METZ CONNECT

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Digital Input Module MR-SI4

11083913

8096/899360

1. Description

The Modbus module with 4 S0 inputs to DIN EN 62053-31 class A was developed for decentralized switching tasks. It is suitable for counting S0 counter pulses. This allows very good integration of the module into an energy controlling system. In case of a power failure, the last counter readings are saved. The inputs can be scanned by means of standard objects via a Modbus master. The module address, the baud rate and the parity are set by means of two address switches on the front.

Suitable for decentralized mounting in serial sub-distributor.

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 METZ CONNECT 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 terminate with 120 Ohms

Supply

Operating voltage range	20 ... 28 V AC/DC (SELV)
Current consumption	170 mA (AC) / 65 mA (DC)
Relative duty cycle	100 %

Input

4x S0 input according to DIN EN 62053-31 Class A

Housing

Dimensions WxHxD	1.4 x 2.8 x 3.0 in. (35 x 70 x 65 mm)
Weight	95 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

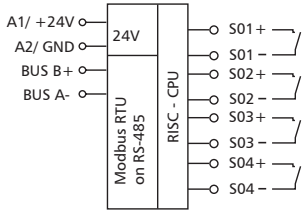
Temperature range

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

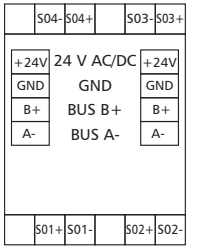
Operating and bus activity	green LED
Error indication	red LED
Status of the inputs	yellow LED

4. Wiring Diagram



24V AC / 170mA
24V DC / 65mA
GND, Class 2

5. Connection Diagram



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Mounting instruction see www.metz-connect.com

6. Mounting

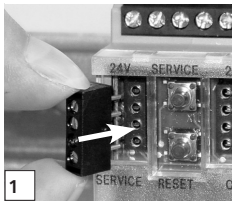
Power down the equipment.

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

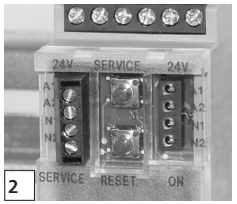
Installation

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.

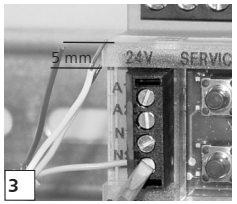


1



2

Connect the cable for bus supply.



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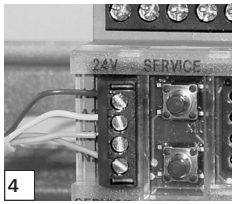
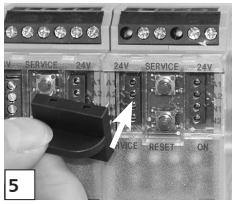


4

Mounting in series.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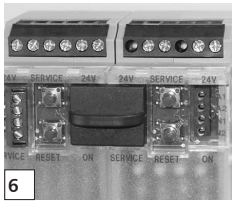

6

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

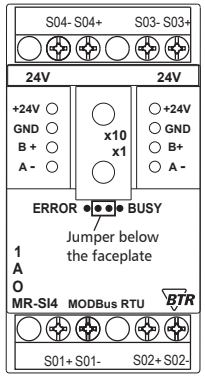
The maximum quantity of modules connected in line is limited to 15 or to a maximum power consumption of 2 Amps (AC or DC) per connection to the power supply. For any similar block of additional modules a separate connection to the power supply is mandatory.

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. Software Description

8.1 I/O Commands

"02 (0x02) Read Discrete Inputs"

Request

Valid Input Starting Address	0 .. 3
Valid Quantity of Inputs	1 .. 4

Response

Byte Count	1
Input Status	Bit0 .. Bit3 (Bit4 .. Bit7 = 0)

Information

1 = Status Input closed

0 = Status Input open

"04 (0x04) Read Input Registers"

Request

Valid Register Starting Address	20
Valid Quantity of Registers	1

Response

Byte Count	2
(Tabulator kontrollieren)	

8.2 Modbus functions

The following functions are used to read or write the registers. The valid address ranges are indicated in brackets.

Read Input Registers (0-20)

Read Holding Registers (0-43)

Write Single Register (20-43)

Write Single Register (65)

Write Multiple Registers (0-43)

For long data types with a length of several registers, these registers are listed directly one after the other and the one with the highest value are indicated first. This data can only be transmitted in complete form.

Discrete Inputs (Read-Only)

Address	Name	Description
0 – 3	INPUT	Switching status of the inputs (switches are connected), 0: Off (switch is open), 1: On (switch is closed)

Input Register (Read-Only)

Address	Name	Description
0 – 11	IZ	Pulse counter Data type uint48_t (3 registers each)
12 – 19	BZ	Calculated counter reading Data type uint48_t (2 registers each)
20	INPUT	Bits 0-3 contain Discrete Input 0-3

Holding Register

Address	Name	Description
0 – 11	IT	Copy of the pulse counter after having pressed the key Data type uint48_t (3 registers each) (EEPROM)
12 – 19	AZ	Initial count Data type uint32_t (2 registers each) Factory setting 0 (EEPROM)
20 – 23	IE	Pulses per unit Data type uint16_t (1 register each) Factory setting 1 (EEPROM)
24 – 27	WI	Current conversion factor Data type uint16_t (1 register each) Factory setting 1 (EEPROM)

(continued) Description of the software

28 – 31	WU	Voltage conversion factor Data type uint16_t (1 register each) Factory setting 1 (EEPROM)
32 – 35	WP	Operating mode for calculation with conversion factor Data type uint16_t (1 register each, only bit 0 valid) Range of values 0…1, see below Factory setting 0 (EEPROM)
36 – 39	ZS	Format of the counter digit display Data type uint16_t (1 register each) (EEPROM) High byte for counter digits, Range of values 0…9, factory setting 7, higher values are limited to 9 Low byte for places after the decimal point, Range of values 0…3, factory setting 1, higher values are limited to 3
40 – 43	TA	Flag for key activation Data type uint16_t (1 register each, flag in bit 0 only) 0: key is locked, 1: key is operational factory setting 1 (EEPROM)
65	BAUD	Codes for baud rates and parity Factory setting 19200 baud, Even Parity (EEPROM)

8.3 Operating mode for calculation with conversion factor

In the WP register, there is a code 0…1 that determines, together with the conversion factors WI and WU, the way how they are included in the calculation. WP, WI and WU depend on whether the converters are switched by the counters, whether the counter indicates the consumption in a primary or secondary way and whether the emitted pulses correspond primarily or secondarily to the consumption.

A difference must be made between the following electricity meter types:

Type 1: Directly measuring counter, display: primary, pulse: primary

Note: Indicates the actual consumption

Species: DIN rail counter with mechanical drum-type counting mechanism, Ferraris counter

Type of formula: WP = 0

Factors: WI = WU = 1

$$BZ = \left(\frac{IZ - IT}{IE} + AZ\right) \cdot WI \cdot WU,\ BZ = \text{counter reading} = \text{consumption}$$

Type 2: Conversion counter, display: primary, pulse: secondary

Note: Indicates the actual consumption

Species: Counter with LCD display

Type of formula: WP = 1

Factors: WI and WU correspond to the converters

$$BZ = \left(\frac{IZ - IT}{IE} \cdot WI \cdot WU\right) + AZ,\ BZ = \text{counter reading} = \text{consumption}$$

Type 3: Conversion counter, display: primary, pulse: primary

Note: Indicates the actual consumption

Species: Counter with LCD display, multi-function meters

Type of formula: WP = 0

Factors: WI = WU = 1

$$BZ = \left(\frac{IZ - IT}{IE} + AZ\right) \cdot WI \cdot WU,\ BZ = \text{counter reading} = \text{consumption}$$

(continued) Description of the software

Type 4: Conversion counter, display: secondary, pulse: secondary

Note: Indicates the consumption reduced by the converter factors

Species: DIN rail counter with mechanical drum-type counting mechanism, Ferraris counter

Type of formula: WP = 0

Consumption and display of the converter counter are different.

Both can be calculated using a different configuration (WI, WU).

Factors: WI = WU = 1:

The calculated counter reading corresponds to the display of the converter counter.

Factors: WI and WU correspond to the converters:

The calculated counter reading corresponds to the consumption.

$$BZ = (\frac{IZ - IT}{IE} + AZ) \cdot WI \cdot WU \,, BZ = \text{counter reading or consumption}$$

8.4. Commissioning

The user reads on site the initial count from the electricity meter and presses the key on the MR-SI4. After this key press, the pulse counter of register IZ is copied into register IT.

Afterwards, the user configures the MR-SI4 via the Modbus using a service program. The following must be entered:

- initial count read from the counter
- pulses per unit,
  e.g. indication on the electricity meter 2000 pulses per kWh
- formula type for calculation with converter factors
- factor for current conversion,
  e.g. indication on the converter 200/5A → factor = 40
- factor for voltage conversion,
  e.g. indication on the converter 20000/100V → factor = 200
- number of digits and places after the decimal point
- deactivate the key to protect the IT register

8.5.Details for calculation

The calculated counter reading should behave exactly in the same way as the electricity meter. This requires that there should be no overflows and rounding off errors for the intermediate results. Therefore, particularly large data types are used for counting and calculation.

Every 60 milliseconds, a pulse can be emitted by the electricity meter.

This results in up to 1,440,000 pulses per day or about 526,000,000 pulses per year.

If the pulse counter was realized with 4 bytes, it could be count to 4,294,967,295. At highest pulse frequency, this would be enough for approx. 8.2 years.

Therefore it is realized with 6 bytes and cannot overflow.

The number of places after the decimal point is considered as an additional multiplier with a power of ten during the calculation. Furthermore, it determines the place of the decimal point in the display of BZ and AZ.

As for the electricity counter which only has a specified number of decimal places, the number of places is limited with the last step in the calculation. This is why the calculated counter reading of the MR-SI4 overflows to 0 as often as the counter reading of the electricity meter.

Calculated counter reading, if WP is 0.

```
BZ =  ( (uint96_t) (IZ - IT)*WU*WI*Power of ten [places after decimal
      point] / IE +
      (uint96_t) AZ       * WU * WI )
      % power of ten [digits]
```

Calculated counter reading, if WP is 1.

```
BZ =  ( (uint96_t) (IZ - IT)*WU*WI*Power of ten [places after decimal
      point] / IE +
      (uint96_t) AZ )
      % power of ten [digits]
```

(continued) Description of the software

8.6 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								Parität				Bitrate			

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
Parität	even	odd	none

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

Response

Echo of Request

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.

(continued) Description of the software

8.7 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 oder 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, Framing)

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.

(continued) Description of the software

"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-SI4"
Object ID	0x02
Object Length	0x04
Object Value	"V2.0"