X20CMR100

Data sheet
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Translation of the original documentation

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B&R Industrial Automation GmbH

B&R Strasse 1

5142 Eggelsberg

Austria

Telephone: +43 7748 6586-0

Fax: +43 7748 6586-26

office@br-automation.com

Disclaimer

1512108758269-1.10

1 General information

1.1 Other applicable documents

For additional and supplementary information, see the following documents.

Other applicable documents

Document name	Title
MAX20	X20 System user's manual

1.2 Order data

Order number	Short description	Figure
	Other functions	
X20CMR100	X20 cabinet monitoring module, integrated temperature and humidity sensor, production data acquisition, integrated Technology Guard	
	Required accessories	
	Bus modules	
X20BM11	X20 bus module, 24 VDC keyed, internal I/O power supply connected through	
X20BM15	X20 bus module, with node number switch, 24 VDC keyed, internal I/O power supply connected through	
	Terminal blocks	
X20TB12	X20 terminal block, 12-pin, 24 VDC keyed	

Table 1: X20CMR100 - Order data

1.3 Module description

The module is designed for measuring ambient conditions in the control cabinet as well as recording operating hours and power-on cycles. In addition, the module is equipped with a Technology Guard and supports blackout mode.

Functions:

- "Measuring and evaluating ambient conditions"
- "Recording operating data"
- "Technology Guarding"
- "Blackout mode"

Measuring and evaluating ambient conditions

The ambient conditions are continuously evaluated by the module. The duration in which individual parameters are within certain ranges is stored internally. This makes it possible, for example, to determine how long the system remained in a certain temperature range. The histograms recorded by the module can be read out by the user.

Technology Guarding

With the integrated Technology Guard, it is possible to implement license protection directly via the module instead of the USB dongle. The same functions can be used as with the USB dongle.

Information:

- **Automation Runtime C4.44 or later is required to use the functions of the Technology Guard.**
- **It is important to note that the Technology Guard is not available in function model "Bus controller"!**
- **This module is not suitable for controller redundancy applications.**

Blackout mode

The integrated blackout mode ensures that module functionality is maintained even in the event of network failure.

2 Technical description

2.1 Technical data

Order number	X20CMR100
Short description	
I/O module	Measurement of ambient conditions: Internal module temperature, relative humidity, operating hours, power-on cycles
General information	
B&R ID code	0xF1AD
Status indicators	Memory access, operating state, module status
Diagnostics	
Module run/error	Yes, using LED status indicator and software
Blackout mode	
Scope	Module
Function	Module functionality
Standalone mode	No
Power consumption	
Bus	0.4 W
Internal I/O	-
Additional power dissipation caused by actuators (resistive) [W]	-
Technology Guard	
Data retention	10 years at room temperature
Guaranteed erase/write cycles	Up to 10 million
Application memory	241 bytes customized data
Coding	128-bit AES, SHA-256, 2048-bit RSA, 224-bit ECC
Certifications	
CE	Yes
UKCA	Yes
UL	cULus E115267 Industrial control equipment
DNV	Temperature: **B** (0 to 55°C) Humidity: **B** (up to 100%) Vibration: **B** (4 g) EMC: **B** (bridge and open deck)
CCS	Yes
LR	ENV1
KR	Yes
ABS	Yes
BV	**EC33B** Temperature: 5 - 55°C Vibration: 4 g EMC: Bridge and open deck
Temperature and humidity sensor	
Sensor position	Module-internal
Sampling rate	1 s
Temperature measurement	
Measurement range	-25 to 125°C
Resolution	0.1°C/LSB
Max. error	±0.3°C
Humidity measurement	
Measurement range	5 to 95%
Resolution	1%/LSB
Max. error	±2% at 10 to 80% relative humidity ±3% at <10 and >80% relative humidity
Operating conditions	
Mounting orientation	
Horizontal	Yes
Vertical	Yes
Installation elevation above sea level	
0 to 2000 m	No limitation
>2000 m	Reduction of ambient temperature by 0.5°C per 100 m
Degree of protection per EN 60529	IP20

Table 2: X20CMR100 - Technical data

Order number	X20CMR100
Ambient conditions	
Temperature	
Operation	
Horizontal mounting orientation	-25 to 60°C
Vertical mounting orientation	-25 to 50°C
Derating	-
Storage	-40 to 85°C
Transport	-40 to 85°C
Relative humidity	
Operation	5 to 95%, non-condensing
Storage	5 to 95%, non-condensing
Transport	5 to 95%, non-condensing
Mechanical properties	
Note	Order 1x terminal block X20TB12 separately. Order 1x bus module X20BM11 separately.
Pitch	$12.5^{+0.2}$ mm

Table 2: X20CMR100 - Technical data

2.2 LED status indicators

For a description of the various operating modes, see section "Additional information - Diagnostic LEDs" in the X20 system user's manual.

Figure	LED	Color	Status	Description
	r	Green	Off	No power to module
			Single flash	Mode RESET
			Double flash	Blackout mode active
			Blinking	Mode PREOPERATIONAL
			On	Mode RUN
	e	Red	Off	Module not supplied with power or everything OK
	e + r	Solid red / Single green flash		Invalid firmware
	TG	Yellow	Off	Technology Guard is not accessed
			On	The module accesses the Technology Guard

2.3 Pinout

3 Function description

3.1 Measuring and evaluating ambient conditions

The module is equipped with internal sensors to collect the following conditions:

- Relative humidity [%]
- Ambient temperature [°C]

Information:

The sampling rate is 1 s.

Since the sensor for relative humidity and ambient temperature is located directly in the module, the measured values depend on the intrinsic heating of the module and the heat radiated by neighboring modules.

The effect of this warming on the measured values can be circumvented by using an external temperature sensor on another module. The value measured with the external temperature sensor is used as a reference. With this value, the relative humidity at the position of the external temperature sensor is calculated using the Magnus formula.

$$\text{saturated water vapor pressure [Pa]} = 611.2 \cdot e^{\frac{17.62 \cdot \text{temperature}}{243.12 + \text{temperature}}}$$

$$\text{absolute humidity [g/m}^3\text{]} = \frac{\text{saturated water vapor pressure}}{461.52 \cdot (273.15 + \text{temperature})} \cdot 1000$$

$$\text{humidity [g/m}^3\text{]} = \text{absolute humidity} \cdot \text{relative humidity}$$

$$\text{relative humidity [\%]} = \frac{\text{humidity}}{\text{absolute humidity}} \cdot 100$$

Example

The following example calculates the relative humidity at the position of the external temperature sensor using the Magnus formula.

- Relative humidity in module: 20%
- Ambient temperature in module: 40°C
- External temperature sensor: 35°C

Module

$$\text{saturated water vapor pressure}_{\text{module}} = 611.2 \cdot e^{\frac{17.62 \cdot 40}{243.12 + 40}} = 7367.5 \text{ Pa}$$

$$\text{absolute humidity}_{\text{module}} = \frac{7367.5}{461.52 \cdot (273.15 + 40)} \cdot 1000 = 50.98 \text{ g/m}^3$$

$$\text{humidity}_{\text{module}} = 50.98 \cdot 0.2 = 10.2 \text{ g/m}^3$$

External temperature sensor

$$\text{saturated water vapor pressure}_{\text{ExtSensor}} = 611.2 \cdot e^{\frac{17.62 \cdot 35}{243.12 + 35}} = 5612.8 \text{ Pa}$$

$$\text{absolute humidity}_{\text{ExtSensor}} = \frac{5612.8}{461.52 \cdot (273.15 + 35)} \cdot 1000 = 39.47 \text{ g/m}^3$$

$$\text{relative humidity}_{\text{ExtSensor}} = \frac{10.2}{39.47} \cdot 100 = 25.84\%$$

In this example, a deviation of the relative humidity of approx. 6% results between the measured value in the module and the calculated value at the position of the external temperature sensor.

3.1.1 Additional information

The ambient conditions are recorded and evaluated in the module. The following values can be read:

- Smallest value occurred
- Largest value occurred

Information:

The values are saved to module-internal FRAM.

If needed, the values can be reset.

Registers are described in section "Additional information" on page 18.

3.1.2 Histogram for relative humidity

A histogram for relative humidity is recorded in the module. The measuring range for the relative humidity is divided into 10 areas:

Area	Relative humidity	Register
1	0 to <10%	RelHumHist01Entry RelHumHist01Time
2	10 to <20%	RelHumHist02Entry RelHumHist02Time
3	20 to <30%	RelHumHist03Entry RelHumHist03Time
4	30 to <40%	RelHumHist04Entry RelHumHist04Time
5	40 to <50%	RelHumHist05Entry RelHumHist05Time
6	50 to <60%	RelHumHist06Entry RelHumHist06Time
7	60 to <70%	RelHumHist07Entry RelHumHist07Time
8	70 to <80%	RelHumHist08Entry RelHumHist08Time
9	80 to <90%	RelHumHist09Entry RelHumHist09Time
10	90 to 100%	RelHumHist10Entry RelHumHist10Time

As soon as the relative humidity reaches one of the predefined areas, a delay time of 3 s begins. After the delay time has expired, the entry counter is increased by 1 and the dwell time begins. The delay time prevents the counter from constantly being incremented in the crossover area.

Information:

The values are saved to module-internal FRAM.

If needed, the registers can be reset.

Registers are described in section "Relative humidity" on page 19.

3.1.3 Histogram for ambient temperature

A histogram for ambient temperature is recorded in the module. The measuring range for the ambient temperature is divided into 12 areas:

Area	Ambient temperature	Register
1	<-20°C	TempHist01Entry TempHist01Time
2	-20 to <-10°C	TempHist02Entry TempHist02Time
3	-10 to <0°C	TempHist03Entry TempHist03Time
4	0 to <10°C	TempHist04Entry TempHist04Time
5	10 to <20°C	TempHist05Entry TempHist05Time
6	20 to <30°C	TempHist06Entry TempHist06Time
7	30 to <40°C	TempHist07Entry TempHist07Time
8	40 to <50°C	TempHist08Entry TempHist08Time
9	50 to <60°C	TempHist09Entry TempHist09Time
10	60 to <70°C	TempHist10Entry TempHist10Time
11	70 to <80°C	TempHist11Entry TempHist11Time
12	≥80°C	TempHist12Entry TempHist12Time

As soon as the ambient temperature reaches one of the predefined areas, a delay time of 3 s begins. After the delay time has expired, the entry counter is increased by 1 and the dwell time begins. The delay time prevents the counter from constantly being incremented in the crossover area.

Information:

The values are saved to module-internal FRAM.

If needed, the registers can be reset.

Registers are described in section "Ambient temperature" on page 19.

3.2 Recording operating data

The following operating data is collected by the module:

- Operating time with active connection to network master
- Operating time without active connection to network master (blackout mode)
- Total operating time
- Number of power-on cycles

Information:

The values are saved to module-internal FRAM.

If needed, the operating data can be reset.

Registers are described in section "Operating data" on page 18.

3.3 Technology Guarding

This module is equipped with a Technology Guard. The Technology Guard integrated in the module results in the following advantages:

- USB interface not required for the Technology Guard
- Module can be used when no additional USB interfaces are available
- Module can be used when USB interfaces are prohibited for security reasons

Technology Guarding via the module is based on the same mechanism as the USB dongle that is connected to the controller. The licenses themselves are verified in Automation Runtime on the target system. Automation Runtime will signal a license violation if the system has licensing requirements that are not covered by the licenses on the Technology Guard.

The Technology Guard provides the following possibilities:

- 2 tamper-resistant operating hours counters
- Possible to store multiple B&R licenses
- Customized license storage possible
- Customized data storage possible

Information:

The extended user-specific operation of the Technology Guard is handled via library "AsGuard". For additional information about library "AsGuard", see Automation Help.

Information:

Automation Runtime C4.44 or later is required to use the functions of the Technology Guard.

3.4 Blackout mode

Blackout mode allows users to continue execution of the application in lower-level subsystems if components of the B&R system fail. In this way, the B&R system – independently of redundancy technology – makes it possible to respond to system-critical situations based on the specific application.

The use of blackout-capable modules is recommended for the following requirements:

- Exit routines on system failure, e.g. to enable the opening of a press if the system fails.
- Stopping or controlled setting of an output on system failure, e.g. to automatically close inflow valves.
- Deceleration sequences on system failure, e.g. to reduce motor speeds before transmitting a stop command.

If blackout-capable modules are configured accordingly, blackout mode will be carried out if the network connection to the higher-level controller is interrupted.

As soon as the network disturbance has been corrected, blackout mode is stopped by the modules and bumpless synchronization with the network takes place.

Requirements for operation

The following requirements must be met in order to use blackout mode:

- The module being used must support blackout mode.
- Parameter "Blackout mode" must be enabled in Automation Studio.

3.4.1 Areas of use

Through the use of blackout-capable modules, a part of the control system can also remain functional if a disturbance in the network or X2X Link connection between the modules occurs.

3.4.1.1 Loss of POWERLINK connection

Initial situation

Several stations in an application are connected to the controller via network cables. A fault occurs that interrupts data transfer between the controller and stations.

Effect

Non-blackout modules are reset and operated according to their default behavior.

Blackout-capable modules show the following behavior:

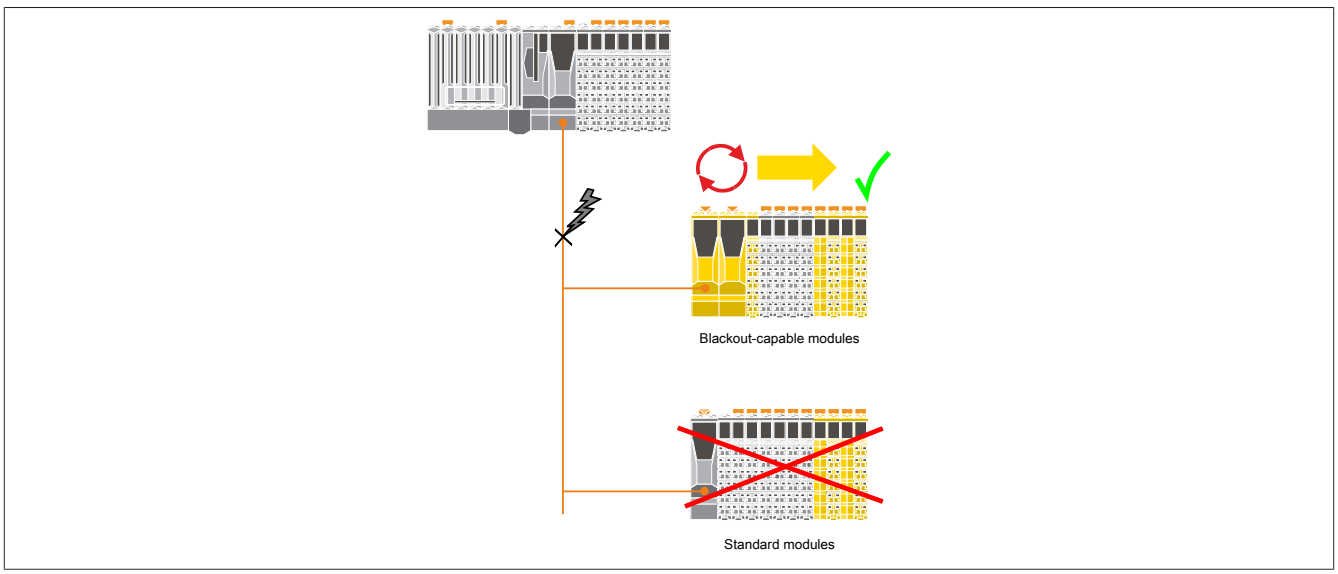
- The programmed function continues to be executed.
- Subordinate networks continue to work.
- Data from the controller is initialized with "0".
- After the disturbance has been corrected, the module bumplessly returns to the higher-level network.

Warning!

Blackout mode causes data from the controller to be initialized with "0". If blackout mode is used in combination with "output inversion", this can result in the unintentional setting of outputs.

Mise en garde !

Le mode « Blackout » entraîne l'initialisation des données du contrôleur avec « 0 ». Si le mode « Blackout » est utilisé en combinaison avec « l'inversion de sortie », il peut en résulter un réglage involontaire des sorties.



3.4.1.2 Loss of X2X Link connection

Initial situation

Modules in an application are connected to the network via X2X Link cables. A defect in the X2X Link cable causes the data transfer between the controller and modules to be interrupted.

Effect

Non-blackout modules are reset and operated according to their default behavior.

Blackout-capable modules show the following behavior:

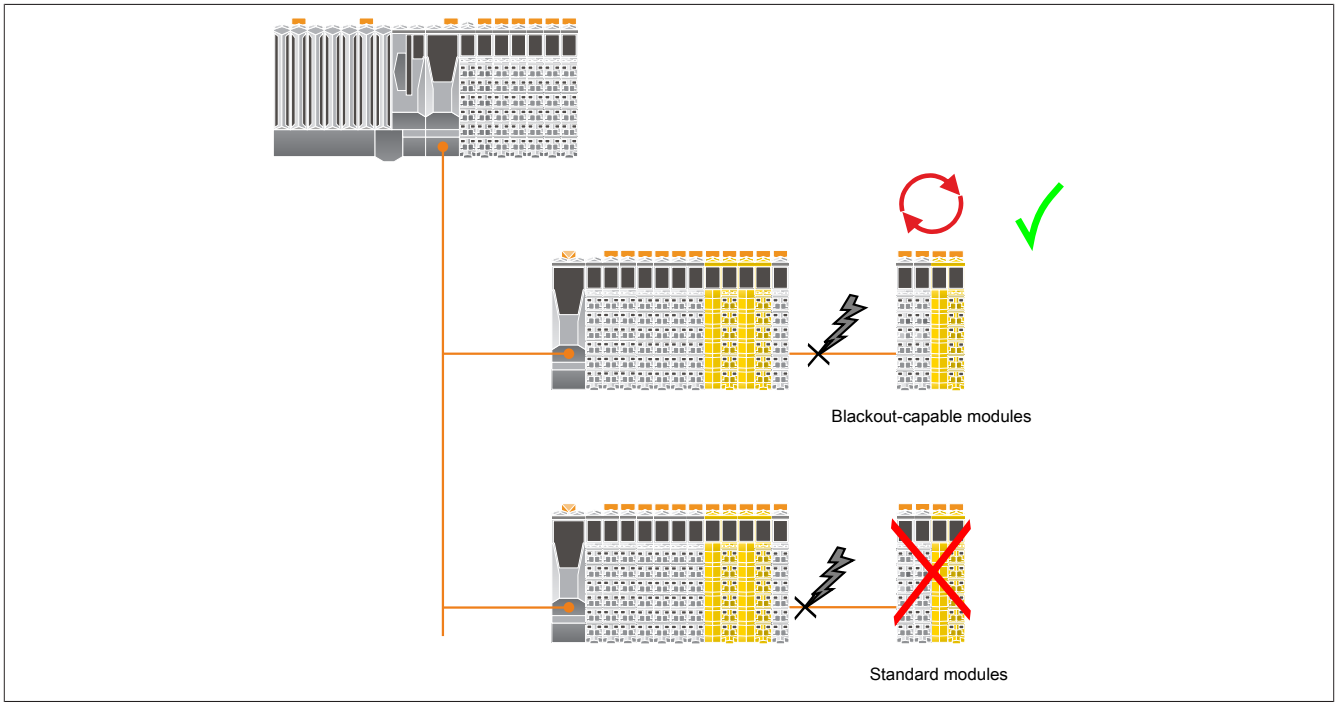
- The programmed function continues to be executed.
- Subordinate networks continue to work.
- Data from the controller is initialized with "0".
- After the disturbance has been corrected, the module bumplessly returns to the higher-level network.

Warning!

Blackout mode causes data from the controller to be initialized with "0". If blackout mode is used in combination with "output inversion", this can result in the unintentional setting of outputs.

Mise en garde !

Le mode « Blackout » entraîne l'initialisation des données du contrôleur avec « 0 ». Si le mode « Blackout » est utilisé en combinaison avec « l'inversion de sortie », il peut en résulter un réglage involontaire des sorties.



3.4.2 Programming blackout mode

Blackout mode cannot be detected by the blackout-capable modules themselves. If it is necessary to program specific blackout behavior in an application, an indirect method must therefore be chosen.

One possibility is to implement a counter in the blackout-capable module's higher-level controller and query it cyclically. Blackout mode would make itself noticeable in this case by a counter value that no longer changes or a counter value of zero.

Blackout-capable modules can be divided into 2 categories:

- **Programmable modules**
  The blackout function is programmed using existing function blocks. In other words, the existing technologies for application programming or reACTION Technology are used.
  The blackout function is executed largely independently of other system components.
- **Standard function modules**
  These modules are not programmable and maintain their default behavior in blackout mode.

4 Commissioning

4.1 Using the module on the bus controller

Function model 254 "Bus controller" is used by default only by non-configurable bus controllers. All other bus controllers can use other registers and functions depending on the fieldbus used.

For detailed information, see section "Additional information - Using I/O modules on the bus controller" in the X20 user's manual (version 3.50 or later).

4.1.1 CAN I/O bus controller

The module occupies 1 analog logical slot on CAN I/O.

5 Register description

5.1 General data points

In addition to the registers described in the register description, the module has additional general data points. These are not module-specific but contain general information such as serial number and hardware variant.

General data points are described in section "Additional information - General data points" in the X20 System user's manual.

5.2 Function model 0 - Standard

Register	Description	Data type	Read		Write	
			Cyclic	Acyclic	Cyclic	Acyclic
Module - Control						
134	Reset additional information and data point histograms	UINT			•	
	ClrStatistics_OperatingData	Bit 0				
	ClrStatistics_RelHumidity	Bit 1				
	ClrStatistics_Temperature	Bit 2				
Measured values						
2	RelHumidity	INT	•			
6	Temperature	INT	•			
Additional information						
4100	OnTimeConnected	UDINT	•			
4108	OnTimeDisconnected	UDINT	•			
4116	OnTimeCombined	UDINT	•			
4124	PowerCycles	UDINT	•			
4134	RelHumidityMin	INT	•			
4138	RelHumidityMax	INT	•			
4150	TemperatureMin	INT	•			
4154	TemperatureMax	INT	•			
Data point histogram						
4244 + N*16	RelHumHist0NEntry (index N = 1 to 10)	UDINT	•			
4252 + N*16	RelHumHist0NTime (index N = 1 to 10)	UDINT	•			
4404 + N*16	TempHist0NEntry (index N = 1 to 12)	UDINT	•			
4412 + N*16	TempHist0NTime (index N = 1 to 12)	UDINT	•			

5.3 Function model 254 - Bus controller

Register	Offset[1)]	Description	Data type	Read		Write	
				Cyclic	Acyclic	Cyclic	Acyclic
Module - Control							
134	-	Reset additional information and data point histograms	UINT				•
		ClrStatistics_OperatingData	Bit 0				
		ClrStatistics_RelHumidity	Bit 1				
		ClrStatistics_Temperature	Bit 2				
Measured values							
2	0	RelHumidity	INT	•			
6	2	Temperature	INT	•			
Additional information							
4100	-	OnTimeConnected	UDINT		•		
4108	-	OnTimeDisconnected	UDINT		•		
4116	-	OnTimeCombined	UDINT		•		
4124	-	PowerCycles	UDINT		•		
4134	-	RelHumidityMin	INT		•		
4138	-	RelHumidityMax	INT		•		
4150	-	TemperatureMin	INT		•		
4154	-	TemperatureMax	INT		•		
Data point histogram							
4244 + N*16	-	RelHumHist0NEntry (index N = 1 to 10)	UDINT		•		
4252 + N*16	-	RelHumHist0NTime (index N = 1 to 10)	UDINT		•		
4404 + N*16	-	TempHist0NEntry (index N = 1 to 12)	UDINT		•		
4412 + N*16	-	TempHist0NTime (index N = 1 to 12)	UDINT		•		

1) The offset specifies the position of the register within the CAN object.

5.4 Controller

5.4.1 Reset additional information and data point histograms

Name:
ClrStatistics_OperatingData
ClrStatistics_RelHumidity
ClrStatistics_Temperature

Setting the respective bit in the register resets operating data, information and histograms. Procedure:

- Set the bit for resetting the desired data
- The bit must remain set until the registers have been reset
- As soon as the user has determined that the data has been reset, then the bit for resetting the data can be deleted.
- If the bit for resetting the data is not deleted, the data will be permanently set to 0.

Information:

It can take up to 1 s until the delete operation for the data is executed.

Data type	Values
UINT	See the bit structure.

Bit structure:

Bit	Name	Value	Information
0	ClrStatistics_OperatingData Reset operating data	0	Do not reset
		1	Reset
1	ClrStatistics_RelHumidity Resets information and histograms for relative humidity	0	Do not reset
		1	Reset
2	ClrStatistics_Temperature Resets information and histograms for ambient temperature	0	Do not reset
		1	Reset
3 - 15	Reserved	0	

5.5 Measured values

5.5.1 Relative humidity

Name:
RelHumidity

An internal sensor measures the relative humidity in the area.

Data type	Values	Information
INT	0 to 100	Relative humidity [%], resolution 1%

5.5.2 Ambient temperature

Name:
Temperature

An internal sensor measures the ambient temperature.

Data type	Values	Information
INT	-250 to 1250	Ambient temperature [°C], resolution 0.1°C

5.6 Additional information

Information:

The following points must be observed:

- **Data recorded on the module is saved in intervals of 10 s.**
- **When reseting the values, it can take up to 1 s until the delete operation is executed (see register "ClrStatistics" on page 17).**

5.6.1 Operating data

Name:
OnTimeConnected
OnTimeDisconnected
OnTimeCombined
PowerCycles

The respective operating data is output in these registers. If needed, the values can be reset using register "ClrStatistics" on page 17.

Register	Data type	Values	Information
OnTimeConnected	UDINT	0 to 4,294,967,295	Operating time during which the module was actively connected to the network master [s], resolution 1 s
OnTimeDisconnected	UDINT	0 to 4,294,967,295	Operating time during which the module was not actively connected to the network master [s] (blackout mode), resolution 1 s
OnTimeCombined	UDINT	0 to 4,294,967,295	Total operating time of the module [s], resolution 1 s
PowerCycles	UDINT	0 to 4,294,967,295	Number of power-on cycles

5.6.2 Relative humidity

Name:
RelHumidityMin
RelHumidityMax

Information about the relative humidity is output in these registers. The sampling interval is 1 s. If needed, the values can be reset using register "ClrStatistics" on page 17.

Register	Data type	Values	Information
RelHumidityMin	INT	0 to 100	Smallest value that occurred [%], resolution 1%
RelHumidityMax	INT	0 to 100	Largest value that occurred [%], resolution 1%

5.6.3 Ambient temperature

Name:
TemperatureMin
TemperatureMax

Information about the ambient temperature is output in these registers. The sampling interval is 1 s. If needed, the values can be reset using register "ClrStatistics" on page 17.

Register	Data type	Values	Information
TemperatureMin	INT	-250 to 1250	Lowest value that occurred [°C], resolution 0.1°C
TemperatureMax	INT	-250 to 1250	Highest value that occurred [°C], resolution 0.1°C

5.7 Data point histogram

5.7.1 Relative humidity

Name:
RelHumHist01Entry to RelHumHist10Entry
RelHumHist01Time to RelHumHist10Time

The relative humidity histogram data recorded on the module is displayed on these registers. If needed, the values can be reset using register "ClrStatistics" on page 17.

Register	Data type	Values	Information
RelHumHist01Entry to RelHumHist10Entry	UDINT	0 to 4,294,967,295	Entry counter for the corresponding area
RelHumHist01Time to RelHumHist10Time	UDINT	0 to 4,294,967,295	Dwell time in corresponding area [s], resolution 1 s

5.7.2 Ambient temperature

Name:
TempHist01Entry to TempHist12Entry
TempHist01Time to TempHist12Time

The ambient temperature histogram data recorded on the module is displayed on these registers. If needed, the values can be reset using register "ClrStatistics" on page 17.

Register	Data type	Values	Information
TempHist01Entry to TempHist12Entry	UDINT	0 to 4,294,967,295	Entry counter for the corresponding area
TempHist01Time to TempHist12Time	UDINT	0 to 4,294,967,295	Dwell time in corresponding area [s], resolution 1 s

5.8 Minimum cycle time

The minimum cycle time specifies how far the bus cycle can be reduced without communication errors occurring. It is important to note that very fast cycles reduce the idle time available for handling monitoring, diagnostics and acyclic commands.

Minimum cycle time
200 µs

5.9 Minimum I/O update time

The minimum I/O update time specifies how far the bus cycle can be reduced so that an I/O update is performed in each cycle.

Minimum I/O update time	
Temperature and relative humidity	1 s
User flash Flatstream communication	<10 ms