4.2 Firmware update via RS-232 is aborted

Reason	Solution
USB to RS-232 converter cable is damaged or can only operate on 115200 baud.	Replace USB to RS-232 converter cable. The programmer requires 57600 baud.

A.5 SDI-12

A.5.1 The MRL-6.1 is not detected by a SDI-12 master device

Reason	Solution
The MRL-6.1 and the SDI-12 master have different grounds.	Verify that the MRL-6.1 and the SDI-12 master are connected by a ground (GND) wire.

A.5.2 Data logger receives no SDI-12 data

Reason	Solution
The Measurement trigger of a connected Sommer Messtechnik sensor is not set to *SDI-12/RS-485*.	Set the Measurement trigger of the sensor to *SDI-12/RS-485*.
Multiple sensors are connected to the data logger and two or more sensors have the same SDI-12 address.	If multiple sensors are connected to the same data logger, each sensor must be assigned a unique SDI-12 address.
The setting Max. measurement duration is too short. If the measurements of multiple SDI-12 sensors are triggered with the *M!* command, Max. measurement duration must be at least the sum of the measurement duration of these sensors. E.g., if sensor 1 has a measurement duration of 65 s and sensor 2 of 30 s, set Max. measurement duration to 100 s (95 s plus some margin).	Check the measurement duration of each sensor and set Max. measurement duration long enough.
Some third-party sensors may not issue a service request when they have completed a measurement.	If a sensor does not issue a service request after a measurement, a `C!` command instead of a `M!` command must be sent to start a measurement. Otherwise the data logger runs into a timeout or is waiting indefinitely for a service request.
The timing of the data logger between triggering a measurement and data request may be too tight.	Verify that the timing between triggering and data request is sufficient. Upon a measurement request, e.g. by an `M!` command, the sensor returns the required measurement duration.

A.6 Modbus

A.6.1 Modbus function 04 returns obscure measurement values

Reason	Solution
Sensor does not run in its own measurement interval, i.e., MeasuremenSet Mt trigger is not set to *Interval*.	Set Measurement trigger of the sensor to *Interval*. A Modbus master can only read measurement data, it cannot trigger measurements.
A second Modbus muster is present in the RS-485 bus.	Make sure that only one Modbus master is communicating with the Modbus slaves.
The signal wires between the Modbus master and the slaves are long and/or the ground potentials of the devices are different.	● Connect the grounds of the devices with an additional wire. ● Reduce the cable length.
Endianness of the Modbus polling unit is swapped. Generally, test values and measurement values are set to big endian. Older firmware versions may return measurement values as little endian.	If the device runs on an older firmware, convert the measurement values to float with little endian.

A.7 Tips & tricks

A.7.1 Send multiple SDI-12 requests

Use

Some serial sensors provide a long list of measurement data that need to be requested by multiple SDI-12 commands, i.e., *M1!*, *M2!*, *M3!*,...

Implementation

Multiple SDI-12 requests are implemented by adding *_M1*, *_M2*, *_M3*, etc. to the S-ADD field of the measurement table. The corresponding D! commands are sent automatically. by the MRL-6.1.

> **NOTE** The *M0!* command is run by default and does not need to be added. Hence, for empty S-ADD fields *_M0* is assumed.

The same principle can be applied to the *R!* and *C!* commands.

F Measurements, table

	Function	Identifier	Unit	Decimals	Scale	Offset			S-TYP	S-NUM	S-MEA	S-ADD
01	actual	Air Temperature	°C	as S		0	Adjustment	Test	SDI2	0	1	_M1
02	actual	Rel. Humidity	%	as S		0	Adjustment	Test	SDI2	0	2	_M1
03	actual	Dewpoint	°C	as S		0	Adjustment	Test	SDI2	0	3	_M1
04	actual	Pressure	hPa	as S		0	Adjustment	Test	SDI2	0	4	_M1
05	actual	Rel. Wind Speed	m/s	as S		0	Adjustment	Test	SDI2	0	2	
06	actual	Rel. Wind Dir.	°	as S		0	Adjustment	Test	SDI2	0	1	
07	actual	Corr. Wind Dir.	°	as S		0	Adjustment	Test	SDI2	0	3	
08	actual	Avg. Wind Speed	m/s	as S		0	Adjustment	Test	SDI2	0	2	_M9
09	actual	Avg. Wind Dir.	°	as S		0	Adjustment	Test	SDI2	0	1	_M9
10	actual	Wind Gust Speed	m/s	as S		0	Adjustment	Test	SDI2	0	4	_M9
11	actual	Wind Gust Dir.	°	as S		0	Adjustment	Test	SDI2	0	3	_M9
12	actual	Status Sensor	-	as S		0	Adjustment	Test	SDI2	0	5	_M1
13	actual	Supply V	V	2	1	0	Adjustment	Test	SYS		+Sup V	
14	actual	Sun Azimuth	°	as S		0	Adjustment	Test	SDI2	0	4	_M7
15	actual	Sun Elevation	°	as S		0	Adjustment	Test	SDI2	0	5	_M7
16	actual	Sunrise	h:m	as S		0	Adjustment	Test	SDI2	0	1	_M7
17	actual	Solar Noon	h:m	as S		0	Adjustment	Test	SDI2	0	2	_M7
18	actual	Sunset	h:m	as S		0	Adjustment	Test	SDI2	0	3	_M7
19	actual	Twilight Civil	h:m	as S		0	Adjustment	Test	SDI2	0	6	_M7
20	actual	X Tilt	°	as S		0	Adjustment	Test	SDI2	0	3	_M4
21	actual	Y Tilt	°	as S		0	Adjustment	Test	SDI2	0	4	_M4

Appendix B Sensor connections

Appendix C CRC-16 array

CRC-16 array

```
crc16tab[] =
{
0x0000, 0x1021, 0x2042, 0x3063, 0x4084, 0x50A5, 0x60C6, 0x70E7,
0x8108, 0x9129, 0xA14A, 0xB16B, 0xC18C, 0xD1AD, 0xE1CE, 0xF1EF,
0x1231, 0x0210, 0x3273, 0x2252, 0x52B5, 0x4294, 0x72F7, 0x62D6,
0x9339, 0x8318, 0xB37B, 0xA35A, 0xD3BD, 0xC39C, 0xF3FF, 0xE3DE,
0x2462, 0x3443, 0x0420, 0x1401, 0x64E6, 0x74C7, 0x44A4, 0x5485,
0xA56A, 0xB54B, 0x8528, 0x9509, 0xE5EE, 0xF5CF, 0xC5AC, 0xD58D,
0x3653, 0x2672, 0x1611, 0x0630, 0x76D7, 0x66F6, 0x5695, 0x46B4,
0xB75B, 0xA77A, 0x9719, 0x8738, 0xF7DF, 0xE7FE, 0xD79D, 0xC7BC,
0x48C4, 0x58E5, 0x6886, 0x78A7, 0x0840, 0x1861, 0x2802, 0x3823,
0xC9CC, 0xD9ED, 0xE98E, 0xF9AF, 0x8948, 0x9969, 0xA90A, 0xB92B,
0x5AF5, 0x4AD4, 0x7AB7, 0x6A96, 0x1A71, 0x0A50, 0x3A33, 0x2A12,
0xDBFD, 0xCBDC, 0xFBBF, 0xEB9E, 0x9B79, 0x8B58, 0xBB3B, 0xAB1A,
0x6CA6, 0x7C87, 0x4CE4, 0x5CC5, 0x2C22, 0x3C03, 0x0C60, 0x1C41,
0xEDAE, 0xFD8F, 0xCDEC, 0xDDCD, 0xAD2A, 0xBD0B, 0x8D68, 0x9D49,
0x7E97, 0x6EB6, 0x5ED5, 0x4EF4, 0x3E13, 0x2E32, 0x1E51, 0x0E70,
0xFF9F, 0xEFBE, 0xDFDD, 0xCFFC, 0xBF1B, 0xAF3A, 0x9F59, 0x8F78,
0x9188, 0x81A9, 0xB1CA, 0xA1EB, 0xD10C, 0xC12D, 0xF14E, 0xE16F,
0x1080, 0x00A1, 0x30C2, 0x20E3, 0x5004, 0x4025, 0x7046, 0x6067,
0x83B9, 0x9398, 0xA3FB, 0xB3DA, 0xC33D, 0xD31C, 0xE37F, 0xF35E,
0x02B1, 0x1290, 0x22F3, 0x32D2, 0x4235, 0x5214, 0x6277, 0x7256,
0xB5EA, 0xA5CB, 0x95A8, 0x8589, 0xF56E, 0xE54F, 0xD52C, 0xC50D,
0x34E2, 0x24C3, 0x14A0, 0x0481, 0x7466, 0x6447, 0x5424, 0x4405,
0xA7DB, 0xB7FA, 0x8799, 0x97B8, 0xE75F, 0xF77E, 0xC71D, 0xD73C,
0x26D3, 0x36F2, 0x0691, 0x16B0, 0x6657, 0x7676, 0x4615, 0x5634,
0xD94C, 0xC96D, 0xF90E, 0xE92F, 0x99C8, 0x89E9, 0xB98A, 0xA9AB,
0x5844, 0x4865, 0x7806, 0x6827, 0x18C0, 0x08E1, 0x3882, 0x28A3,
0xCB7D, 0xDB5C, 0xEB3F, 0xFB1E, 0x8BF9, 0x9BD8, 0xABBB, 0xBB9A,
0x4A75, 0x5A54, 0x6A37, 0x7A16, 0x0AF1, 0x1AD0, 0x2AB3, 0x3A92,
0xFD2E, 0xED0F, 0xDD6C, 0xCD4D, 0xBDAA, 0xAD8B, 0x9DE8, 0x8DC9,
0x7C26, 0x6C07, 0x5C64, 0x4C45, 0x3CA2, 0x2C83, 0x1CE0, 0x0CC1,
0xEF1F, 0xFF3E, 0xCF5D, 0xDF7C, 0xAF9B, 0xBFBA, 0x8FD9, 0x9FF8,
0x6E17, 0x7E36, 0x4E55, 0x5E74, 0x2E93, 0x3EB2, 0x0ED1, 0x1EF0
}
```

Glossary

I

IP-Call

A technology that provides communications services (voice, SMS, voice-messaging) over the Internet, rather than via the public telephone network.

M

Modbus

A serial communications protocol for connecting industrial electronic devices.

R

RS-485

A standard defining the signal transmission in serial communication systems.

S

SBP

Sommer Bus Protocol

SDI-12

Asynchronous serial communications protocol for intelligent sensors (Serial Digital Interface at 1200 baud)

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