TRICOR®

TCD 9010 Modbus RTU Communication

TRICOR
Coriolis Technology

Manual-Version

TCD_9010_COMO_S_EN_200428_E005

This document is supplied as standard in electronic media with the device. Latest version can be downloaded at www.tricorflow.com.

NOTE:

This manual applies to the Coriolis Flow Meter with the brand TRICOR.

Index

1. Introduction

1.1. Purpose of this Documentation

This manual contains all information needed to integrate the process instruments into a communications network. The manual is aimed at control system designers, system integrators, instrument engineers.

Safe operation of the product requires reading and following instructions in the product specific manual that contains more detailed information. It is available for download from TRICOR Flow website: https://tricorflow.com/support/downloads/manuals/).

This manual applies to the TCD 9010 transmitter Modbus version only.

NOTE:

Use in a domestic environment
This Class A Group 1 equipment is intended for use in industrial areas.
In a domestic environment this device may cause radio interference.

1.2. Legal information

Warning notice system

This manual contains notices you have to observe in order to ensure your personal safety, as well as to prevent damage to property. The notices referring to your personal safety are highlighted in the manual by a safety alert symbol, notices referring only to property damage have no safety alert symbol. These notices shown below are graded according to the degree of danger.

DANGER!

indicates that death or severe personal injury **will** result if proper precautions are not taken.

WARNING!

indicates that death or severe personal injury **may** result if proper precautions are not taken.

CAUTION!

indicates that minor personal injury can result if proper precautions are not taken.

NOTE:

indicates that property damage can result if proper precautions are not taken.

If more than one degree of danger is present, the warning notice representing the highest degree of danger will be used. A notice warning of injury to persons with a safety alert symbol may also include a warning relating to property damage.

Qualified Personnel

The product/system described in this documentation may be operated only by **personnel qualified** for the specific task in accordance with the relevant documentation, in particular its warning notices and safety instructions. Qualified personnel are those who, based on their training and experience, are capable of identifying risks and avoiding potential hazards when working with these products/systems.

Proper use of KEM products

Note the following:

WARNING!

KEM products may only be used for the applications described in the catalog and in the relevant technical documentation. If products and components from other manufacturers are used, these must be recommended or approved by KEM. Proper transport, storage, installation, assembly, commissioning, operation and maintenance are required to ensure that the products operate safely and without any problems. The permissible ambient conditions must be complied with. The information in the relevant documentation must be observed.

NOTE:

Use in a domestic environment
This Class A Group 1 equipment is intended for use in industrial areas.
In a domestic environment this device may cause radio interference.

Trademarks

All names identified by ® are registered trademarks of KEM. The remaining trademarks in this publication may be trademarks whose use by third parties for their own purposes could violate the rights of the owner.

Disclaimer of Liability

We have reviewed the contents of this publication to ensure consistency with the hardware and software described. Since variance cannot be precluded entirely, we cannot guarantee full consistency. However, the information in this publication is reviewed regularly and any necessary corrections are included in subsequent editions.

2. Communication

2.1. System integration

This chapter provides information on how to integrate the device in a point-to-point or multidrop Modbus RTU network in non-hazardous or hazardous areas. Many details of network design are beyond the scope of these operating instructions. The points below provide an overview of the major design criteria. For further details contact KEM Küppers Elektromechanik GmbH (KEM).

2.2. System configuration

Non-hazardous areas

The following figures show examples of installations in point-to-point and multidrop configurations in non-hazardous areas.

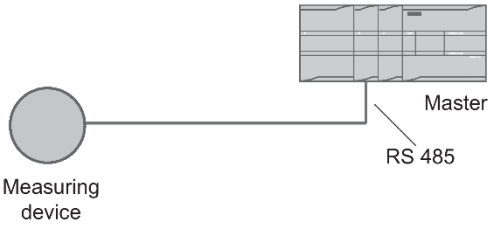


Fig. 1: Point to point configuration in non-hazardous locations

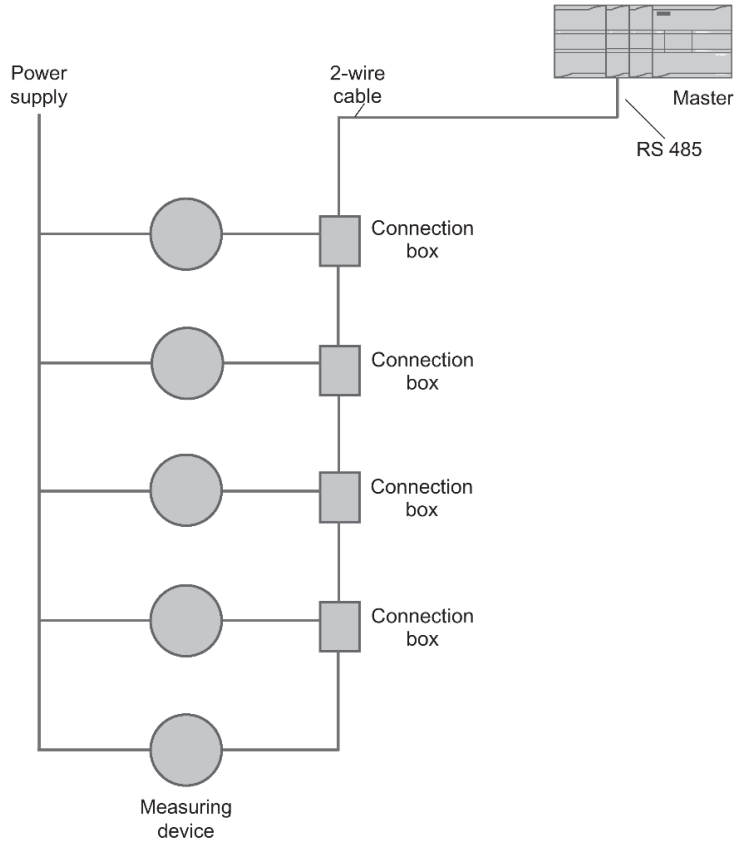


Fig. 2: Multidrop configuration (branch) in non-hazardous area

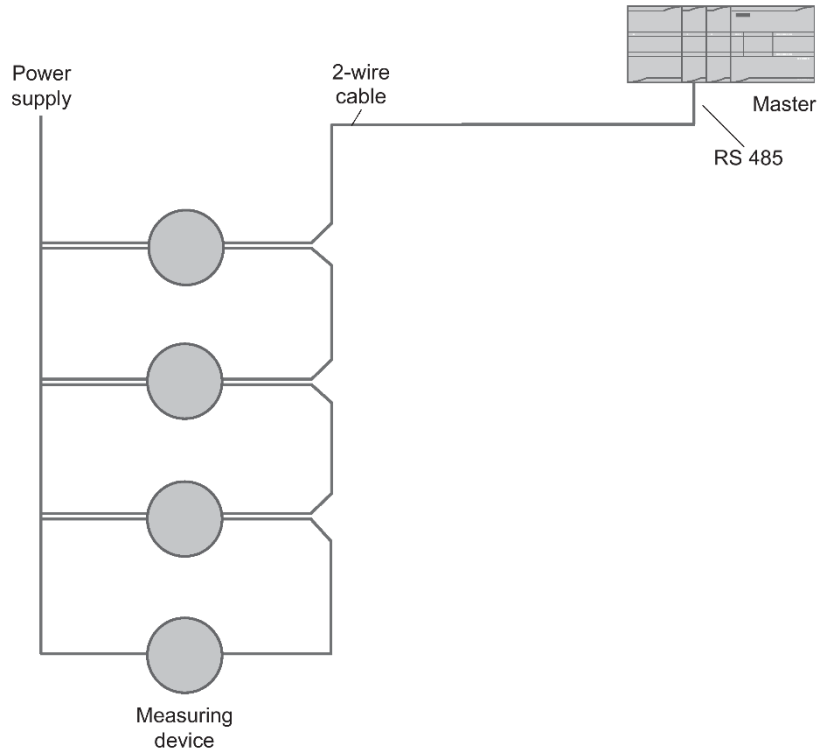


Fig. 3: Point-to-point configuration in hazardous area

Hazardous areas

The following figures show examples of installations in point-to-point and multidrop configurations in hazardous areas (for flameproof installation).

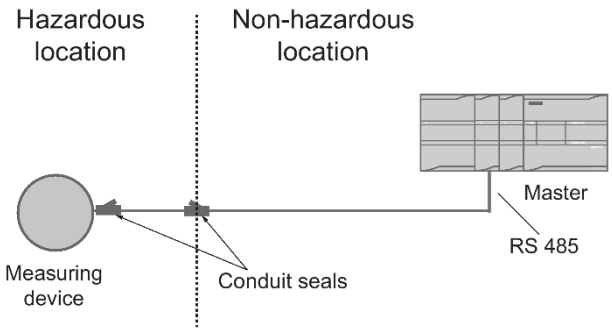


Fig. 4: Point-to-point configuration in hazardous area

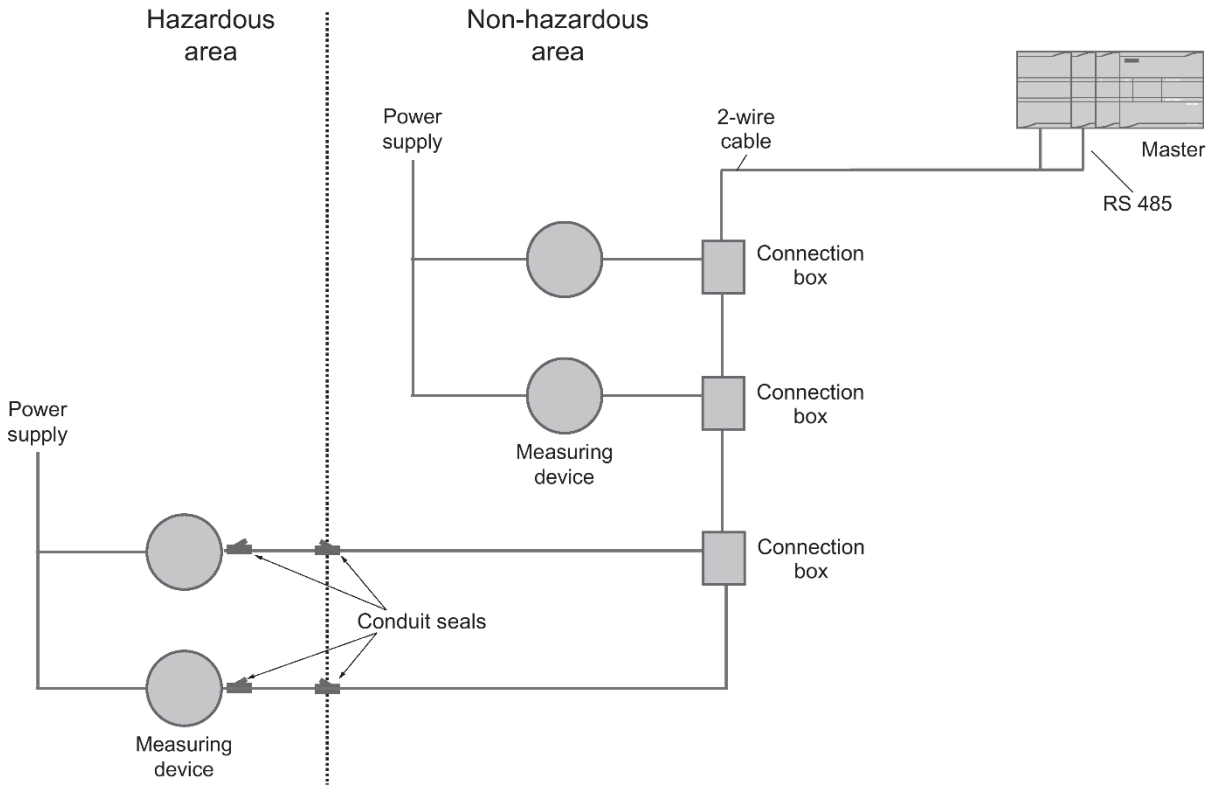


Fig. 5: Multidrop configuration in hazardous area

NOTE:

Flameproof conduit seals

Two flameproof conduit seals are required for each device in hazardous area installations.

NOTE:

Equipment approved for hazardous areas

Ensure that the equipment is approved for installation in hazardous areas.

2.3. System writing

The device is slave in a 2-wire Modbus RTU RS485 bus system. Terminal A on the device must be connected to terminal A on the master/host system. Terminal B on the device must be connected to terminal B on the master/host system This corresponds to a half-duplex communication where the slave will only reply to a request from the master.

This example shows an EMC shielded enclosure for multidrop installation. Cable shield must be grounded at host system, in connection box, and at flowmeter to comply with EMC requirements. Keep the cable shield to the ground as short as possible.

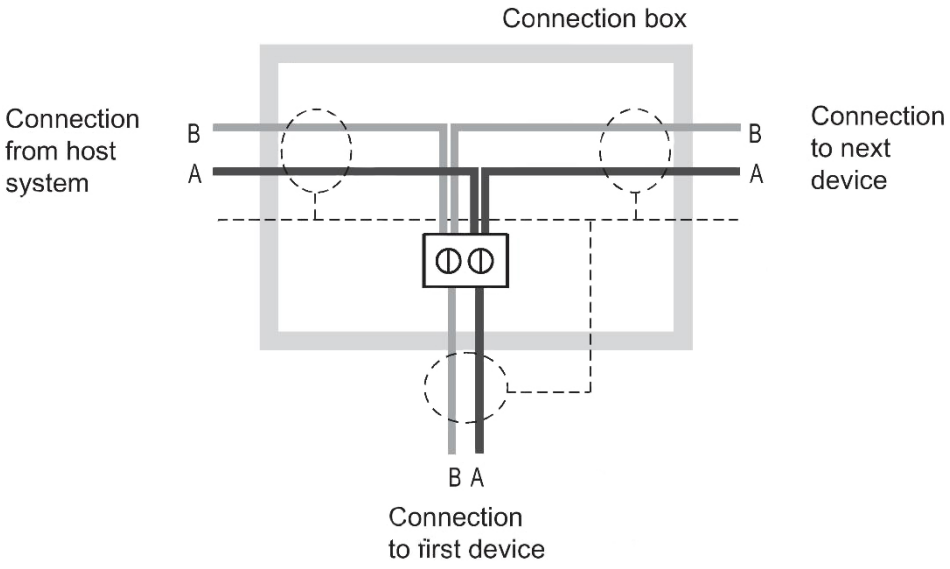


Fig. 6: EMC shielded enclosure for multidrop installation

Topology

The device supports a two-wire electrical interface in accordance with EIA/TIA-485 standard.

An RS485 Modbus configuration without repeater has one trunk cable, along which devices are connected, directly (daisy chaining) or by short branch cables.

NOTE:

Multidrop examples in this document show a trunk cable with short branch cables.

Maximum cable lengths

The end to end length of the trunk cable must be limited. The maximum length depends on the baud rate, the cable (gauge, capacitance or characteristic impedance), the number and types of loads on the daisy chain, and the network configuration.

NOTE:

Maximum branch cable length

Branch cables must be short, never more than 20 m.

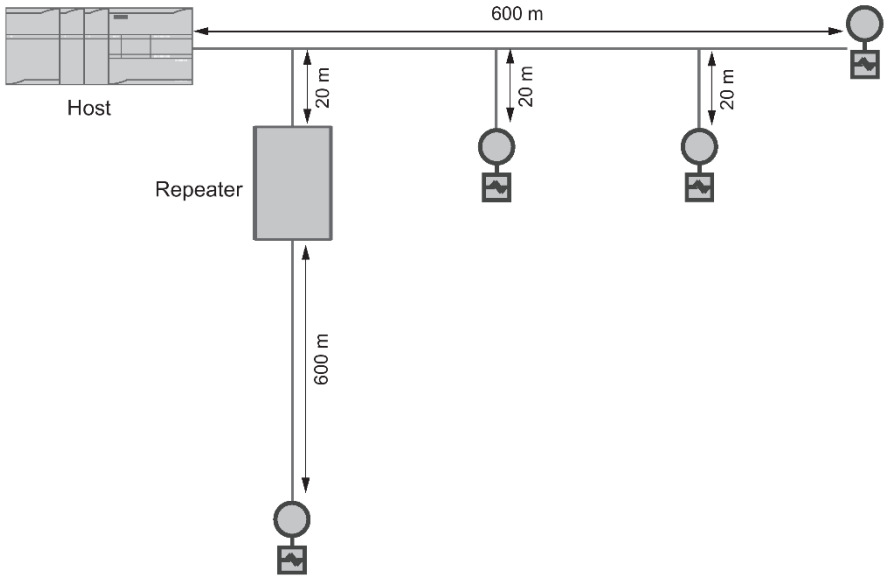


Fig. 7: Maximum cable lengths in multidrop configuration

2.4. Connecting

NOTE:

End Of Line (EOL) termination

The TCD 9010 EOL termination DIP switch is default set to EOL active. Avoid DIP switch settings not shown in the table below. Otherwise, reduced communication interface reliability will occur.

The DIP switch is located on the frontend cassette (main transmitter /Ch1 cassette).

DIP switch Communication set-up

Description	Switch 1	Switch 2	Switch 3	Switch 4
EOL Active	OFF	OFF	OFF	OFF
EOL Inactive	ON	ON	OFF	OFF

2.5. Connecting the Modbus

2.5.1. M12-version

The device is provided with a preformed cable terminated with M12 style stainless steel weather-proof plugs.

The cable screen is physically and electrically terminated within the body of the plug.

Take care when handling the cable and passing it through cable ducting that the plug is not subjected to excessive tension (pulling) as the internal connections may be disengaged.

NOTE:

Never pull the cable by the plug - only by the cable itself

1. Connect the device using the supplied 4-wire cable with M12 connectors.

NOTE:

Grounding

The sensor cable screen is electrically connected to the grounding terminal (PE), only when the M12 plug is correctly tightened.

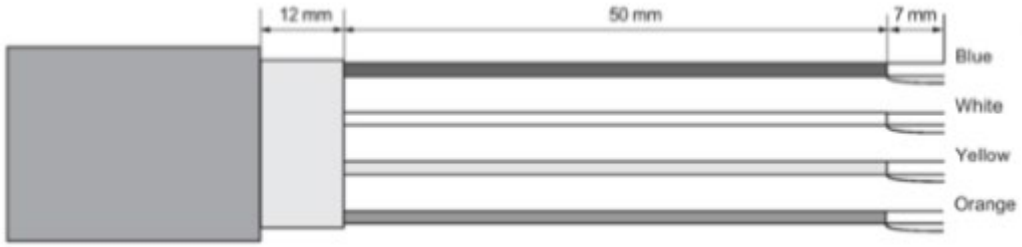
Terminal number	Description
1	24 VDC
2	0 VDC
3	B
4	A

2. Set Modbus communication parameters to factory settings

COM PORT	Depending on instrument
Device Address	1
Baudrate	19200
Parity/Stopbits	Even, 1

2.5.2. Cable termination version

Prepare the cable by stripping it at both ends.



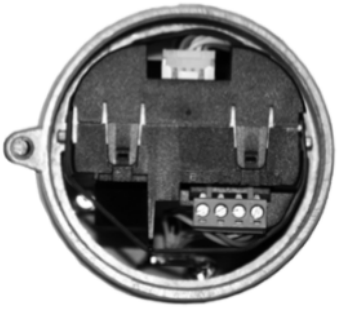
Connect wires within the sensor terminal space

1. Remove the lock screw and remove the lid.
2. Undo the flexible strap.
3. Disconnect the sensor connection (white plug) from the electronic.
4. Loosen the mounting screw using a TX10 Torx driver and remove the electronic from the housing.
5. Remove the cap and the ferrule from the cable gland and slide onto the cable.
6. Push the cable through the open gland and anchor the cable shield and the wires with the clamp bar.
7. Remove the terminal block from the electronic.
8. Connect the wires to the terminals according to the list below.

Terminal number	Description
1	24 V DC
2	0 V DC
3	B
4	A

9. Reinstall the electronic including the mounting screw.
10. Connect the sensor connection and the sensor cable.

11. Restore the flexible strap around all wires.



12. Assemble and tighten the cable gland.
13. Remove the O-ring from lid.
14. Reinstate the lid and screw in until the mechanical stop. Wind back the lid by one turn.
15. Mount the O-ring by pulling it over the lid and tighten the lid until you feel friction from the O-ring on both sides. Wind the lid by one quarter of a turn to seal on the O-ring.
16. Reinstate and tighten the lid lock screw.

3. Modbus holding register

3.1. Modbus addressing model

The device allows read/write access to the following standard Modbus RTU data holding register blocks:

Holding registers (ref. 4x address range)

- The minimum value allowed to be written to a **holding register** (that allows Read/Write) can be read by adding 10000 to the Modbus address of the register.
- The maximum value allowed to be written to a **holding register** (that allows Read/Write) can be read by adding 20000 to the Modbus address of the register.
- The default value of a holding register (that allows Read/Write) can be read by adding 30000 to the Modbus address of the register.

3.2. Modbus function codes

This device supports following function codes: 3, 8 and 16.

Function codes 3 and 16 are used for accessing registers, max. 16 registers per read/write request is accepted.

Function code 8 is used for reading Modbus communication diagnostic information.

Below the various function code are described. The device allows read/write access to the following standard Modbus RTU data holding register blocks:

Function code 3 (Read holding registers)

General exceptions:

- Requesting less than 1 or more than 16 registers => Exception 3 (Illegal data value)
- Requesting invalid start address or start address with invalid quantity => Exception 2 (Illegal data address)

Application exceptions:

- Application errors; min/max limit of parameter exceeded; or parameter write-protected => Exception 4 (Slave device error)

Holes/register alignment:

- The read command always returns data if no exception is given.
- Holes in the holding register map return value zero in all bytes. E.g. reading 2 registers starting at 4:0004 above will result in 2 bytes of "float B" followed by 2 zeroes.

Function code 3 example

Query

Slave address	1 byte
Function	1 byte
Starting Address Hi	1 byte
Starting Address Lo	1 byte
Quantity of Registers Hi	1 byte
Quantity of Registers Lo	1 byte
CRC	2 byte

Response

Slave address	1 byte
Function	1 byte
Byte count	1 byte
Register Value Hi	1 byte
Register Value Lo	1 byte
…	…
Register Value Hi	1 byte
Register Value Lo	1 byte
CRC	2 byte

Example: Read absolute Mass Flow (address 3000)

Query: 1,3,11,184,0,2,70,10
Slave address = 1 (0x01)
Function = 3 (0x03)
Starting Address Hi,
Lo = 11, 184 (0x0B,0xB8)
Quantity of Registers Hi , Lo = 0, 2 (0x00,0x02)
CRC = 70,10 (0x46, 0x0A)
Starting address 0x0BB8 = 3000
Quantity of registers = 0x0002 = 2

Response: 1,3,4,64,195,82,139,98,200
Slave address = 1 (0x01)
Function = 3 (0x03)
Byte Count = 4 (0x04)
Register 1 - Register Value Hi, Lo = 64, 195 (0x40, 0xC3)
Register 2 - Register Value Hi, Lo = 82, 139 (0x52, 0x93)
CRC = 98,200 (0x62, 0xC8)
Absolute Mass Flow = 0x40C35293 = 6.10383 kg/sec

Function code 16 (Write multiple registers)

General exceptions

- Writing less than 1 or more than 16 registers => Exception 3 (Illegal data value)
- If ByteCount is not exactly 2 times NoOfRegisters => Exception 3 (Illegal data value)
- Requesting invalid start address or start address with invalid quantity => Exception 2 (Illegal data address)

Application exceptions:

- Application errors; min/max limit of parameter exceeded; or parameter write-protected => Exception 4 (Slave device error)
- Application errors include writing to ReadOnly holding registers

Holes/register alignment:

- If start-address is not the start of a mapped holding register => Exception 2 (Illegal data address)
- Writing to holes is allowed (ie ignored - and no exception occurs) - except for the condition described above
- If the end address is only part of a mapped holding register item (e.g. one half of a float value), the action depends on the data type. Writing parts of all data types => Exception 4 (Slave device error)

Function code 16 example

Query

Slave address	1 byte
Function	1 byte
Starting Address Hi	1 byte
Starting Address Lo	1 byte
Quantity of Registers Hi	1 byte
Quantity of Registers Lo	1 byte
Byte Count	1 byte
Register Value Hi	1 byte
Register Value Lo	1 byte
…	…
Register Value Hi	1 byte
Register Value Lo	1 byte
CRC	2 byte

Response

Slave address	1 byte
Function	1 byte
Byte count	1 byte
Starting Address Hi	1 byte
Starting Address Lo	1 byte
Quantity of Registers Hi	1 byte
Quantity of Registers Lo	1 byte
CRC	2 byte

Example: Read absolute Mass Flow (address 3000)

Query: 1,16,2,17,0,1,2,0,5,70,210
Slave address = 1 (0x01)
Function = 16 (0x10)
Starting Address Hi, Lo = 2, 17 (0x02,0x11)
Quantity of Registers Hi, Lo = 0, 1 (0x00,0x01)
Byte Count = 2 (0x02)
Registers Value Hi, Lo = 0, 5 (0x00,0x05)
CRC = 70,10 (0x46, 0x0A)
Starting address 0x0211 = 529
Number of registers = 0x0001 = 1
Data 0x0005 = (115200 = value 5)

Response: 1,16,2,17,0,1,80,116
Slave address = 1 (0x01)
Function = 16 (0x10)
Starting Address Hi, Lo = 2, 17 (0x02,0x11)
Quantity of Registers Hi, Lo = 0, 1 (0x00,0x01)
CRC = 80,116 (0x50, 0x74)

Function code 8 example

Slave address	1 byte
Function	1 byte
Sub-function Hi	1 byte
Sub-function Lo	1 byte
Data Hi	1 byte
Data Lo	1 byte
…	…
Data Hi	1 byte
Data Lo	1 byte
CRC	2 byte
Slave address	1 byte
Function	1 byte
Sub-function Hi	1 byte
Sub-function Lo	1 byte
Data Hi	1 byte
Data Lo	1 byte
…	…
Data Hi	1 byte
Data Lo	1 byte
CRC	2 byte

Example: Read Return Slave Message Count (address 529)

Query: 1,8,0,14,0,0,129,200
Slave address = 1 (0x01)
Function = 8 (0x08)
Sub-function Hi, Lo = 0, 14 (0x00,0x0E)
Data Hi, Lo = 0, 0 (0x00,0x00)
CRC = 129,200 (0x81, 0xC8)
Sub-function 0x000E = 14 = Read Return Slave Message Count

Response: 1,8,0,14,0,97,64,32
Slave address = 1 (0x01) Function = 8 (0x08)
Sub-function Hi, Lo = 0, 14 (0x00,0x0E)
Data Hi, Lo = 0, 97 (0x00,0x65)
CRC = 64,32 (0x41, 0xE3)
Read Return Slave Message Count = 0x0065 = 97 message received

3.3. Modbus holding registers tables

In the following the Modbus RTU holding registers available for TRICOR TCD 9010 are described.

NOTE:
All Write parameters require password access.

3.3.1. Process values

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
3000	Float/4	Mass Flow	Measured mass flow	[kg/s]	-	Read only
3002	Float/4	Volume Flow	Measured volume flow	[m³/s]	-	Read only
3004	Float/4	Density	Measured density	[kg/m³]	-	Read only
3010	Float/4	Temperature	Measured temperature of the process media	[°C]	-	Read only
3023	Float/4	Frame Temperature	Measured temperature of the sensor frame (version dependent)	[°C]	-	Read only

Tab. 1: Process values

3.3.2. Identification

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
4000	String/20	Manufacturer	Device manufacturer	KEM	-	Read only
4020	String/10	Sensor Firmware Revision	Sensor firmware version	-	-	Read only
4025	String/16	Sensor Serial Number	Sensor type (see device nameplate)	TRICOR	-	Read only
4033	String/20	SensorType	Unique sensor serial number	-	-	Read only
4095	String/10	Sensor Hardware Revision	(see device nameplate)	-	-	Read only
4100	String/10	10 Sensor Frontend Type	Sensor hardware version	-	-	Read only
4121	String/20	Sensor Order Number	Sensor hardware variant	-	-	Read only
4131	String/32	Sensor Order Number	Sensor order number part 1(see device nameplate)	-	-	Read only
4147	String/32	Sensor Order Number	Sensor order number part 3	-	-	Read only
4164	String/32	Long TAG	Enter a unique TAG name for the device (up to 32 characters)	-	-	
4180	String/16	Descriptor	Enter a unique description for the measurement point (up to 16 characters)	-	-	
4188	String/16	Startup	Date Enter the installation date of the device	-	-	

Tab. 2: Tricor Identification

3.3.3. Setup

Operating conditions

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2100	Unsigned/2	Flow Direction	Define positive and negative flow direction. Default positive flow direction is indicated by the arrow on the sensor. Possible selections: 0: Negative: The flow is measured '+' in default negative direction and '-' in default positive direction. 1: Positive: The flow is measured '+' in default positive direction and '-' in default negative direction.	1	0 to 1	Read/ Write
2130	Unsigned/2	Process Noise Damping	Select process noise damping level: 0: 55 ms filtering (Centrifugal Pump) 1: 110 ms filtering (Triplex Pump) 2: 220 ms filtering (Duplex Pump) 3: 400 ms filtering (Simplex Pump) 4: 800 ms filtering (Cam Pump)	2	0 Low to 4 High	Read/ Write

Tab. 3: Operating conditions

Mass Flow

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2125	Float/4	Low Mass Flow CutOff	Set Mass Flow limit for low flow cut-off. Below this limit Mass Flow output is forced to zero. If Low Flow Cut-Off is set to 0, the cut-off functionality is disabled. Notice: It is recommended to set a lower value for gas applications.	Sensor size specific [kg/s]	0 to 1023	Read/ Write
2426	Float/4	Mass Flow Correction Factor	Specify correction factor for use in the Mass Flow calculation.		-1.999 to +1.999	Read/ Write

Tab. 4: Mass Flow

Volume Flow

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2170	Float/4	Low Volume Flow CutOff	Define the numerical Volume Flow value below which the Volume Flow output is forced to zero.	Sensor size specific [m^3/s]	0 to 0.177	Read/ Write

Tab. 5: Volume Flow

Density

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2127	Float/4	Empty Tube Limit	Define threshold value of empty tube.	500 [kg/m^3]	-14000 to +14000	Read/ Write
2129	Unsigned/2	Empty Tube Detection	Set automatic detection of Empty Tube On/Off. 0: off (Empty tube is off). 1: on (a density value below Empty Tube Limit triggers an alarm. All flow rate values are forced to zero %)	0	0 to 1	Read/ Write

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2442	Float/4	Density Correction Factor	Set density compensation value (gain) in order to make a density correction (scale factor). To increase the displayed density value with +0.5 %, set the density factor to 1.005. The displayed density value will now be 0.5 % higher than before.	-	-1.999 to +1.999	Read/ Write
2444	Float/4	Density Correction Offset	Set density compensation value (offset) in order to make an offset on the measured density. To make the flowmeter show + 2 kg/m^3, change the density offset to 2.000 kg/m^3 in the 'Sensor' menu.	0 [kg/m³]	-1400 to +1400	Read/ Write

Tab. 6: Density

Totalizer

NOTE:

Totalizer register is a non-persistent value and set to default (0) in case of a power loss.

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2609	Unsigned/2	Totalizer State	Totalizer state 0: paused 1: running	-	0 to 1	Read only
2610	Float/4	Totalizer Value	The totalized MASS value in kg	0 [kg]	-1.70E+38 to 1.70E+38	Read only
3018	Unsigned/4	Totalizer fixed point part	The totalized MASS value in kg. Most significant word of the totalizer (MSW). The format of the totalizer is a TotalType. The TotalType represent a fixed point value in the MSW 32 bit and a fractional part in the LSW 32 bit. Example: 2.03 would be represented as fixed point part = 2 and fractional part = 30000000 Note: the data type is unsigned32, but shall be	0 [kg]	Min. -2147483648 Max. 2247483647	Read Only

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
			converted into a signed32 by the host since signed32 is not supported in the device. Example conversion to float64 tag by the host: Float64 tag = fixed point part + (fraction part/1000000000.0).			
3020	Unsigned/4	Totalizer fractional part	The totalized MASS value in kg. Least significant word of the totalizer (LSW). The format of the totalizer is a TotalType. The TotalType represent a fixed point value in the MSW 32 bit and a fractional part in the LSW 32 bit.	0 [kg]	Min -999999999 Max 999999999	Read Only
2612	Unsigned/2	Reset totalizer	Reset totalizer value	-	Enter 1 to reset	Read/ Write
2613	Unsigned/2	Pause totalizer	Pause totalizer Totalizer can only be paused when running	-	Enter 1 to pause	Read/ Write
2614	Unsigned/2	Resume totalizer	Resume totalizer Totalizer can only be resumed when paused	-	Enter 1 to pause	Read/ Write

Tab. 7: Totalizer

3.3.4. Units

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units] (units register)	Value range / Setting options	Access level
7500	Unsigned/2	Volume flow units	Units for volume flow values.	19	15: ft³/min (cubic feet per minute) 16: gal/min (US gallons per minute) 17: l/min (liters per minute) 18: i.gal/min (Imperial gallons per minute) 19: m³/h (cubic meters per hour) 22: gal/s (US gallons per second)	Read/ write

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units] (units register)	Value range / Setting options	Access level
					23: Mgal/d (million US gallons per day) 24: l/s (liters per second) 25: Ml/d (million liters per day) 26: ft³/s (cubic feet per second) 27: ft³/d (cubic feet per day) 28: m³/s (cubic meters per second) 29: m³/d (cubic meters per day) 30: i.gal/h (Imperial gallons per hour) 31: i.gal/d (Imperial gallons per day) 130:ft³/h (cubic feet per hour) 131:m³/min (cubic meters per minute) 132:BBL42/s (1 barrel = 42 US gallons) 133:BBL42/min (1 barrel = 42US gallons) 134:BBL42/h (1 barrel = 42 US gallons 135:BBL42/d (1 barrel = 42 US gallons 136:gal/h (US gallons per hour) 137:i.gal/s (Imperial gallons per second) 138:l/h (liters per hour) 170:BBL31/s (1 barrel = 31 US gallons 171:BBL31/min (1 barrel = 31 US gallons) 172:BBL31/h (1 barrel = 31 US gallons	
7400	Unsigned/2	Mass flow units	Units for mass flow values.	75	70: g/s (grams per second) 71: g/min (grams per min) 72: g/h (grams per hour) 73: kg/s (kilograms per second)	Read/ write

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units] (units register)	Value range / Setting options	Access level
					74: kg/min (kilograms per minute) 75: kg/h (kilograms per hour) 76: kg/d (kilograms per day) 77: t/min (1 t = 1000 kg) 78: t/h (1 t = 1000 kg) 79: t/d (1 t = 1000 kg) 80: lb/s (pounds per second) 81: lb/min (pounds per minute) 82: lb/h (pounds per hour) 83: lb/d (pounds per day) 84: STon/min (1 STon = 2000 lb) 85: STon/h (1 STon = 2000 lb) 86: STon/d (1 STon = 2000 lb) 87: T/h (1 T = 2240 lb) 88: T/d (1 T = 2240 lb) 253: custom units (see Custom mass flow units string (8458) / factor (8456))	
7600	Unsigned/2	Density units	Units for density values.	92	91: g/cm³ (grams per cubic) centimeters 92: kg/m³ (kilograms per cubic meter) 93: lb/gal (pounds per US gallon) 94: lb/ft³ (pounds per cubic foot) 95: g/ml (grams per mililiter) 96: kg/l (kilograms per liter) 97: g/l (grams per liter) 98: lb/in³ (pounds per cubic inch) 99: STon/yd³ (1 STon = 2000 lb) 146: µg/l (micrograms per liter)	Read/ write

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units] (units register)	Value range / Setting options	Access level
					147:µg/m³ (micrograms per cubic meter) 170:mg/l (milligrams per liter) 253:custom units (see Custom density units string (8464) / factor (8462))	
7700	Unsigned/2	Tempera-ture units	Units for temperatur e values.	32	32: °C (degrees Celsius) 33: °F (degrees Fahrenheit) 34: °R (degrees Rankine) 35: K (kelvins)	Read/ write
8320	Unsigned/2	Totalizer 1 units	Units for mass quantities of totalizer 1 (totalizer 1 is configured to mass flow).	61	60: g (grams) 61: kg (kilograms) 62: t (1 t = 1000 kg) 63: lb (pounds) 64: STon (1 STon = 2000 lb) 65: T (1 T = 2240 lb) 125:oz (ounces) 253:custom units (see Custom mass units string (8476) / factor (8474))	Read/ write

Tab. 8: Units settings for values and quantities communicated via Modbus

3.3.5. Maintenance & Diagnostics

Access level

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
404	Unsigned/2	Access level	Access level status	-	32 (logged in) 4 (logged out)	Read only
412	Unsigned/2	User password	Password to enable writing commands	-	2207 (enable user password) 0 (disable user password)	Read/ Write

Tab. 9: Access level

Maintenance

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
700	Unsigned/2	Set to default	Reset all parameters to factory settings	-	Enter 1 to reset	Write
2700	Unsigned/4	Operating Time Total	Total operating time since first power up	0 [h]	-	Read Only
2702	Unsigned/4	Operating Time	Operating time since last power up	0 [h]	-	Read Only
4088	String/14	Firmware Time Stamp	Firmware time stamp specifies the date and time when the sensor firmware was built	-	-	Read Only
4105	String/32	Sensor PCBA Serial Number	Serial number of the sensor electronic	-	-	Read Only

Tab. 10: Maintenance

Device diagnostics

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2756	Float/4	Driver Current	Actual sensor driver current The actual driver current is viscosity and sensor size dependent	- [A]	0 to 0.124	Read Only
2758	Float/4	Pick-up Amplitude 1	Actual pick-up 1 amplitude	- [V]	0 to 0.9999	Read Only
2760	Float/4	Pick-up Amplitude 2	Actual pick-up 2 amplitude	- [V]	0 to 0.9999	Read Only
2762	Float/4	Sensor Frequency	Actual sensor frequency	- [Hz]	0 to 1023	Read Only
3032	Float/4	PCB Temperature	Actual sensor electronic temperature	- [C°]	-50 to 200	Read Only

Tab. 11: Device diagnostics

Aerated flow

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2200	Unsigned/2	Aerated Flow Alarm Limit	Alarm limit calculated in per cent of accepted bad measurements.	80 [%]	0 to 99	Read/ Write
2201	Unsigned/2	Aerated Flow Warning Limit	Warning limit calculated in per cent of accepted bad measurements	0 [%]	0 to 99	Read/ Write
2202	Unsigned/2	Measure-ment Sample Time	The time period over which the actual percentage of bad measurements is calculated	5 [s]	1 to 10	Read/ Write
2203	Unsigned/2	Aerated Flow Filter	Aerated flow filter 0: Disabled 1: Enabled 2: Auto Auto means that filtering starts automatically when aerated flow is measured	2	0 to 2	Read/ Write
2204	Unsigned/2	Filter Time Constant	PV Filter Time Constant 0: 0.5 seconds 1: 1 second 2: 2 seconds 3: 5 seconds 4: 10 seconds 5: 20 seconds 6: 30 seconds 7: User Defined Value	4	0 to7	Read/ Write
2205	Float/4	Filter Start Hysteresis	The filter is active when the hysteresis value is exceeded. Aerated Flow Filter must be set to Auto.	0.015 [V]	0 to 0.124	Read/ Write
2207	Unsigned/2	Minimum Filtering Time	The filtering time is reset each time hysteresis band is exceeded.	10 [ms cycles]	0 to 65535	Read/ Write
2214	Unsigned/2	Pickup Amplitude Filter	Enable/disable pickup amplitude filter. 0: Disable 1: Enable	1	0 to 1	Read/ Write
2215	Unsigned/2	Bad Measure-ment Count	Number of bad measurements counted during the last period	0	0 – 65535	Read Only
2216	Unsigned/2	Filter Iteration	Set the number of times to repeat the same filter. Increasing the number will increase the damping. Active only if Filter Time Constant is set to 7	3	1 to 5	Read/ Write

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2217	Unsigned/2	Bandwidth Factor	Increase the Bandwidth Factor to reduce the LP (low pass) bandwidth filtering. Active only if Filter Time Constant is set to 7.	2	0 to 4	Read/ Write
2218	Unsigned/2	Filter Pole Shift	Configure the bandwidth and damping in the stop band. A high number will give a small bandwidth and an increased damping in the stop band. Active only if Filter Time Constant is set to 7.	2	1 to 5	Read/ Write

Tab. 12: Aerated flow

Zero point adjustment

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2132	Unsigned/2	Zero Point Adjustment	Select zero point adjustment method. Automatic zero point adjustment is recommended. 0: Auto 1: Manual	0	0 to 1	Read/ Write
2133	Float/4	Manual Zero Point Offset	Enter agreed zero point offset value for manual zero point adjustment mode.	0 [kg/s]	0 to 1023	Read/ Write
2135	Unsigned/2	Zero Point	Duration Define duration of zero point adjustment.	30 [s]	1 to 999	Read/ Write
2136	Float/4	Standard Deviation	Standard deviation during auto zero point adjustment	0 [kg/s]	-1023 to +1023	Read only
2138	Float/4	Standard Deviation Limit	Set limit for zero point adjustment Standard Deviation value. If the Standard Deviation exceeds the Standard Deviation Limit, the auto zero point adjustment is aborted.	Sensor size specific [kg/s]	0 to +1023	Read/ Write
2140	Float/4	Zero Point Offsett Limit	Set limit for zero point offset. If the zero point offset exceeds the zero point offset limit, the zero point offset cannot be stored	Sensor size specific [kg/s]	-1023 to +1023	Read/ Write
2142	Float/4	Zero Point Offset Value	Default zero point offset based on factory calibration of sensor. A Zero point offset compensates for sensor variations due to process conditions.	0 [kg/s]	-1023 to +1023	Read only

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2144	Unsigned/2	Zero Point Adjust Progress	Shows the progress of the currently running Zero Point adjustment in percentage	0 [%]	0 to 100	Read Only
2145	Unsigned/2	Zero Point Adjust Status	Status of the last zero point adjustment performed Every high bit ('1') represents an error occurred in the last zero point adjustment performed. No high bits equals ok. Bit 1: Zero sigma limit exceeded Bit 2: Zero offset limit exceeded Bit 4: Quality of zero point conditions	-	Bit 1 Bit 2 Bit 4	Read Only
2180	Unsigned/2	Start Zero Point Adjust-ment	Start automatic zero point adjustment. The automatic zero point adjustment determines the application specific zero point offset automatically. Possible selections: 0: Idle 1: Running 2: Start	0	0 to 2	Read/ Write

Tab. 13: Zero point adjustment

3.3.6. Communication

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
527	Unsigned/2	Float byte order	The float byte order used in Modbus messages. Selection 0: Byte order: 1-0-3-2 Selection 1: Byte order: 0-1-2-3 Selection 2: Byte order: 2-3-0-1 Selection 3: Byte order: 3-2-1-0 The first mentioned byte is the first byte sent. Byte 3 corresponds to the left-most byte (MSB) of a 32 bit float in big endian format, byte 0 corresponds to the right-most byte (LSB).	3	0 to 3	Read/ Write
528	Unsigned/2	Modbus Address	Set Modbus Device Address	1	1 to 247	Read/ Write

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
529	Unsigned/2	Baudrate	Set communication baudrate. Following baud rates are available: 0: 9 600 1: 19 200 (Default) 2: 115 200 3: 460 800 4: 38 400 5: 57 600 6: 76 800	1	0 to 6	Read/ Write
530	Unsigned/2	Modbus Parity Framing	RS 485 parity and framing 8 databits are always used 0: even parity, 1 stopbit 1: odd parity, 1 stopbit 2: no parity, 2 stopbits	0	0 to 2	Read/ Write
600	Unsigned/2	Restart communica-tion	Restart Modbus communication Write: 0: No effect 1: Restart Read: always 0	-	0 to 1	Write

Tab. 14: Modbus

3.3.7. Characteristics

Sensor

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2113	Float/4	Minimum Frame Temperature	Lower limit of the frame temperature	-50 [°C]	-	Read only
2115	Float/4	Maximum Frame Temperature	Lower limit of the frame temperature	200 [°C]	-	Read only
4043	String/16	Sensor size	Nominal sensor diameter (DN)	-	-	Read only
4053	String/16	Hazardous area approval	Hazardous area approval of the sensor	-	-	Read only
4078	String/16	Wetted materials	Sensor enclosure material	-	-	Read only

Tab. 15: Sensor

Volumeflow calibration

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2103	Float/4	Maximum Volume Flow Capacity	Maximum Volume Flow measurement capacity of the sensor	Sensor size specific [m^3/s]	0 to 0.177	Read only

Tab. 16: Volume Flow calibration

Massflow calibration

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2101	Float/4	Maximum Mass Flow Capacity	Maximum Mass Flow measurement capacity of the sensor	Sensor size specific [kg/s]	0 to 1023	Read only
2402	Float/4	Calibration Factor	Factory-set sensor-specific calibration factor.	-	Min: 5.00E+07 Max: 4.29E+09	Read only

Tab. 17: Mass Flow calibration

Density calibration

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2428	Float/4	Density Calibration Offset	Specify an offset in the density flow calculation	-	- 14000 to +14000	Read only
2430	Float/4	Density Calibration Factor	Specify gain factor in the density flow calculation	-	-1.999 to +1.999	Read only
2432	Float/4	Dens. Comp. Tube Temp.	Specifies a tube temperature coefficient in the density calculation	-	-0.001953 to +0.001953	Read only
2434	Float/4	Dens. Comp. Frame Temp.	Specifies a frame temperature coefficient in the density calculation	-	-0.001953 to +0.001953	Read only

Tab. 18: Density calibration

3.3.8. Simulation

Modbus register	Data type / Size in bytes	Parameter	Description	Default value [units]	Value range	Access level
2764	Float/4	Mass Flow Simulation Value	Set Mass Flow simulation value. The Mass Flow will be set to this value on all outputs, if Simulation Mass Flow is enabled	0 [kg/s]	-1023 to +1023	Read/ Write
2766	Float/4	Density Simulation Value	Set density simulation value. The density will be set to this value on all outputs, if Simulation Density is enabled	1000 [kg/m³]	-20000 to +20000	Read/ Write
2768	Float/4	Tube Temperature Simulation Value	Set tube temperature simulation value. The tube temperature will be set to this value on all outputs if Simulation Tube Temperature is enabled	0 [°C]	-50 to +200	Read/ Write
2770	Float/4	Frame Temperature Simulation Value	Set frame temperature simulation value. The frame temperature will be set to this value on all outputs if Simulation Frame Temperature is enabled	0 [°C]	-50 to +200	Read/ Write
2772	Float/4	Volume Flow Simulation Value	Set Volume Flow simulation value. The volume flow will be set to this value on all outputs, if Simulation Volume Flow is enabled	[m³/s]	-65 to +65	Read/ Write
2780	Unsigned/2	Enable Simulation	Activate simulation. Select one of the following values: Bit 0: Mass Flow Bit 1: Density Bit 2: Volume Flow Bit 3: Tube temperature Bit 4: Frame temperature	0	0 to 63	Read/ Write

Tab. 19: Simulation

3.3.9. Alarms

Modbus register	Data type / Size in bytes	Para-meter	Description	Default value [units]	Value range	Access level
3012	Unsigned/4	Alarm Group 1	The following bit is set in case of active alarm: Bit 4: Power Supply Malfunction Bit 6: Temperature Circuit Malfunction Bit 10: Measurement Out Of Range Bit 14: Calibration Malfunction Bit 15: Compensation Out Of Range Bit 17: Pickup Malfunction Bit 23: Driver Malfunction Bit 26: Measurement Out Of Range Bit 27: Mass Flow Max Limit Exceeded Bit 28: Volume Flow Max Limit Exceeded Bit 29: Density Max Limit Exceeded Bit 30: Min Tube Temp Exceeded Bit 31: Max Tube Temp Exceeded	-	-	Read only
3014	Unsigned/4	Alarm Group 2	The following bit is set in case of active alarm: Bit 0: Min Frame Temp Exceeded Bit 1: Max Frame Temp Exceeded Bit 2: Zero Sigma Limit Exceeded Bit 3: Zero Offset Limit Exceeded Bit 4: Quality Of Zero Point Conditions Bit 5: Empty Pipe Bit 6: Sensor Partially Filled Bit 7: Storage Malfunction Bit 8: System Internal Bit 14: Unstable Measurement Conditions Bit 15: Auto-filtering enabled Bit 23: Sensor Startup	-	-	

Tab. 20: Alarms

3.3.10. Quality codes for process values

Modbus register	Data type / Size in bytes	Para-meter	Description	Default value [units]	Value range	Access level
3014	Unsigned/4	Alarm Group 2	Quality code of a measured value	Process values for quality codes Media temperature Density Volume Flow Mass Flow Quality code for each process value consist of 2 bits: Bit 24/25: Media temperature Bit 26/27: Density Bit 28/29: Volume Flow Bit 30/31: Mass Flow	11 Good 01 Reserved 10 Simulation 00 Bad	Read only

Tab. 21: Quality codes for process values

4. Listings

4.1. List of Figures

4.2. List of Tables

NORTH & SOUTH AMERICA

AW Lake Company
2440 W. Corporate Preserve Dr. #600
Oak Creek WI 53154 | USA
+1 414 574 4300
sales@aw-lake.com
www.aw-lake.com

EUROPE (ROW)

KEM Küppers Elektromechanik GmbH
Liebigstraße 5
85757 Karlsfeld | Germany
+49 8131 59391-100
sales@kem-kueppers.com
www.kem-kueppers.com

ASIA PACIFIC & MIDDLE EAST

KEM Küppers Elektromechanik GmbH
Liebigstraße 5
85757 Karlsfeld | Germany
+49 8131 59391-0
info@kem-kueppers.com
www.kem-kueppers.com

CHINA

KEM flow technology (Beijing) Co., Ltd.
Rm. 906, Block C, Ruipu Office Bldg, No. 15
HongJunYingNan Road
Chaoyang District, Beijing 100012 | China
+86 10 84929567
sales@kem-kueppers.com
www.kem-kueppers.cn

TRICOR Coriolis Technology