BlueEye™ Ex-D

Modbus
Communication
Protocol

MANUAL (15.10.2026_v1)
Firmware version: V.4.1.1 or higher



BlueEye™ Ex-D Modbus Communication

The BlueEye™ Ex-D features RS485 Modbus communication,
allowing the user to read measurement values,
and configure the device according to individual preferences.

BlueEye™ Ex-D Modbus Communication - RS485 settings

Serial type	RS485
Bits per second	19200
Data bits	8
Parity	None
Stop bits	1
Flow control	None
Byte order	Little-endian

BlueEye™ Ex-D Modbus Communication – Wiring

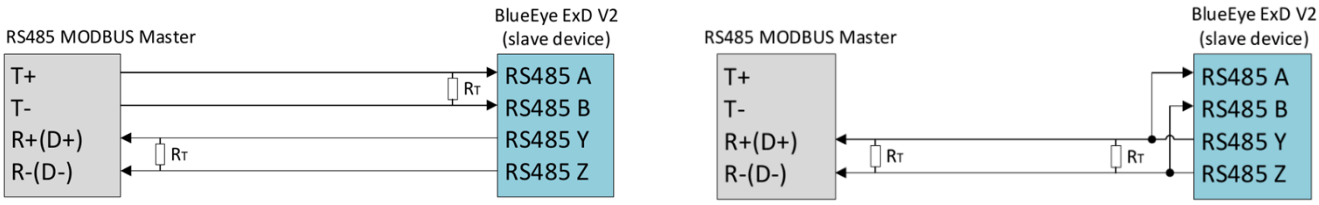
Connect to the BlueEye™ Ex-D using either the full-duplex or the half-duplex RS485 Modbus configuration, as described in the wiring schematics below.
Once connected, the device can be accessed via its default Modbus address:
18 (0x12 in hexadecimal format).

BlueEye™ Ex-D Wiring

Wire ID	Description	
1, Black	Power supply	+24 VDC
2, Black	Power supply	-24 VDC
3, Black	4-20 mA Current Loop	+
4, Black	4-20 mA Current Loop	-
5, Black	T+	RS485_A
6, Black	T-	RS485_B
7, Black	R+ (D+)	RS485_Y
8, Black	R- (D-)	RS485_Z
9, Yellow/Green	GND	Ground

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BlueEye™ Ex-D Modbus Wiring Schematics



BlueEye™ Ex-D Modbus Communication – Holding register

The device can be configured by modifying the holding register.

Changes to the holding register will only take effect if a valid configuration password has been entered in register 100, 101 and 102. This password protection is used to restrict modifications to the holding register (device settings), and it is recommended to set these register values to zero during normal operation.

There are six authorization level passwords which determine which settings the user can modify. These six levels are colour coded in the holding register table below.

Example: The user enters the level 1 password in registers 100, 101 and 102, and is then allowed to modify settings in registers 0 – 16, 34 – 38, 100, and 106 – 111. The remaining registers require a higher level of authorization and cannot be modified with a level 1 password.

BlueEye™ Ex-D Modbus Holding Register

Address (+40'001)	Type	Content	Options	Level					
				0	1	2	3	4	5
0	Int16	Unit settings	**1**: *Metric1*, **2**: *Metric2*, **3**: *Imperial1*, **4**: *Imperial2* See Unit Options table below	-	✓	✓	✓	✓	✓
1	Int16	Reference conditions	**1**: 0°C/0°C, **2**: 15°C/0°C, **3**: 25°C/0°C, **4**: 15°C/15°C, **5**: 20°C/20°C, **6**: 25°C/20°C at 1013.25 mbara. **7**: 60°F at 14.696 psia, **8**: 60°F at 14.65 psia, **9**: 60°F at 14.73 psia, **10**: 60°F at 15.025 psia.	-	✓	✓	✓	✓	✓
2	Int16	Modbus moving average on/off	0: Off, 1: On, 2: Hourly average*	-	✓	✓	✓	✓	✓
3	Int16	Modbus moving average count	Max. 10000	-	✓	✓	✓	✓	✓
4	Int16	4-20 mA moving average	0: Off, 1: On, 2: Hourly average*	-	✓	✓	✓	✓	✓
5	Int16	4-20 mA moving average count	Max. 10000	-	✓	✓	✓	✓	✓
…									
10	Int16	Year	YYYY	-	✓	✓	✓	✓	✓
11	Int16	Month	MM	-	✓	✓	✓	✓	✓
12	Int16	Day	DD	-	✓	✓	✓	✓	✓
13	Int16	Hour	hh	-	✓	✓	✓	✓	✓
14	Int16	Minute	mm	-	✓	✓	✓	✓	✓
15	Int16	Second	ss	-	✓	✓	✓	✓	✓
16	Int16	Boosting	Write a '1' to initiate boosting (~5 minutes)	-	✓	✓	✓	✓	✓
…									
18	Int16	Correlative model	0: Standard, 6: Hydrogen, 7: CO_2	-	-	✓	✓	✓	✓
…									

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30	Int16	Current loop DAC min	DAC value corresponding to 4 mA	-	-	✓	✓	✓	✓
31	Int16	Current loop DAC max	DAC value corresponding to 20 mA	-	-	✓	✓	✓	✓
32	Int16	Override DAC output	0: Normal current loop operation, 1: Override DAC output of the current loop	-	-	✓	✓	✓	✓
33	Int16	DAC value	DAC output (0-4096)	-	-	✓	✓	✓	✓
34	Int16	4-20 mA output parameter	**1**: *WI_s*, **2**: *H_s*, **3**: *H_i*, **4**: *Rho*, **5**: *Rho rel.*, **6**: *Z*, **7**: *AFR*, **8**: *s-AFR*, **9**: *MN*, **10**: *WI_i*, **11**: *CO_2*, **12**: *H_2*, **13**: *Temperature*, **14**: *Absolute pressure*	-	✓	✓	✓	✓	✓
35 36	Float32	4 mA equivalent	Override default value	-	✓	✓	✓	✓	✓
37 38	Float32	20 mA equivalent	Override default value	-	✓	✓	✓	✓	✓
39 40	Float32	Granularity of average	For input registers: 110 - 137	-	✓	✓	✓	✓	✓
41	Int16	CO_2/CH_4 sensor function: Zero sensor / Span sensor	Enter - 28001 to zero CO_2 sensor - 28002 to Span CO_2 sensor - 28003 to zero CH_4 sensor - 28004 to Span CH_4 sensor See complete description of the function in the next page	-	-	-	✓	✓	✓
…										
49	Int16	Modbus address (1-255)	Set Modbus address. Default is 0x12. Restart device for change to take effect.	-	-	-	✓	✓	✓
…										
52	Float32	CO_2SpanMol CH_4SpanMol	Mole percent span concentration when spanning the CO_2/CH_4 sensor, using the Span CO_2/CH_4 sensor command	-	-	-	✓	✓	✓
…										
77	Float32	Density external input	External density input in kg/m^3 to improve H_2 determination	✓	✓	✓	✓	✓	✓
…										
100	Int16	Configuration password 1	Enter configuration password to change device settings. NOTE: The password might change depending on the setting the user wants to modify.	-	✓	✓	✓	✓	✓
101	Int16	Configuration password 2							
102	Int16	Configuration password 3							
103	Int16	Viscosity & thermal conductivity passcode	Only visible with authorisation level passwords 4 or 5.	-	-	-	-	✓	✓
104	Int16	Normalized viscosity & thermal conductivity passcode	Only visible with authorisation level passwords 4 or 5.	-	-	-	-	✓	✓
105	Int16	Raw viscosity passcode	Only visible with authorisation level passwords 4 or 5.	-	-	-	-	✓	✓
106	Int16	GUI password 1	Enter GUI password to access the BlueEye Ex-D RS485 Interface (Only relevant for customers that acquire said Interface).	✓	✓	✓	✓	✓	✓
107	Int16	GUI password 2							
108	Int16	GUI password 3							
109	Int16	Modbus password 1	Enter Modbus password to access the BlueEye Ex-D RS485 Interface with a certain authorization level (Only relevant for customers that acquire said Interface).	✓	✓	✓	✓	✓	✓
110	Int16	Modbus password 2							
111	Int16	Modbus password 3							
112	Int16	Firmware upgrade password	Reserved for firmware upgrade password.	-	-	-	-	-	✓
* Hourly average → 1 data point per hour (ex: at 11h08 it shows average value for 10h00 to 11h00)										

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Password entry

When entering a password in registers 100 – 102, 106 – 108 or 109 – 111, the original password must be split in three parts before it can be saved to said registers. Below is an example of how a 6-character password is converted into three 16-bit values that can be saved to the registers.

Example: Save a 6-character configuration password to registers 100, 101, and 102.

password = '**a0b1c2**'

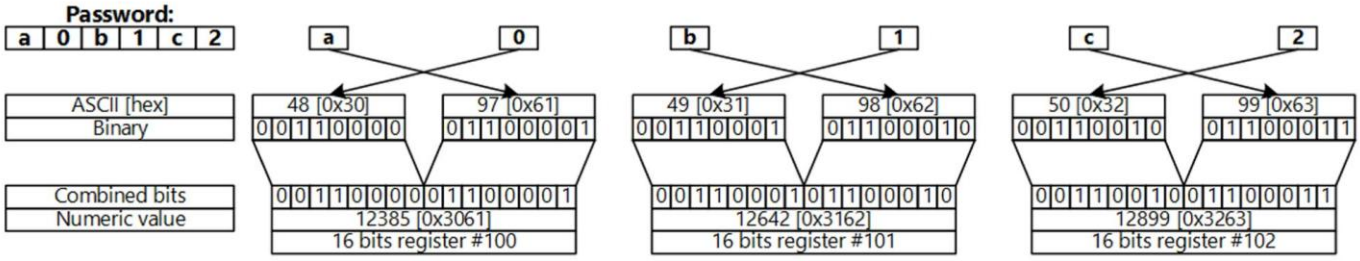
password_utf8 = password.encode('utf-8') # Encode password as UTF-8.

register100 = ((password_utf8[1] & 0xFF) << 8) | (password_utf8[0] & 0xFF)

register101 = ((password_utf8[3] & 0xFF) << 8) | (password_utf8[2] & 0xFF)

register102 = ((password_utf8[5] & 0xFF) << 8) | (password_utf8[4] & 0xFF)

Save the register100, register101 and register102 values to the holding registers 100, 101 and 102, respectively.



CO_2/CH_4 sensor function

Code	Level	Description	Details
28001	3	Zero CO_2 sensor	When executed, Status2, bit 13 will be set to zero. When zeroing is completed, this bit will be set to 1.
28002	3	SPan CO_2 sensor	When executed, Status2, bit 14 will be set to zero. When spanning is completed, this bit will be set to 1.
28003	3	Zero CH_4 sensor	When executed, Status3, bit 1 will be set to zero. When zeroing is completed, this bit will be set to 1.
28004	3	SPan CH_4 sensor	When executed, Status3, bit 2 will be set to zero. When spanning is completed, this bit will be set to 1.

Access Level

In order to zero or span the sensor, you must have access level 3.

Zero CO2 Sensor

In order to properly zero the CO_2 sensor, pure CH_4 should be flown through the BlueEye™ Ex-D for at least 15min at a flow rate of 30mL/min.

Make sure that the Pressure or Temperature is in the accepted range (Zero or Span will not occur if the Pressure <103500 Pa or >106500 Pa or temperature (in K) <293.15 or >303.15.)

Write the integer value 28001 to holding register 41 (CO_2 sensor function holding register 41).

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After a few seconds, check Status2 Register (input register 47), bit 13. If it is set, the sensor was successfully zeroed. If not, an error occurred or the Pressure or Temperature was out of the accepted range (see NOTE below) and you may try again by writing 28001.

NOTE
Zero or Span will not occur if the Pressure <103500 Pa or >106500 Pa or temperature (in K) <293.15 or >303.15. In that case, Status2 Register (input register 40), bit3 will be set to 1 (faulty).

Span CO2 Sensor

In order to properly span the CO_2 sensor, a mixture of 2%CO_2 in pure CH_4 should be flown through the BlueEye™ Ex-D for at least 15min at a flow rate of 30mL/min.

Write the exact CO_2 concentration mole percent of the calibration gas to the holding register 52. For instance, if the cylinder contains 1.989%CO_2 in CH_4, the value 19890 should be written to register 52.

Then write the integer value 28002 to holding register 41 (CO_2 sensor function holding register 41).

After a few seconds, check Status2 Register (input register 47), bit 14. If it is set, the sensor was successfully spanned. If not, an error occurred or the Pressure or Temperature was out of the accepted range (see NOTE below) and you may try again by writing 28002.

NOTE
Zero or Span will not occur if the Pressure <103500 Pa or >106500 Pa or temperature (in K) <293.15 or >303.15. In that case, Status2 Register (input register 40), bit3 will be set to 1 (faulty).

Zero CH4 Sensor

In order to properly zero the CH_4 sensor, pure N_2 should be flown through the BlueEye™ Ex-D for at least 15min at a flow rate of 30mL/min.

Make sure that the Pressure or Temperature is in the accepted range (Zero or Span will not occur if the Pressure <103500 Pa or >106500 Pa or temperature (in K) <293.15 or >303.15.)

Write the integer value 28003 to holding register 41 (CH_4 sensor function holding register 41).

After a few seconds, check Status2 Register (input register 40), bit 1. If it is set, the sensor was successfully zeroed. If not, an error occurred or the Pressure or Temperature was out of the accepted range (see NOTE below) and you may try again by writing 28003.

NOTE
Zero or Span will not occur if the Pressure <103500 Pa or >106500 Pa or temperature (in K) <293.15 or >303.15. In that case, Status2 Register (input register 40), bit3 will be set to 1 (faulty).

Span CH4 Sensor

In order to properly span the CH_4 sensor, a mixture of 14%N_2 in pure CH_4 should be flown through the BlueEye™ Ex-D for at least 15min at a flow rate of 30mL/min.

Write the exact CH_4 concentration mole percent of the calibration gas to the holding register 52. For instance, if the cylinder contains 14.01%CO_2 in CH_4, the value 140100 should be written to register 52.

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Then write the integer value 28004 to holding register 41 (CH_4 sensor function holding register 41).

After a few seconds, check Status2 Register (input register 40), bit 2. If it is set, the sensor was successfully spanned. If not, an error occurred or the Pressure or Temperature was out of the accepted range (see NOTE below) and you may try again by writing 28004.

NOTE
Zero or Span will not occur if the Pressure <103500 Pa or >106500 Pa or temperature (in K) <293.15 or >303.15. In that case, Status2 Register (input register 40), bit3 will be set to 1 (faulty).

External Control Values Input

In order to improve the accuracy of the Hydrogen determination in natural gas, external control values can be input to the analyzer.

In particular, the density in kg/m3, can be input to the analyzer to improve the Hydrogen determination accuracy. In that case, the density of natural gas is measured accurately before its mixing with Hydrogen occurs. Then, this value can be supplied to holding register 77. If the density value supplied to holding register 77 is accurate, the downstream Hydrogen measurement of this natural gas mixed with Hydrogen by the analyzer will be more accurate.

Once a value is set, it will remain in the holding registers until it is changed or the analyzer is rebooted. Zero (or below) values are not used.

The analyzer does not retain external property values, so when the analyzer starts, all external property values are zero. Login is not required (no user level).

If a supplied property value is greater than zero, it will be used in the calculations. To stop using the external property, set its value to zero.

You can read back the supplied density property by reading the Input register 281.

A float value is defined as Single Precision IEEE-754 in the CDAB (Mid-Big Endian) format.

Unit Options Table

Unit Options	Energy	Pressure	Density	Temperature
Metric1	MJ/m³	Pa	kg/m³	°C
Metric2	KWh/m³	Pa	kg/m³	°C
Imperial1	Btu(IT)/scf	Psi	lb/scf	°F
Imperial2	therm(U.S)/scf	Psi	lb/scf	°F

BlueEye™ Ex-D Modbus Communication – Input register

The measurement output can be read from the input register. The user has read-only access to the input register. The output is updated every second.

Float32 data in the input register span 2 registers, as each register is 16bits wide. Consequently, a Float32 value must be calculated based on its two registers.

Here is an example of the "word swap" procedure to calculate the *WI* (Float32) based on register 0 and 1:

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a. Read input register addr. 0 (lower addr.) → return 0x7e5d
b. Read input register addr. 1 (upper addr.) → return 0x4248
c. Concatenate the two values: 0x42487e5d
d. When interpreting this 32bits value as a Float32 (IEEE754) = 50.1234

The input register is described in the table below.

BlueEye™ Ex-D Modbus Input Register

Address (+30'001)	Type	Content	Details
0	Float32	WI_s	Unit and moving average settings: See **Holding Register**
1			
2	Float32	H_s	Unit and moving average settings: See holding register
3			
4	Float32	H_i	Unit and moving average settings: See holding register
5			
6	Float32	Rho	Unit settings: See **Holding Register**
7			
8	Float32	Rho relative	Unit settings: See **Holding Register**
9			
10	Float32	Temperature	Unit settings: See **Holding Register**
11			
12	Float32	Absolute pressure	Unit settings: See **Holding Register**
13			
14	Float32	CO_2 content	% mol
15			
16	Float32	H_2 content	% mol
17			
18	Float32	WI_i	Unit and moving average settings: See **Holding Register**
19			
20	Int16	Unit settings (1-4)	Unit settings: See **Holding Register**
21	Float32	Reference condition t_1	°C / °F, example: '15' or '60'
22			
23	Float32	Reference condition t_2	°C / psia, example: '0' or '14.696'
24			
25	Int16	Modbus moving average	0: Off, 1: On, 2: Hourly average
26	Int16	Modbus moving average count	Moving average over *n* measurements
27	Int16	4-20 mA moving average	0: Off, 1: On, 2: Hourly average
28	Int16	4-20 mA moving average count	Moving average over *n* measurements
…			
30	Float32	Z	
31			
32	Float32	AFR	
33			
34	Float32	s-AFR	
35			

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36 37	Float32	MN	
38	Int16	Viscosity sensor ID	
…			
40	Int16	Status3	Reserved
41	Int16	Status4	Reserved
42	Int16	Status5	Reserved
43	Int16	Status6	Reserved
44	Int16	Status7	BluEye4 Error0.Bytes 1 & 2
45	Int16	Status8	BluEye4 Error0.Bytes 3 & 4
46	Int16	Status1	See **Status1 Register** table
47	Int16	Status2	See **Status2** Register table
48	Int16	Year	Current time of the system
49	Int16	Month	Current time of the system
50	Int16	Day	Current time of the system
51	Int16	Hour	Current time of the system
52	Int16	Minute	Current time of the system
53	Int16	Second	Current time of the system
54 55	Float32	Average granularity	For input registers: 110 - 137
…			
60 61	Float32	20 mA equivalent	Currently used value
62 63	Float32	4 mA equivalent	Currently used value
64	Int16	4 mA calibration counter	Currently used value
65	Int16	20 mA calibration counter	Currently used value
66	Int16	4-20 mA output parameter	**1**: *WI_s*, **2**: *H_s*, **3**: *H_i*, **4**: *Rho*, **5**: *Rho rel.*, **6**: *Z*, **7**: *AFR*, **8**: *s-AFR*, **9**: *MN*, **10**: *WI_i*, **11**: *CO_2*, **12**: *H_2*, **13**: *Temperature*, **14**: *Absolute pressure*
67	Int16	Currently selected correlative model	0: Standard, 6: Hydrogen, 7: CO2
68	Int16	Firmware version	Example: 207 → Version 2.0.7
…			
70	Int16	Interface login result	
71	Int16	Modbus address of device	
72	Int16	Available correlative models	Models: Extended, H_2, CO_2 Example: 101 → Available models: Extended and CO2
73	Int16	Device hardware model	
74 75	Float32	Device serial ID	
…			
84 85	Float32	Time constant	
86 87	Float32	TCD transfer	
88	Float32	Viscosity	

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89			
90	Float32	Thermal conductivity	
91			
92	Float32	Raw viscosity	
93			
…			
96	Float32	Normalized viscosity	
97			
98	Float32	Normalized thermal conductivity	
99			
…			
110	Float32	Average WI_s	
111			
112	Float32	Average WI_i	
113			
114	Float32	Average H_s	
115			
116	Float32	Average H_i	
117			
118	Float32	Average Rho	
119			
120	Float32	Average Relative Rho	
121			
122	Float32	Average Z	
123			
124	Float32	Average AFR	
125			
126	Float32	Average s-AFR	
127			
128	Float32	Average MN	
129			
130	Float32	Average temperature	
131			
132	Float32	Average pressure	
133			
134	Float32	Average CO_2	
135			
136	Float32	Average H_2	
137			
…			
194	Int16	ThermalCondSensorID1	
195	Int16	ThermalCondSensorID2	
196	Int16	ThermalCondSensorID3	
197	Int16	ThermalCondSensorID4	
198	Int16	ThermalCondSensorID5	

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199	Int16	ThermalCondSensorID6	
200	Int16	ChecksumOS1	OS checksum, part 1.
201	Int16	ChecksumOS2	OS checksum, part 2.
202	Int16	ChecksumOS3	OS checksum, part 3.
203	Int16	ChecksumOS4	OS checksum, part 4.
204	Int16	ChecksumOS5	OS checksum, part 5.
205	Int16	ChecksumOS6	OS checksum, part 6.
206	Int16	ChecksumOS7	OS checksum, part 7.
207	Int16	ChecksumOS8	OS checksum, part 8.
208	Int16	ChecksumEXD1	ExD firmware (dorinius bin) checksum part 1
209	Int16	ChecksumEXD2	ExD firmware checksum part 2
210	Int16	ChecksumEXD3	ExD firmware checksum part 3
211	Int16	ChecksumEXD4	ExD firmware checksum part 4
212	Int16	ChecksumEXD5	ExD firmware checksum part 5
213	Int16	ChecksumEXD6	ExD firmware checksum part 6
214	Int16	ChecksumEXD7	ExD firmware checksum part 7
215	Int16	ChecksumEXD8	ExD firmware checksum part 8

BlueEye™ Ex-D Modbus Communication – Status registers

The status registers provide the user with information concerning the overall device status. When the device is working correctly the registers should display nominal values.

See tables below for a detailed overview of the status registers.

BlueEye™ Ex-D Modbus Status1 Register

Address (30'046)	Description	Details*
bit 0	WI_s and WI_i	0 = nominal / 1 = faulty
bit 1	H_s	0 = nominal / 1 = faulty
bit 2	H_i	0 = nominal / 1 = faulty
bit 3	Rho	0 = nominal / 1 = faulty
bit 4	Rho relative	0 = nominal / 1 = faulty
bit 5	Temperature	0 = nominal / 1 = faulty
bit 6	Absolute pressure	0 = nominal / 1 = faulty
bit 7	Viscosity	0 = nominal / 1 = faulty
bit 8	Thermal conductivity	0 = nominal / 1 = faulty
bit 9	Z	0 = nominal / 1 = faulty
bit 10	AFR	0 = nominal / 1 = faulty
bit 11	s-AFR	0 = nominal / 1 = faulty
bit 12	MN	0 = nominal / 1 = faulty
bit 13	Raw viscosity	0 = nominal / 1 = faulty
bit 14	Time and date have been set	0 = nominal / 1 = faulty
bit 15	Boosting	0 = nominal / 1 = sensor is boosting
*All 0 → Normal operation		

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BlueEye™ Ex-D Modbus Status2 Register

Address (30'047)	Description	Details*
bit 0	SD card detected and functional	0 = nominal / 1 = faulty
bit 1	Viscosity sensor ID & alpha table ID match	0 = nominal / 1 = faulty
bit 2	SHT serial ID & alpha table serial ID match	0 = nominal / 1 = faulty
bit 3	TCD sensor ID & TC alpha poly ID match	0 = nominal / 1 = faulty
bit 4	4-20 mA calibration overridden	0 = nominal / 1 = faulty
bit 5	Debug mode	0 = nominal / 1 = faulty
bit 6	TC sensor	0 = nominal / 1 = faulty
bit 7	CO_2 sensor	0 = nominal / 1 = faulty
bit 8	CH4	0 = nominal / 1 = faulty
bit 9	N2	0 = nominal / 1 = faulty
bit 10	Analog out of range	0 = nominal / 1 = faulty
bit 11	BlueEye serial number	0 = nominal / 1 = faulty
bit 12	TC serial number	0 = nominal / 1 = faulty
bit 13	CO2 sensor is successfully zeroed. See CO2 Zero and Span	0 = nominal / 1 = faulty
bit 14	CO2 sensor is successfully spanned. See CO2 Zero and Span.	0 = nominal / 1 = faulty
bit 15	-	0 = nominal / 1 = faulty
*All 0 → Normal operation		

BlueEye™ Ex-D Modbus Status3 Register

Address (30'040)	Description	Details*
bit 0	BlueEye spike	0 = nominal / 1 = faulty
bit 1	CH4 sensor is successfully zeroed. See CH4 Zero and Span	0 = nominal / 1 = faulty
bit 2	CH4 sensor is successfully spanned. See CH4 Zero and Span.	0 = nominal / 1 = faulty
bit 3	CO2 or CH4 Zero or Span temperature or pressure out of range	0 = nominal / 1 = faulty
bit 4	-	0 = nominal / 1 = faulty
bit 5	-	0 = nominal / 1 = faulty
bit 6	-	0 = nominal / 1 = faulty
bit 7	-	0 = nominal / 1 = faulty
bit 8	-	0 = nominal / 1 = faulty
bit 9	-	0 = nominal / 1 = faulty
bit 10	-	0 = nominal / 1 = faulty
bit 11	-	0 = nominal / 1 = faulty
bit 12	-	0 = nominal / 1 = faulty
bit 13	-	0 = nominal / 1 = faulty
bit 14	-	0 = nominal / 1 = faulty
bit 15	-	0 = nominal / 1 = faulty
*All 0 → Normal operation		

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