METZ CONNECT

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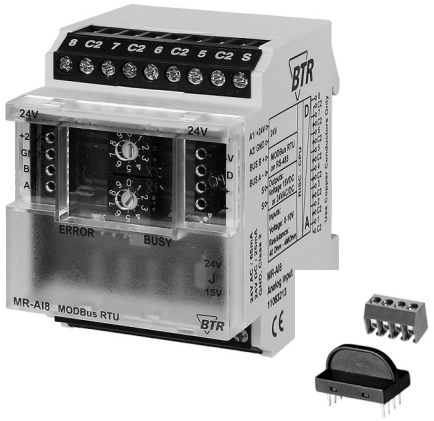
C | Logline

Analog Input Module MR-AI8

11083213

7170/899289



1. Description

The Modbus module with 8 individually configurable resistance or voltage inputs is designed for local switching operations. It is suitable to record resistance or voltage values of for example passive and active temperature sensors electrical ventilation or mixing valves, valve positions etc. The inputs are universally configurable and can be scanned via a Modbus-Master. Setting of the slave address, bit rate and parity is done with the two address switches (x1 / x10) on the front. Possible settings are addresses 00 to 99 and baud rates 1200, 2400, 4800, 9600, 19200, 38400, 57600 und 115200 Bd.

The device does not participate in bus communication if the address is 00 (reserved for broadcast commands).

2. Declaration of Conformity

The device was tested according to the applicable standards. Conformity was proofed. The declaration of conformity is available at the manufacturer BTR NETCOM GmbH.

Notes Regarding Device Description

These instructions include indications for use and mounting of the device. In case of questions that cannot be answered with these instructions please consult supplier or manufacturer.

The indicated installation directions or rules are applicable to the Federal Republic of Germany. If the device is used in other countries it applies to the equipment installer or the user to meet the national directions.

Safety Instructions

Keep the applicable directions for industrial safety and prevention of accidents as well as the VDE rules.

Technicians and/or installers are informed that they have to electrically discharge themselves as prescribed before installation or maintenance of the devices.

Only qualified personnel shall do mounting and installation work with the devices, see section "qualified personnel".

The information of these instructions have to be read and understood by every person using this device.

Symbols

Warning of dangerous electrical voltage

Danger

means that non-observance may cause risk of life, grievous bodily harm or heavy material damage.

Qualified Personnel

Qualified personnel in the sense of these instructions are persons who are well versed in the use and installation of such devices and whose professional qualification meets the requirements of their work.

This includes for example:

- Qualification to connect the device according to the VDE specifications and the local regulations and a qualification to put this device into operation, to power it down or to activate it by respecting the internal directions.
- Knowledge of safety rules.
- Knowledge about application and use of the device within the equipment system etc.

3. Technical Data

Modbus Interface

Protocoll	Modbus RTU
Transmission rate	1200 ... 115200 Bd (factory setting 19200 Bd Even)
Cabling	RS485 two wire bus with voltage equalizing cable in bus / line
topology	

Supply

Operating voltage range	20 ... 28 V AC/DC (SELV)
Current consumption	65 mA (AC) / 25 mA (DC)
Relative duty cycle	100 %

Input

Resistance range	40 Ω to 4 MΩ
Voltage input	0 ... 10 V DC
Resolution	1 mV
Error	
Voltage input	about ±10 mV
Resistance input	< 12 kΩ = 0,1 % / > 12 kΩ = 1 %

Housing

Dimensions WxHxD	2.0 x 2.8 x 2.6 in. (50 x 70 x 65 mm)
Weight	104 g
Mounting position	any
Mounting	standard rail TH35 per IEC 60715
Mounting in series without space	the maximum quantity of modules connected in line is limited to 15 or to a maximum power consumption of 2 Amps (AC or DC) per connection to the power supply. For any similar block of additional modules a separate connection to the power supply is mandatory.
Material	
Housing	Polyamide 6.6 V0
Terminal blocks	Polyamide 6.6 V0
Cover plate	Polycarbonate
Type of protection (IEC 60529)	
Housing	IP40
Terminal blocks	IP20

Terminal blocks

Supply and bus	
4 pole terminal block	max. AWG 16 (1,5 mm²) solid wire max. AWG 18 (1,0 mm²) stranded wire
Wire diameter	min. 0.3 mm up to max. 1.4 mm (terminal block and jumper plug are included to each packing unit)
Module connection	
Input/Output	max. AWG 12 (4.0 mm²) solid wire max. AWG 14 (2.5 mm²) stranded wire
Wire diameter	min. 0.3 mm up to max 2.7 mm

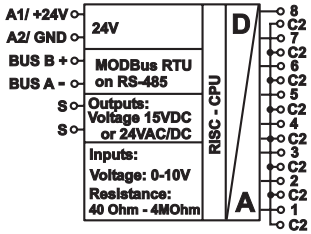
Temperature range

Operation	-5 °C ... +55 °C
Storage	-20 °C ... +70 °C
Protective circuitry	polarity reversal protection of operating voltage polarity reversal protection of supply and bus

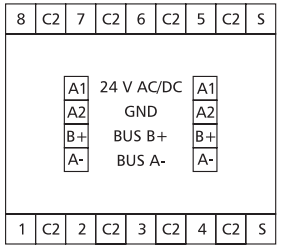
Display

Operating and bus activity	green LED
Error indication	red LED

4. Wiring Diagram



5. Connection Diagram



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Mounting instruction see www.metz-connect.com

6. Mounting

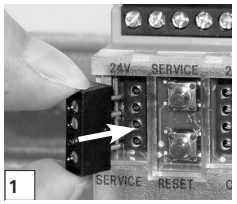
Power down the equipment

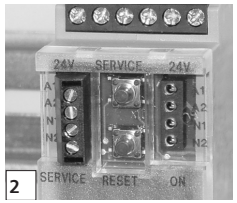
Mount the module on standard rail (TH35 per IEC 60715 in junction boxes and/or on distribution panels).

Installation

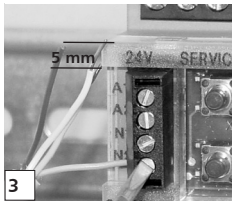
Electric installation and device termination shall be done by qualified persons only, by respecting all applicable specifications and regulations.

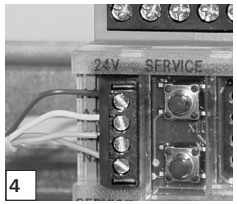
Plug in the terminal block for bus connection



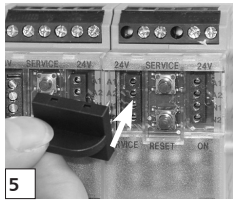


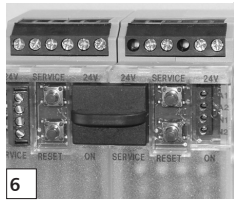
Connect the cable for bus supply





Mounting in series





The module can be aligned without interspace. Use the jumper plug to connect bus and supply voltage when the modules are mounted in series.

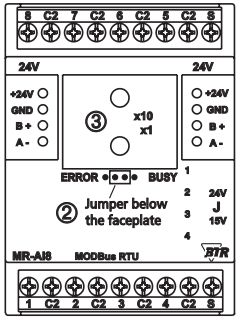
The maximum quantity of modules connected in line is limited to 15 or to a maximum power consumption of 2 Amps (AC or DC) per connection to the power supply. For any similar block of additional modules a separate connection to the power supply is mandatory.

7. Bit rate and Parity setting

The bit rate and parity can be set in the programming mode when ajumper is plugged behind the front cover of the module. This jumper is removed in normal mode. A connection to the bus is not required during bit rate setting.

The bit rate of the modules can be set in the following way:

1. remove the front cover of the module;
2. plug a jumper to the two middle pins of the 4 pole header between the red and green LED (②);
3. set the desired parity and bit rate with the address switches (③) in accordance to the chart below.



4. switch on the supply voltage of the module; it is now permanently saving the bit rate in an EEPROM;
5. switch off the supply voltage of the module;
6. remove the jumper from the header and place the front cover.

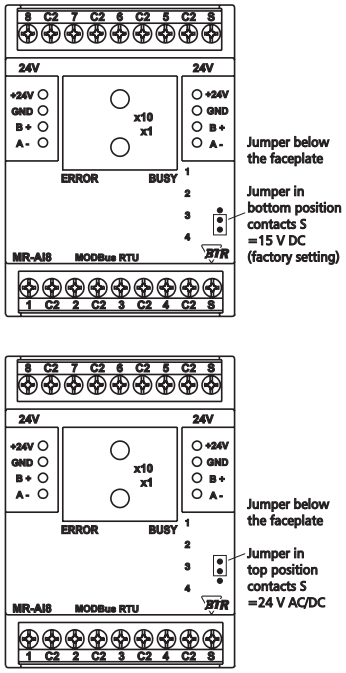
Switch x10	1	2	3
Parity	even	odd	none

Switch x1	1	2	3	4	5	6	7	8
Bitrate (Bit/s)	1200	2400	4800	9600	19200	38400	57600	115200

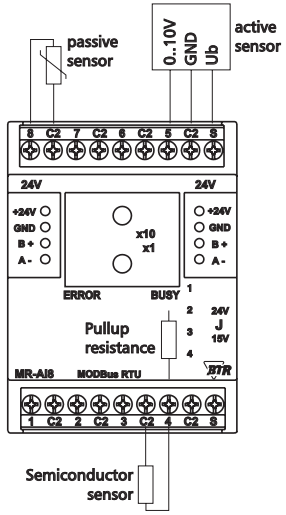
If the settings differ from the settings specified in the chart the factory setting applies.

Factory setting: 19200 Bd Even

8. Jumper Positions for Voltage feeding of Active Sensors



9. Connection examples



10. Software Description

10.1 I/O Commands

„04 (0x04) Read Input Registers"

Request:

Valid Starting Address 0 .. 15

Valid Quantity of Registers 1 .. 16 (1 to 8 inputs)

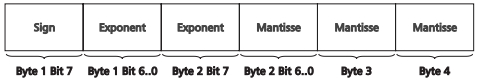
Response:

Byte Count 2 x Quantity o. R.

Registers Values Quantity o. R x 2 Bytes

Input	Register	Information	
1	0-1	Values are supplied in 2 registers (4 Bytes).	
2	2-3	Data type in registers can be configured (see Registers 16 to 23):	
3	4-5	Float value	needs 2 registers (fig. 1)
4	6-7	signed int value	is in 1st register
5	8-9	signed int 0	fills 2nd register
6	10-11	Value remains 0 until a measurement takes place	
7	12-13	Data types composed from 2 registers start at an even address	
8	14-15		

Figure 1



Configuration Registers

Input circuit and measuring range, data type and value unit and the sensor characteristic for usual temperature sensors are set for the 8 inputs with the 8 configuration registers.

Register contents is stored in an EEPROM.

Modbus functions:

"03 (0x03) Read Holding Registers" (max. 20 at once)

"06 (0x06) Write Single Register"

"16 (0x10) Write Multiple Registers" (max. 20 at once)

Holding Register 0-15 Offset Register is added to the measured value in 2 succeeding registers, (Input 1 = Register 0 - 1) Float in both or Signed Integer 16 in the first one, same as for measured value

Holding Register 16-23 Configuration register (EEPROM) used to set measuring range, data type of the measured value (Float / Integer 16), unit of the measured value and the sensor characteristic (Input 1 = Register 16)

Holding Register 24-63 Register for interpolation charts (EEPROM), alternately temperature and resistance, Float in two succeeding registers

Configuration Register for voltage or resistance measurement:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0								0	range		number				

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Continuation Software Description

Bit 15-8: occupied
Bit 7: 0 = voltage or resistance
Bit 6-5: range, defines input circuit or measuring range
- 0 0 voltage 0to10 V (factory setting)
- 0 1 voltage 0to10 V, with Pullup 2k at 5 V
- 1 0 resistance
- 1 1 occupied

Bit 4-0: number, defines presentation of value

Voltage measurement:
- 0 value with data type float, unit = 1V (factory setting)
- 1 value with data type signed int, unit = 10.24 V/2^{15} = 1V/3200 = 0.3125 mV
- 2-31 reserved for other presentations

Resistance measurement:
- 0 value with data type float, unit = 1 Ω
- 1 value with data type signed int, unit = 0.1 Ω (max. 3.2767 kΩ)
- 2 value with data type signed int, unit = 1 Ω (max. 32.767 kΩ)
- 3 value with data type signed int unit = 10 Ω (max. 327.67 kΩ)
- 4 value with data type signed int unit = 100 Ω (max. 3276.7 kΩ)
- 5-31 reserved for other presentations

Configuration Register for voltage or resistance measurement:

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0								1	number						Type

Bit 15-8: occupied
Bit 7: 1 = temperature with sensor characteristic
Bit 6-1: number, serves to distinguish between sensor and measuring range
- 0 Sensor PT100 (-50..150 °C)
- 1 Sensor PT500 (-50..150 °C)
- 2 Sensor PT1000 (-50..150 °C)
- 3 Sensor NI1000-TK5000 (-50..150 °C)
- 4 Sensor NI1000-TK6180 (-50..150 °C)
- 5 Sensor BALCO 500 (-50..150 °C)
- 6 Sensor KTY81-110 (-50..150 °C)
- 7 Sensor KTY81-210 (-50..150 °C)
- 8 Sensor NTC-1k8 (-50..150 °C)
- 9 Sensor NTC-5k (-50..150 °C)
- 10 Sensor NTC-10k (-50..150 °C)
- 11 Sensor NTC-20k (-50..150 °C)
- 12 Sensor LM235 (-40..120 °C)
- 13-55 reserved for other sensors
- 56-61 use of interpolations chart see below
- 62-63 occupied

Bit 0: Data type of value
- 0 float, unit 1°C
- 1 signed int, unit 0,1°C

Configuration Register for the use of the Interpolation chart:

This chart can be used to linearize individually defined sensor characteristics.

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0								1	7			range		Int	Type

Continuation Software Description

Bit 15-8: occupied
Bit 7: 1 = temperature with sensor characteristic
Bit 6-4: 7 = interpolation chart
Bit 3-2: range, defines input circuit or measuring range
- 0 0 voltage 0-10V
- 0 1 voltage 0-10V, Pullup 2k at 5V
- 1 0 resistance
- 1 1 occupied

Bit 1: selection of interpolation
- 0 sensor characteristic is approx. linear
- 1 sensor characteristic is approx. exponential (NTC)

Bit 0: data type of value
- 0 float, unit 1 °C
- 1 signed int, unit 0.1 °C

Configurations Registers are shown above in a way to display the meaning of the individual bit. For the application it is more convenient if the register contents is displayed as a whole, see the following chart.

Dez	Hex	Measuring range Voltage or resistance	Data type	Unit	Maximum
0	0x00	Voltage 0-10 V	float	1 V	
1	0x01	Voltage 0-10 V	signed int	0,3125 mV	10,24 V
32	0x20	Voltage/Pullup	float	1 V	
33	0x21	Voltage/Pullup	signed int	0,3125 mV	10,24 V
64	0x40	Resistance	float	1 Ω	
65	0x41	Resistance	signed int	0,1 Ω	3,2767 kΩ
66	0x42	Resistance	signed int	1 Ω	32,767 kΩ
67	0x43	Resistance	signed int	10 Ω	327,67 kΩ
68	0x44	Resistance	signed int	100 Ω	3276,7 kΩ
Temperature measurement with data type float. (Value charts for sensors see annex):					
128	0x80	Sensor PT100	float	1 °C	(-50..150 °C)
130	0x82	Sensor PT500	float	1 °C	(-50..150 °C)
132	0x84	Sensor PT1000	float	1 °C	(-50..150 °C)
134	0x86	Sensor NI1000-TK5000	float	1 °C	(-50..150 °C)
136	0x88	Sensor NI1000-TK6180	float	1 °C	(-50..150 °C)
138	0x8A	Sensor BALCO 500	float	1 °C	(-50..150 °C)
140	0x8C	Sensor KTY81-110	float	1 °C	(-50..150 °C)
142	0x8E	Sensor KTY81-210	float	1 °C	(-50..150 °C)
144	0x90	Sensor NTC-1k8	float	1 °C	(-50..150 °C)
146	0x92	Sensor NTC-5k	float	1 °C	(-50..150 °C)
148	0x94	Sensor NTC-10k	float	1 °C	(-50..150 °C)
150	0x96	Sensor NTC-20k	float	1 °C	(-50..150 °C)
152	0x98	Sensor LM235	float	1 °C	(-40..120 °C)

Continuation Software Description

Dez	Hex	Measuring range Voltage or resistance	Data type	Unit	Maximum
Temperature measurement with data type signed int, register contents is larger by 1 as above:					
129	0x81	Sensor PT100	signed int	0,1 °C	(-50..150 °C)
131	0x83	Sensor PT500	signed int	0,1 °C	(-50..150 °C)
133	0x85	Sensor PT1000	signed int	0,1 °C	(-50..150 °C)
135	0x87	Sensor NI1000-TK5000	signed int	0,1 °C	(-50..150 °C)
137	0x89	Sensor NI1000-TK6180	signed int	0,1 °C	(-50..150 °C)
139	0x8B	Sensor BALCO 500	signed int	0,1 °C	(-50..150 °C)
141	0x8D	Sensor KTY81-110	signed int	0,1 °C	(-50..150 °C)
143	0x8F	Sensor KTY81-210	signed int	0,1 °C	(-50..150 °C)
145	0x91	Sensor NTC-1k8	signed int	0,1 °C	(-50..150 °C)
147	0x93	Sensor NTC-5k	signed int	0,1 °C	(-50..150 °C)
149	0x95	Sensor NTC-10k	signed int	0,1 °C	(-50..150 °C)
151	0x97	Sensor NTC-20k	signed int	0,1 °C	(-50..150 °C)
153	0x99	Sensor LM235	signed int	0,1 °C	(-40..120 °C)
Temperature measurement with interpolation chart:					
240	0xF0	Voltage 0-10 V	float	linear	
241	0xF1	Voltage 0-10 V	signed int	linear	
242	0xF2	Voltage 0-10 V	float	exponentiell	
243	0xF3	Voltage 0-10 V	signed int	exponentiell	
244	0xF4	Voltage/Pullup	float	linear	
245	0xF5	Voltage/Pullup	signed int	linear	
246	0xF6	Voltage/Pullup	float	exponentiell	
247	0xF7	Voltage/Pullup	signed int	exponentiell	
248	0xF8	Resistance	float	linear	
249	0xF9	Resistance	signed int	linear	
250	0xFA	Resistance	float	exponentiell	
251	0xFB	Resistance	signed int	exponentiell	

Register 24-63 (0x18-0x3F) interpolation chart

This chart can be used to convert and linearize values for sensors without a characteristic already defined in the device. The chart contains up to 10 nodes of the sensor characteristic to interpolate between.

Example: conversion from resistance to temperature with temperature sensors.

Register contents is stored in the EEPROM.

The description refers to temperature sensors. Other sensors than temperature sensors (e.g. humidity) are also possible and it is also possible to measure voltage instead of resistance.

These properties can be set in the configuration register:

Measuring range: voltage
voltage, Pullup 2k at 5V (e.g. for LM235)
resistance (normal case with temperature sensors)

Interpolation: sensor characteristic is approx. linear
sensor characteristic is approx. exponential (für NTCs)

Data type of value: float (unit 1 °C)
signed int (unit 0.1 °C)

Continuation Software Description

Modbus-Funktionen

"03 (0x03) Read Holding Registers"
"16 (0x10) Write Multiple Registers"

Node	Register Temperature	Register Resistance
1	24-25	26-27
2	28-29	30-31
3	32-33	34-35
4	36-37	38-39
5	40-41	42-43
6	44-45	46-47
7	48-49	50-51
8	52-53	54-55
9	56-57	58-59
10	60-61	62-63

The nodes (up to 10) are filled from the beginning of the chart, it ends with

Temperature = resistance = 0, if less nodes exist.

Temperature and resistance values have to be sorted in ascending or descending order.

Data type in registers: float temperature, resistance

10.2 Bit rate setting with Modbus command

Parity and bit rate have the same value as when setting them by address switch.

If Parity or Bit has the value 0, no setting or storage is carried out.

The register content is stored in the EEPROM.

"06 (0x06) Write Single Register"

Request

Valid Register Address 0x41 (65)

Valid Register Value 2 Bytes

15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
0x53								Parity				Bit rate			

Bit 15-8: Magic-Number 0x53 = 83 as protection against accidental writing.
The command will be further analysed only with this number.

Bit 7-4	1	2	3
Parity	even	odd	none

Bit 3-0	1	2	3	4	5	6	7	8
Bit rate	1200	2400	4800	9600	19200	38400	57600	115200

Response

Echo of Request

Continuation Software Description

Example for a frame:

Slave address	0x12	Setting of rotary switch (18)
Function	0x06	Write Single Register
Register address Hi	0x00	
Register address Lo	0x41	Bit rate and parity (65)
Register contents Hi	0x53	Magic-Number
Register contents Lo	0x15	Parity Even, 19200 Baud

All devices can be switched simultaneously with a Broadcast command (Slave address 0x00) However, it is advised not to do so as this can cause problems:

- Devices from other manufacturers may have under this address a register for a different purpose that will then be operated in the wrong way.
- There is no feedback from the individual devices. Consequently the control cannot immediately recognize if the command was correctly received.

It is safer to address and switch each device individually.

The device will then answer with the old settings of parity and bit rate. Switching will take place only afterwards. However, the answer can get lost if the bus is disturbed.

When all devices are switched; it is advised to check communication. Any function of the device providing a feedback is suitable. If a single function is to be used being independent from the process periphery then the function „Diagnostic" sub-function „Return Query Data" is suitable, it returns the transferred data.

If bit rate and parity setting of a device are unknown it is possible to address the device successively with all combinations of bit rate and parity until the device answers. Try the most likely combinations first. Try the lower bit rates last as they take longer.

10.3 General Commands

"08 (0x08) Diagnostics"

Subfunction "0 (0x0000) Return Query Data"

Data Field Any

Response: Echo of Request

Subfunction "1 (0x0001) Restart Communication Option"

Data Field 0x0000 or 0xFF00

Response: Echo of Request

Action: Clears all Error Counters, Restarts node

Subfunction "4 (0x0004) Force Listen Only Mode"

Data Field 0x0000

No Response

Action: No response until Node Reset or Function Code 08 Subcode 01

Subfunction "10 (0x000A) Clear Counters"

Data Field 0x0000

Response: Echo of Request

Action: Clears all Error Counters

Subfunction "11 (0x000B) Return Bus Message Count"

Data Field 0x0000

Response: Quantity of messages that the remote device has detected on the communications system since its last restart, clear counters operation, or power–up.

Subfunction "12 (0x000C) Return Bus Communication Error Count"

Data Field 0x0000

Response: Quantity of errors encountered by the remote device since its last restart, clear counters operation, or power–up. (CRC, Length <3, Parity, Frame)

Continuation Software Description

Subfunction "13 (0x000D) Return Bus Exception Error Count"

Data Field 0x0000

Response: Quantity of MODBUS exception responses returned by the remote device since its last restart, clear counters operation, or power–up.

Subfunction "14 (0x000E) Return Slave Message Count"

Data Field 0x0000

Response: quantity of messages addressed to the remote device, or broadcast, that the remote device has processed since its last restart, clear counters operation, or power–up.

Subfunction "15 (0x000F) Return Slave No Response Count"

Data Field 0x0000

Response: Quantity of messages addressed to the remote device for which it has returned no response (neither a normal response nor an exception response), since its last restart, clear counters operation, or power–up.

"43 /14 (0x2B / 0x0E) Read Device Identification"

Request

Read Device ID code: 0x01

Object ID 0x00

Response

Device ID code	0x01
Conformity level	0x01
More follows	0x00
Next object ID	0x00
Number of objects	0x03
Object ID	0x00
Object Length	0x03
Object Value	"BTR"
Object ID	0x01
Object Length	0x06
Object Value	"MR-AI8"
Object ID	0x02
Object Length	0x04
Object Value	"V1.0"