

**Operating Manual**

**X-Series Modbus & Smartphone Application Guide**



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**⚠ WARNING!**

These instructions must be provided to users before use of the product and retained for ready reference by the user. Read this manual carefully before using or maintaining the device. The device will perform as designed only if it is used and maintained in accordance with the manufacturer's instructions. Otherwise, it could fail to perform as designed, and persons who rely on this device could sustain serious injury or death.

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The warranties made by MSA with respect to the product are voided if the product is not installed and used in accordance with the instructions in this manual. Please protect yourself and your employees by following the instructions.

Please read and observe the WARNINGS and CAUTIONS inside. For additional information relative to use or repair, call 1-800-MSA-2222 during regular working hours.

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### 1 Introduction and Interface

This document is intended as a support guide and source of information for X30 & X50 Refrigerant Monitor communications setup and integration. There are also details and outlined steps regarding the features and operation of the accompanying smartphone application. Please consult this document for information regarding Modbus commissioning and activities, the smartphone application, fault codes, and other codes and tables required to manage and maintain the device.

#### **WARNING!**

Always read and understand the Instruction Manual of any product you are using.

**Failure to follow this warning can result in serious personal injury or death.**

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#### 1.1 Modbus RTU RS-485 Interface

For wiring the Modbus RS-485 communication network, use a 16 to 24 AWG (0.2 to 1.5 mm<sup>2</sup>) 3-core, 2 twisted pair + ground, shielded cable with 120  $\Omega$  characteristic impedance. (Recommended: Belden 3106A or equivalent.)

The Modbus address, baud rate, stop bit, and parity is configurable through the mobile app or Modbus interface. No jumpers or hardware switch settings are required.

The Modbus parameters at factory default settings are:

- Address: 1
- Baud Rate: 9600
- Parity: None
- Stop Bits: 1

Ensure that the communication parameters within the network, including the Building Management System, are configured identically.

For optimal performance of the Modbus network, ensure the following guidelines are implemented:

- Instruments are configured in a single bus topology, connecting multiple buses in parallel or branching multiple units from the main bus, may introduce impedance mismatches, reflections, and/or signal distortions.
- Avoid long stubs when connecting instruments to the bus (stubs should be less than 1 meter in length).
- Instruments at the end of the bus have the 120 $\Omega$  terminating resistor enabled via a hardware switch.
- A/B signal polarity is maintained throughout RS-485 network.
- Connect cable shield drain to physical earth or ground at the controller only.
- Connect cable shield drain to (SH) terminal at instrument.
- Cable shield integrity is maintained throughout RS-485 network.
- Do not use shield connection for signal ground. Use cable that provides dedicated ground conductor for signal ground. Connect signal ground to (GND) terminal of instrument.

## 2 MSA Bacharach X-Series Smartphone Application



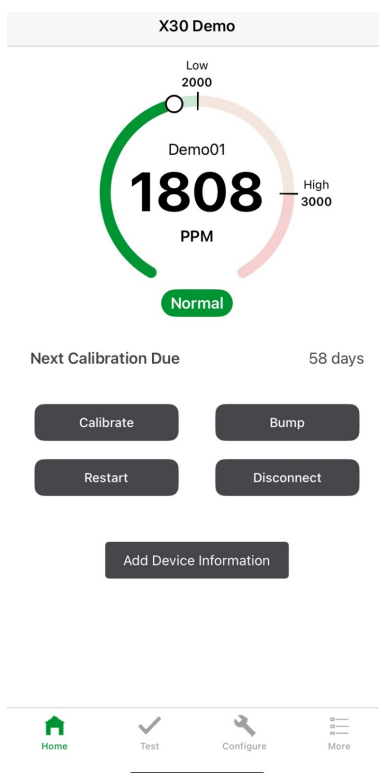
To download the MSA Bacharach X-Series App, visit the App Store or Google Play Store on your mobile device. The mobile application can be searched and found under the name "X-Series Gas Detection." The companion smartphone application allows users to perform a variety of functions to configure and interact with the X-Series refrigerant monitor, including:

- View real-time measurements
- Configure the instrument
- Test outputs
- Calibrate / bump test instrument
- Generate customizable calibration certificates

### 2.1 Checking Status

**NOTE:** The X-Series Gas Detection mobile application is a useful tool for displaying output information for the device. However, the direct analog or digital output from the device should be considered the primary output for controller and system integration and related actions.

Current instrument status can be viewed from the Home tab.



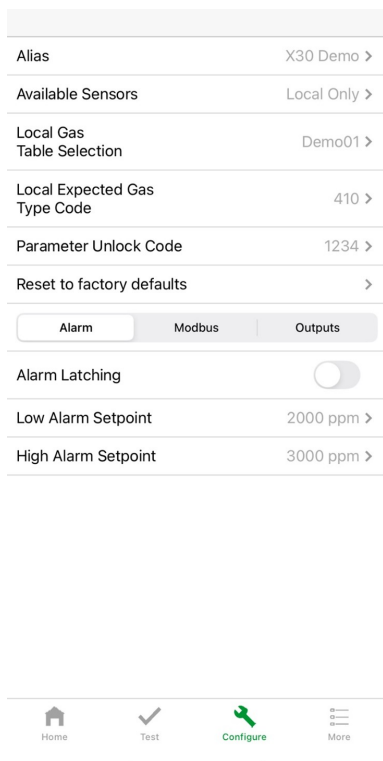
## 2 MSA Bacharach X-Series Smartphone Application

From the Home screen, users can understand operating status of the instrument at a glance. The gas concentration is displayed in relevant units in the center of the status ring. The ring also shows current alarm setpoints and a text description of device operating status. Calibration reminders are noted in days. Each tab at the bottom of the menu will navigate to another page: Test, Configure, and More.

The table below lists the color code for indication of operating status within the status ring.

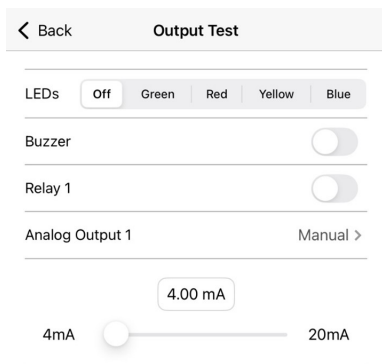
State	Status Ring	Description
Warm-up	Green	Refrigerant monitor stabilizing after power on or restart
Normal	Green	Normal operation
Low Alarm	Orange	Gas measurement has exceeded low alarm setpoint
High Alarm	Red	Gas measurement has exceeded high alarm setpoint
Offline	Green	Refrigerant monitor in maintenance mode and is not actively monitoring gas
Fault	Yellow	A fault has been detected
Negative Gas Fault	Yellow	Refrigerant Monitor calibration has drifted below zero, requires zero calibration
Zero Cal. Fault	Yellow	Error occurred during zero calibration. Zero calibration has not be updated. Zero calibration required.
Span Cal. Fault	Yellow	Error occurred during span calibration. Span calibration has not be updated. Span calibration required.

### 2.2 Tab Screen Overview

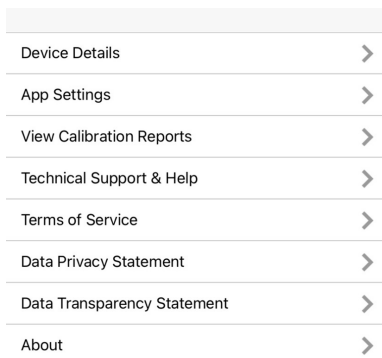


Detailed configuration options are available on the Configure tab. In this menu, the user can change the number of sensors within the configuration as well as their gas type. The parameter unlock code may be changed or the unit may be restored to factory default settings. The user can change the alarm latching status and the high / low alarm setpoints. When troubleshooting, consult this menu to ensure that the device configuration matches the expected settings for the system.

Please refer to [7 Sensor Type Code](#) of this document to access the Sensor Gas Type Code table.



Navigating to the Test tab will allow the user to access the visual, audio, relay, and analog outputs for manual testing. Use the toggle buttons and sliding scale features to modify outputs or turn them on and off for testing.



Additional functions and features are available within the last menu tab, titled 'More'. This area stores device details and links to troubleshooting, help, and disclosure statements.

The Factory Calibration Report for the device can be accessed via the app, if the mobile phone or tablet is connected to the internet. If internet connection is not available, the Factory Calibration Report is accessible on an MSA webpage. Each time the unit is calibrated onsite, a calibration report will be captured within this space.



## 2.3 Instrument Configuration

For security, access to configuration and calibration options are restricted to authorized users only. Access to these functions require use of an unlock code.

- When prompted, enter unlock code to access device configuration. The instrument's default code is "1234". Instrument will remain unlocked until Bluetooth® connection has ended.
- Default alias and unlock code can be changed on the Configure tab of the mobile application on the Configure tab of the mobile application.

### **WARNING!**

- For security purposes, the Unlock Code should be changed during instrument commissioning to prevent unauthorized access to instrument configuration and calibration.

**Failure to follow this warning can result in serious personal injury or death.**

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### 2.3.1 Change Unlock Code

- On the Configure tab, locate the Parameter Unlock Code setting, enter new 4-digit unlock code for instrument, select OK.
- Instrument must be restarted for change to take effect. Navigate to the Home tab and select "Restart" to reboot the device.
- Reconnect to instrument to confirm that the unlock code has been updated.

### **WARNING!**

If the custom unlock code is forgotten, the unlock code can be reset to the default value (1234) by resetting the system to factory defaults. Conducting a system factory reset of the device will return all system configurations, including alarm and relay functions, to their default factory settings.

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## 2.4 Alarm Level Setpoint Configuration

### Low Alarm Setpoint

The low alarm setpoint is the value above which a low alarm condition occurs. The low alarm setpoint must be less than the high alarm setpoint and greater than the low alarm limit. The low alarm limit is the fixed minimum limit that is sensor-specific and not editable.

The range of acceptable setpoints is displayed when this parameter is updated. To update the setpoint:

- On the Configure tab, locate the Low Alarm Setpoint setting, enter new setpoint, and select OK to confirm.

**NOTE:** To prevent intermittent alarm operation at the setpoint due to measurement noise, this instrument implements hysteresis at the setpoint. Once the alarm level is exceeded, the gas measurement must return a fixed percentage below the alarm threshold before the alarm is disabled. Typical hysteresis value is set at 5% of full scale; this is sensor specific and non-editable.

### High Alarm Setpoint

The high alarm setpoint is a value above which a high alarm condition occurs. The high alarm setpoint must be less than the sensor full scale range and greater than the low alarm setpoint.

The range of acceptable setpoints is displayed when this parameter is updated. To update the setpoint:

- On the Configure tab, locate the High Alarm Setpoint setting, enter new setpoint, and select OK to confirm.

**NOTE:** To prevent intermittent alarm operation at the setpoint due to measurement noise, this instrument implements hysteresis at the setpoint. Once the alarm level is exceeded, the gas measurement must return a fixed percentage below the alarm threshold before the alarm is disabled. Typical hysteresis value is set at 5% of full scale; this is sensor specific and non-editable.

### Indicator Latching

Enabling alarm latching will maintain alarm or fault condition even after the alarm or fault conditions is no longer active. When latched, the alarm or fault condition must be manually acknowledged before the condition will be cleared. This allows transient alarm or fault conditions to be identified.

If an alarm is latched, i.e. the condition has occurred but is no longer active, an acknowledgment button will appear on the home screen. Select this button to acknowledge the latched condition and clear the alarm or fault.

When alarm latching is disabled, the alarm or fault status clears automatically as soon as the condition is no longer active. To configure:

- On the Configure tab, locate the Alarm Latching setting, select Enable or Disable.

## 2.5 Output Settings and Configuration

### Analog Output Range

Adjust this parameter to change the analog output type and range for the device (i.e voltage or milliamp). Available ranges: 1-5V (Default), 2-10V, 4-20mA. To set the range:

- On the Configure tab under Output settings, locate Analog Output Range, select desired range, select OK to confirm

### Buzzer

A user can enable or disable the buzzer with this setting. The buzzer provides a local audible alarm/fault indication and is enabled by default. To enable/disable the buzzer:

- On the Configure tab under Output settings, locate Buzzer, select enable/disable, select OK to confirm

### Relay Failsafe

Enable or disable the Relay Failsafe operation with this setting. When configured for fail-safe operation, the relays are energized during normal operation. Fail-safe operation ensures relays are triggered in cases of power failure at the instrument. In failsafe operation normally open and normally closed terminals are reversed as indicated in Section 3.4.3 of the operating manual (PN: 10253483). Configuration for the 4th relay on X50 models is customizable to the application. It can be configured in the app for action on low alarm, high alarm, or fault conditions.

Relays are configured as non-failsafe by default. To enable/disable relay failsafe:

- On the Configure tab under Output settings, locate Relay Failsafe, select enable/disable, select OK to confirm

### Alarm Delay

Activating this setting sets a delay in seconds, before the instrument will indicate an alarm condition, after the low or high alarm threshold has been exceeded. The alarm delay feature may be used to prevent transient environmental conditions from activating alarms. Alarm delays may be set for 0-15 minutes, and the alarm delay is configured as 0 minutes by default. To set an alarm delay:

- On the Configure tab under Output settings, locate the Alarm Delay setting, enter desired delay in seconds (0-900), select OK to confirm.

### Analog Zero Adjust

The Analog Zero adjust applies a fixed offset to the analog output. This allows removal of small errors in the output between the instrument and the measurement at the controller due to cable resistance when using voltage outputs.

**NOTE:** MSA Bacharach MGS-Series Controllers use a digital interface. This analog adjustment is only required when using a third party controller using analog interface for gas concentration and status monitoring.

To apply an adjustment, first ensure the instrument is outputting a fixed voltage. The default is 1V at zero ppm, or you can use output test function to set a specific voltage value. Then, monitor the remote measurement and adjust the zero offset until the remote measurement matches the expected voltage output.

Adjustment is limited to  $\pm 10\%$  full scale. To set analog zero adjustment:

- Navigate to the "Configure" tab, select Outputs, then locate the Analog Zero Adjust setting.
- Alternatively, tap "Analog Zero Adjust (X.X%)" text and enter specific offset required (-10 to 10)

### 3 Modbus Configuration

#### Address

This setting sets instrument address for connection to the RS-485 Modbus interface. The Internal (local) sensor has a default node address of 1. An external (X10 Remote) sensor will have a default address of 2.

To set the address:

- On the Configure tab, navigate to the Modbus Address, select 1-247 and save the setting.

#### **WARNING!**

Ensure all instruments on the RS-485 bus have been configured with unique node addresses. If two instruments have been configured with same address, bus contention will occur, preventing communications with these instruments via the RS-485 interface.

**Failure to follow this warning can result in serious personal injury or death.**

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#### Baud Rate

Sets instrument baud rate for connection to RS-485 Modbus interface. (Default: 9600 baud) To set baud rate:

- On the Configure tab under Modbus settings, locate Baud Rate, and select 9600/19200, and select OK to confirm

#### Stop Bits

Sets instrument stop bits for connection to RS-485 Modbus interface. (Default: 1 stop bits) To set number of stop bits:

- On the Configure tab under Modbus settings, locate Stop Bits, select 1 or 2, and select OK to confirm

#### Parity

Sets instrument parity for connection to RS-485 Modbus interface. (Default: None) To set parity:

- On the Configure tab under Modbus settings, locate Parity, select None/Odd/Even, and select OK to confirm

#### Enable 120Ω Termination

For optimal communication reliability, in RS-485 Modbus networks, the last instrument physically connected to the RS-485 bus must include a 120Ω termination resistor. This is to reduce the potential for electrical signal reflection on long buses due to impedance mismatches.

The X30 X50 instruments include a termination resistor on all of the instruments. Please reference the operating manual (PN: 10253483) for an image of the location of the TERMINATE switch on each model's circuit board.

#### **WARNING!**

The termination resistor should only be enabled on the last instrument physically connected to RS-485 bus. An external resistor should not be connected where this is enabled on the instrument.

**Failure to follow this warning can result in serious personal injury or death.**

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## 4 Hexadecimal Format

All fault codes can be retrieved through the Modbus interface and are shown in hexadecimal (hex) format. A hex digit can represent multiple codes as shown below:

Hex Code	Equivalent Error Code(s)
0	0
1	1
2	2
3	1+2
4	4
5	1+4
6	1+2+3
7	1+2+4
8	8
9	1+8
A	2+8
B	1+2+8
C	4+8
D	1+4+8
E	2+4+8
F	1+2+4+8

## 5 Fault Codes

If the issue re-occurs after performing the required actions, contact MSA Technical Support.

Fault Bit	Fault Description	Possible Causes	Required Action(s)
<b>Monitor Faults (Modbus Registers 1108 &amp; 1110)</b>			
0x0001	Software Fault	A software fault has occurred.	Power-cycle.
0x0002	Voltage out of specification	Input voltage outside of allowed tolerances.	Verify correct input voltage.
0x0004	Reserved	N/A	N/A
0x0008	Reserved	N/A	N/A
0x0010	Memory fault	Periodic flash or RAM check has failed. The memory has been corrupted or is experiencing a hardware failure.	Power-cycle.
0x0020	System configuration error	An unexpected sensor has been attached to the monitor that is inconsistent with its current configuration. For example, an external sensor is attached to a monitor that is in "internal sensor only" configuration.	Remove the unexpected sensor. or Using Bluetooth or Modbus register 2120, set the system configuration to match the connected sensor configuration.
		The monitor's configuration has been corrupted.	Follow the factory reset procedure.
		The monitor's configuration is an unsupported configuration version.	Contact MSA Technical Support.
0x0040	Reserved	N/A	N/A
0x0080	Modbus server fault	Error in setting new Modbus communication settings.	Using the default Modbus settings, send new, valid, Modbus settings.  Follow the factory default reset procedure.
	Modbus hardware or software fault	A hardware or software error has occurred related to Modbus.	Contact MSA Technical Support.
0x0100	Analog output software error	A hardware or software error related to the analog output has occurred.	Power-cycle.  Follow the factory reset procedure.
0x0200	A Bluetooth hardware or software error has occurred.	Error detected when communicating to the Bluetooth module.	Attempt to start Bluetooth advertising.  Power-cycle.
0x0400	Push Button 1 or 2 fault	Push Button 1 or 2 is stuck in a pressed state.	Clear any obstructions impeding the buttons.  Power-cycle.
0x0800	Error detected in the ADC	An ADC hardware or software error has occurred.	Power-cycle.
0x1000	Invalid user settings	User settings have been corrupted.	Follow the factory default reset procedure.

Fault Bit	Fault Description	Possible Causes	Required Action(s)
<b>Monitor Faults (Modbus Registers 1108 &amp; 1110)</b>			
0x2000	Reserved	N/A	N/A
0x4000	Monitor Hardware Fault	A hardware fault has occurred.	Power-cycle.
0/8000	Reserved	N/A	N/A

Fault Bit	Fault Description	Possible Causes	Required Action(s)
<b>Sensor Faults (Modbus Registers 1109 &amp; 1111)</b>			
0x0001	Software Fault	A software fault has occurred.	Power-cycle
	Sensor version not supported.	The attached monitor does not support the version of this sensor.	Connect the sensor to a monitor that supports this version.
0x0002	Sensor Missing Fault	This sensor is not detected.	Check sensor connections.
0x0004	Voltage out of specification	Input voltage outside of allowed tolerances or a hardware fault has occurred.	Verify correct input voltage.
0x0008	Memory fault	Periodic flash or RAM check has failed. The memory has been corrupted or is experiencing a hardware failure.	Power-cycle.
0x0010	Invalid Gas Table Selection Fault	Sensor Gas table selection is invalid.	Update the selected gas table using the Bluetooth application or Modbus register 2156.
	Monitor to sensor settings failure	The user has attempted to set a value on the sensor that is not valid or allowed.	Resend a valid value for the failed setting Acknowledge the fault. This keeps the original setting.
	Invalid User Settings Fault	The user settings have been corrupted.	Factory reset.
0x0020	Invalid Calibration Fault	Sensor calibration is not valid.	Perform a valid Zero and / or Span Calibration. See section 5.4 Calibration Instructions for further details.
0x0040	Sensor Element Fault	The sensor element has malfunctioned.	Power-cycle.
0x0080	Error detected in the ADC	An ADC hardware or software error has occurred.	Power-cycle.
0x0100	Reserved	N/A	N/A
0x0200	Configuration Fault	<ul style="list-style-type: none"> <li>Mismatch between the system configuration and the connected sensor.</li> <li>The selected gas table is invalid.</li> <li>The sensor could be incompatible with the transmitter.</li> </ul>	<ul style="list-style-type: none"> <li>Set a valid configuration to match connected sensor (Modbus register 2120). Reconfigure all connected sensors. Check transmitter for supported configuration version.</li> <li>Set a valid gas table for the sensor module.</li> <li>The incompatible sensor is for future sensors.</li> <li>Send the instruments factory reset command.</li> </ul> <p><b>NOTE:</b> If this is done all settings must be checked</p>

## 5 Fault Codes

Fault Bit	Fault Description	Possible Causes	Required Action(s)
<b>Sensor Faults (Modbus Registers 1109 &amp; 1111)</b>			
		<ul style="list-style-type: none"> <li>The sensors EEPROM data is invalid.</li> </ul>	<p>since the instrument and attached sensors will return to the factory settings.</p> <p>Contact MSA Technical Support.</p>
0x0400	Monitor to sensor communication fault	Communication between the monitor and the sensor has failed.	<p>Check sensor wiring. Power-cycle if wiring check does not resolve.</p> <p>Contact MSA Technical Support.</p>
	Modbus hardware or software fault	A hardware or software error has occurred related to Modbus.	Contact MSA Technical Support.
0x0800	Gas sensor type mismatch	The user expected gas type code does not match the gas type code of this sensor.	Unlock the device and then set the correct expected gas type code.
	Analog Output Fault	The analog output channel for this sensor is in fault.	<p>If in 4-20mA mode, verify that there is a load resistor across the terminals.</p> <p><b>NOTE:</b> The unit will need power cycled to clear this error condition.</p>
	Sensor Hardware Fault	A hardware fault has occurred.	Power-cycle.
0x1000	Negative Gas Fault	Gas concentration is less than the negative gas limit.	Perform a successful zero calibration.
0x2000	Zero Calibration Fault	Performing a zero calibration failed.	<p>Acknowledge failed calibration.</p> <p>Verify calibration gas kit is correct.</p> <p>Verify correct gas is being applied.</p> <p>See section 5.4 Calibration Instructions for further details.</p>
		Sensor does not contain a valid zero calibration.	Perform a successful zero calibration. See section 5.4 Calibration Instructions for further details.
0x4000	Span Calibration Fault	Performing a span calibration failed.	<p>Acknowledge failed calibration.</p> <p>Verify calibration gas kit is correct.</p> <p>Verify correct gas is being applied.</p> <p>See section 5.4 Calibration Instructions for further details.</p>
		Sensor does not contain a valid span calibration.	Perform a successful span calibration. See section 5.4 Calibration Instructions for further details.
0x8000	Sensor Gas Calculation Fault	Error in sensor gas calculation has occurred.	<p>Perform a successful zero calibration.</p> <p>Perform a successful span calibration.</p> <p>Verify calibration gas kit is correct.</p> <p>Verify correct gas is being applied.</p> <p>See section 5.4 Calibration Instructions for further details.</p>

## 6 Modbus Registers

**NOTE:** This instrument uses 2 Modbus addresses to access the internal sensor and the external sensor. The transmitter settings can be set via either Modbus address. Keep in mind that if the instrument is configured to the internal sensor only option then the external sensors Modbus address will be ignored.

To unlock the Modbus registers:

- Write the correct unlock code to Modbus register 2100 to allow changes to be made to the system configuration. The unlock code is a 4 digit decimal value from 0000-9999 (default "1234"). System parameters which require the system be unlocked are indicated in the below table with a lock symbol.

### 6.0.1 Integration - Dynamic Sensor Data

Input Register (Function 04 Read)

1090	High Resolution Temperature	Shows the current temperature (.01'ths of °C)	16-bit Signed Integer
1091	Factory Reset Status	(0 or 1 = Factory Reset)	Boolean
1092	Calibration Due	(0 or 1 = cal due) Set if burning hours > calibration interval or invalid calibration data present	Boolean
1093	Selected Gas Table	Selected gas table value. This value should be a value of 1 to the maximum tables the sensor has installed	16-bit Unsigned Integer
1094	Signed Raw Gas Concentration (PPM/PPB/VOL/LEL)	Signed Raw Gas Concentration PPM Refer to address 1167 for the Number of Gas Tables - no thresholding; used for zero-calibration to see negative values	32-bit Signed Integer
1095			
1096	Signed Raw Gas Concentration (PPM)	Signed Raw Gas Concentration PPM - no thresholding; used for zero-calibration to see negative values	32-bit Float
1097			
1098	Sensor Uptime	Hours since last restart	16-bit Unsigned Integer
1099	Offline Mode Status	Offline mode status	
1100	Concentration % FS (0-100)	Gas concentration in % full-scale set when off-line	
1101	Concentration (PPM/PPB/VOL/LEL)	Concentration in display units	32-bit Float
1102	Concentration PPM	Unsigned concentration in PPM only. Value is squelched, capped, averaged, smoothed & scaled.	
1103		Special state: value will be zeroed if true reading is within squelch range value will be zeroed in the event of a sensor fault.	
1104	Sensor Burning Hours	Hours since last calibration	16-bit Unsigned Integer
1105	PPM Hours	Accumulated PPM Hours since sensor manufacture (100ppm for 2 hours = 200ppm hours)	32-bit Unsigned Integer
1106			
1107	Temperature (°C)	Current sensor temperature sensor reading (°C)	16-bit Signed Integer
1108	Transmitter Current Fault Code	Bit packed transmitter fault codes, currently active (see faults sheet for details of flags)	16-bit Unsigned

## 6 Modbus Registers

1109	Sensor Current Fault Code	Bit packed sensor fault codes, currently active.	Integer
1110	Transmitter Last/Previous Faults Code	Sticky faults as above but fault bits remain set after clearing to catch transient faults	16-bit Unsigned Integer
1111	Sensor Last/Previous Faults Code	Sticky faults as above but fault bits remain set after clearing to catch transient faults	
1112	Calibration Expired Flag	Calibration expired flag, when set sensor needs recalibration	Boolean
1113	Transmitter/sensor warm-up flag	Set if transmitter or sensor is still in warm-up stabilization period	
1114	Low Alarm Flag	Set if low alarm is active	
1115	High Alarm Flag	Set if high alarm is active	
1116	Fault Flag	Set if any fault flag is active	
1117	Sensor Saturation Flag	Set if gas concentration exceeds full-scale range	
1118	Sensor Underflow Flag	Set if gas concentration falls below zero	
1119	Auto Cal Zero Time Remaining	Seconds remaining in auto zero calibration procedure	16-bit Unsigned Integer
1120	Auto Cal Span Time Remaining	Seconds remaining in auto span calibration procedure	
1121	Auto Cal Recovery Time Remaining	Seconds remaining in span recovery	16-bit Unsigned Integer
1122	Maximum Temperature Reported (°C)	Maximum Temperature reported by sensor Temperature sensor	16-bit Signed Integer
1123	Maximum Gas Concentration Reported (%FS)	Maximum Gas Concentration reported by sensor	16-bit Unsigned Integer

### 6.0.2 Integration - Static Sensor Data

**NOTE:** %LEL and %VOL parameters are scaled x10

Input Register (Function 04 Read)

1124	Sensor Type Code	Type code of connected sensor module (Refer to section below Sensor Type Code)	16-bit Unsigned Integer
1125	Display units sensor (PPM / PPB / VOL / LEL)	Indication of connected sensor gas concentration unit (ppm=1 , ppb =2, vol=3, lel=4) VOL/LEL scale x10 i.e. 123 = 12.3%	
1126	Full-scale (PPM / PPB / VOL / LEL)	Full-scale in display units VOL/LEL scale x10 i.e. 123 = 12.3%	
1127	Local Low Alarm Set point (PPM / PPB / VOL / LEL)	Low Alarm in display units (alias of 2151) VOL/LEL scale x10 i.e. 123 = 12.3%	
1128	Local High Alarm Set point (PPM / PPB / VOL / LEL)	High Alarm in display units (alias of 2152) VOL/LEL scale x10 i.e. 123 = 12.3%	
1129	Calibration Gas Concentration (PPM / PPB /	Sensor Calibration gas concentration in display units VOL/LEL scale x10 i.e. 123 = 12.3%	

	VOL / LEL)		
1130	Sensor Squelch, Unit dependent (PPM / PPB / VOL / LEL)	Value below which gas concentration reads zero to suppress low level noise  VOL/LEL scale x10 i.e. 123 = 12.3%	
1131	Low Alarm Behavior	Low Alarm Behavior Flag, Sensor. 0 => alarm triggered when gas above alarm level; 1 => alarm triggered when gas below alarm level	Boolean
1132	Sensor cal gas lower limit (PPM / PPB / VOL / LEL)	Sensor calibration gas lower limit in display units  VOL/LEL scale x10 i.e. 123 = 12.3%	16-bit Unsigned Integer
1133	Sensor cal gas upper limit (PPM / PPB / VOL / LEL)	Sensor calibration gas upper limit in display units  VOL/LEL scale x10 i.e. 123 = 12.3%	
1134	Sensor Low Alarm Limit (PPM / PPB / VOL / LEL)	Sensor Low Alarm Limit in display units. (The minimum which the level low alarm set point may be set.)  VOL/LEL scale x10 i.e. 123 = 12.3%	
1135	% LEL to PPM Conversion Factor	%LEL to PPM conversion scaled x 10 (e.g. 44 for gas with 4.4% LEL)	
1136	Gas Type Text Char 1,2	Gas Type Characters 1 & 2 (10 character gas string = "XXXXXXXXXX")	16-bit Unsigned Integer
1137	Gas Type Text Char 3,4	Gas Type Characters 3 & 4 (10 character gas string = "XXXXXXXXXX")	
1138	Gas Type Text Char 5,6	Gas Type Characters 5 & 6 (10 character gas string = "XXXXXXXXXX")	
1139	Gas Type Text Char 7,8	Gas Type Characters 7 & 8 (10 character gas string = "XXXXXXXXXX")	
1140	Gas Type Text Char 9,10	Gas Type Characters 9 & 10 (10 character gas string = "XXXXXXXXXX")	
1141	Sensor Module SID Char 1,2	SID Characters 1 & 2 (8 char UID in format of 8 hex bytes, displayable as 16 characters)	
1142	Sensor Module SID Char 3,4	SID Characters 3 & 4 (8 char UID in format of 8 hex bytes, displayable as 16 characters)	
1143	Sensor Module SID Char 5,6	SID Characters 5 & 6 (8 char UID in format of 8 hex bytes, displayable as 16 characters)	
1144	Sensor Module SID Char 7,8	SID Characters 7 & 8 (8 char UID in format of 8 hex bytes, displayable as 16 characters)	
1145	Sensor Controller UID Char 1,2	UID Characters 1 & 2 (8 char UID in format of 8 hex bytes, displayable as 16 characters)	
1146	Sensor Controller UID Char 3,4	UID Characters 3 & 4 (8 char UID in format of 8 hex bytes, displayable as 16 characters)	
1147	Sensor Controller UID Char 5,6	UID Characters 5 & 6 (8 char UID in format of 8 hex bytes, displayable as 16 characters)	
1148	Sensor Controller UID Char 7,8	UID Characters 7 & 8 (8 char UID in format of 8 hex bytes, displayable as 16 characters)	

## 6 Modbus Registers

1149	Alias Text Char 1,2	Alias Characters (16 character alias string = "XXXXXXXXXXXXXXXXXX")	
1150	Alias Text Char 3,4		
1151	Alias Text Char 5,6		
1152	Alias Text Char 7,8		
1153	Alias Text Char 9,10		
1154	Alias Text Char 11,12		
1155	Alias Text Char 13,14		
1156	Alias Text Char 15,16		
1157	Software Version Transmitter Major	Major software version level (XX in firmware XX.YY.ZZZZ format)	
1158	Software Version Transmitter Minor	Minor software version level (YY in firmware XX.YY.ZZZZ format)	
1159	Software Version Transmitter Revision	Revision software version level (ZZZZ in firmware XX.YY.ZZZZ format)	
1160	Reserved	Returns a value of 0.	16-bit Signed Integer
1161	Reserved	Returns a value of 0.	
1162	Software Version SmartSensor Major	Major software version level (XX in firmware XX.YY.ZZZZ format)	16-bit Unsigned Integer
1163	Software Version SmartSensor Minor	Minor software version level (YY in firmware XX.YY.ZZZZ format)	
1164	Software Version SmartSensor Revision	Revision software version level (ZZZZ in firmware XX.YY.ZZZZ format)	
1165	Reserved	Returns a 0.	
1166	Reserved	Returns a 0.	
1167	Number of Gas Tables	This will indicate how many gas tables are in the sensor itself. All gas sensor will return a value of 1 or greater.	
1168	Applied Cal Gas Concentration (PPM/PPB/VOL/LEL)	Applied Calibration Gas concentration (Alias of 2200) in display units.  VOL/LEL scale x10 i.e. 123 = 12.3%	
1169	Calibration Interval (Hours)	Time until calibration expires in hours.	

### 6.0.3 Integration - General System Setup

**NOTE:** System needs to be unlocked via register 2100 or BLE to make any changes to all the registers in this section.

Holding Register (Function 03/06 Read / Write)

2100	Parameter Unlock	Writing the correct unlock code allows an external controller to change system parameters (0000-9999)  <b>NOTE:</b> 30 minute timeout applies.	16-bit Unsigned Integer
2101	RS-485 Node Address for the Internal Sensor	Modbus address 1-247	
2102	RS-485	Modbus address 1-247	16-Bit

	Node Address for the External Sensor		Unsigned Integer
2102	Baud Rate	0 = 9600 Baud; 1 = 19200 Baud	Boolean
2104	Stop Bits	Stop bits = 1 or 2	16-bit Unsigned Integer
2105	Parity	0 = None, 1 = Odd, 2 = Even	
2106	Buzzer disable	0 = Buzzer normal operation, 1 = Buzzer disabled* Does not disable BLE chirp	16-bit Unsigned Integer
2107	Relay Contact Behavior / Failsafe	0= Normal relay operation, 1 = Failsafe relay operation.	
2108	Latching Behavior	0 = Alarms / Faults automatically reset, 1 = Alarms / Faults must be acknowledged	
2109	Alarm ON Delay (0-900) seconds	Alarm on delay in seconds Range (0-900 secs), i.e. (0-15 mins)	16-bit Unsigned Integer
2110	Alias Text Char 1,2	Alias Characters 1 & 2 of the 16 characters (16 char alias string = "XXXXXXXXXXXXXXXXXX")	
2111	Alias Text Char 3,4	Alias Characters 3 & 4 of the 16 characters (16 char alias string = "XXXXXXXXXXXXXXXXXX")	
2112	Alias Text Char 5,6	Alias Characters 5 & 6 of the 16 characters (16 char alias string = "XXXXXXXXXXXXXXXXXX")	
2113	Alias Text Char 7,8	Alias Characters 7 & 8 of the 16 characters (16 char alias string = "XXXXXXXXXXXXXXXXXX")	
2114	Alias Text Char 9,10	Alias Characters 9 & 10 of the 16 characters (16 char alias string = "XXXXXXXXXXXXXXXXXX")	
2115	Alias Text Char 11,12	Alias Characters 11 & 12 of the 16 characters (16 char alias string = "XXXXXXXXXXXXXXXXXX")	
2116	Alias Text Char 13,14	Alias Characters 13 & 14 of the 16 characters (16 char alias string = "XXXXXXXXXXXXXXXXXX")	
2117	Alias Text Char 15,16	Alias Characters 15 & 16 of the 16 characters (16 char alias string = "XXXXXXXXXXXXXXXXXX")	
2118	Unlock code	4-digit code used to unlock user settings (0000-9999), numeric, can only be read/written if system is already unlocked	
2119	Bluetooth advertising	Bluetooth advertising status (timeout after 2 minutes)	Boolean
2120	Indication of available sensors	1 = internal sensor only, 2 = both internal and external sensors (X10) available (X50 only), 3 = external sensor only (X50 only)	16-bit Unsigned Integer
2121	4th Relay Operation	0 = follows fault relay (default), 1 = follows low alarm relay, 2 = follows high alarm relay.	

## 6 Modbus Registers

### 6.0.4 Integration - General Sensor Setup

**NOTE:** System needs to be unlocked via register 2100 or BLE to make any changes to all the registers in this section

Holding Register (Function 03/06 Read/Write)

2150	User Expected Sensor Type Code	Sensor Type code the users expects for the connected Smart Sensor. If this does not match what is connected an error will occur. Refer to section below Sensor Type Code	16-bit Unsigned Integer
2151	Sensor Low Alarm (PPM/PPB/VOL/LEL)	Low gas alarm in display units. This register is essentially write-only and will always return 0. See 1127 for reading.  VOL/LEL scale x10 i.e. 123 = 12.3%	
2152	Sensor High Alarm (PPM/PPB/VOL/LEL)	High gas alarm in display units. This register is essentially write-only and will always return 0. See 1128 for reading.  VOL/LEL scale x10 i.e. 123 = 12.3%	
2153	Analog Output Configuration	Set analog output (0=1-5V, 1=2-10V, 2=4-20mA)	
2154	Analog Output Zero Offset	Sets Analog output zero offset to allow output calibration (in DAC codes)	16-bit Signed Integer
2155	Reserved		
2156	Gas Table Selection	Selected gas table value. Returns a value of 0. This value should be a value of 1 to the maximum tables the sensor has installed. This register is essentially write-only and will always return 0. See 1093 for reading.	16-bit Unsigned Integer

### 6.0.5 Integration – Calibration

Holding Register (Function 03/06 Read/Write)

2200	Sensor Calibration gas applied (PPM/PPB/VOL/LEL)	Concentration of calibration gas applied during calibration (must be set before calibration if using gas != sensor nominal) set to sensor nominal on reset  VOL/LEL scale x10 i.e. 123 = 12.3%	16-bit Unsigned Integer
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### 6.0.6 Integration - User Debug Tools

**NOTE:** System needs to be unlocked to set all registers in this section

Holding Register (Function 03/06 Read/Write)

2800	Offline Mode	Setting this flag places the unit into offline mode. When offline the unit will not respond to gas events or generate alarm conditions. The flag will remain asserted for the duration of offline mode. Offline mode will end after 30 minutes or by clearing this flag. Off-line mode cannot be entered if the unit is in a fault, alarm state, or in manual override	Boolean
2801	Manual override Enable	Override external outputs to test system functionality. Time out after 30 minutes  Will also place the system off-line so alarms will not be generated.  Manual override cannot be entered if the unit is in fault, alarm state, or Off-line Mode.	
2802	Relay 1 state (Low Alarm)	Set state of relay 1 (1 = energized)	

2803	Relay 2 state (High Alarm)	Set state of relay 2 (1 = energized)	
2804	Relay 3 state (Fault)	Set state of relay 3 (1 = energized)	
2805	Relay 4 (Configurable)	Set State of relay 4 (1 = energized)	
2806	Buzzer state	Set state of buzzer (1 = active)	
2807	Green LED State	Set status LEDs to green (1 = on)	
2808	Red LED State	Set status and perimeter LEDs to red (1 = on)	
2809	Yellow LED State	Set sensor status LEDs to yellow (1 = on)	
2810	Blue LED State	Set sensor status and perimeter LEDs to blue (1 = on)	
2811	Analog Output #1 Value	Set value of analog output #1 in % full-scale (0% to 100%) <b>NOTE:</b> 2812 will need to be set to a value of 0 for this to function.	16-bit Unsigned Integer
2812	Analog Output #1 Value State	Set value control state of analog output #1 (0=Manual, 1= Fault, 2 = Offline, 3 = Underflow, 4= Overflow, 5=Normal, 6= Zero)	16-bit Unsigned Integer
2813	Analog Output #2 Value	Set value of analog output #2 in % full-scale (0% to 100%) <b>NOTE:</b> 2812 will need to be set to a value of 0 for this to function.	16-bit Unsigned Integer
2814	Analog Output #2 State	Set value control state of analog output #2 (0=Manual, 1= Fault, 2 = Offline, 3 = Underflow, 4= Overflow , 5= Normal, 6= Zero)	

### 6.0.7 MGS Compatibility - Status Flags

Read Input Status (Function 02 Read)

3000	Alarm flag (0 or 1 = alarm) for Any Alarm	Set if low or high alarm state Special state: value will be false in the event of a sensor fault	Boolean
3001	Relay state (0 or 1=energized) for any Relay	Set if any relay is active (follows relay logical state not physical if failsafe is active)	
3002	Sensor fault (0 or 1 = fault) for Any Sensor or System Fault	Set if any fault flag is active	
3003	Reserved	Returns 0	
3004	Reserved	Returns 0	
3005	Saturation (0 or 1= gas outside limits)	Set if gas concentration exceeds full-scale range. Special state: value will be false in the event of a sensor fault	
3006	Start up (0=normal op 1=starting up)	Set if transmitter or sensor is still in warm-up stabilization period	

### 6.0.8 Integration - Status Flags

Read Input Status (Function 02 Read)

## 6 Modbus Registers

3100	Sensor Warm-up	Set if transmitter or sensor is still in warm-up stabilization period	Boolean
3101	Low Alarm flag (0 or 1 = alarm)	Set if low alarm is active. Special state: value will be false in the event of a sensor fault	
3102	High Alarm flag (0 or 1 = alarm)	Set if high alarm is active. Special state: value will be false in the event of a sensor fault	
3103	Transmitter or sensor fault (0 or 1 = fault)	Set if any fault flag is active	
3104	Sensor Saturation (0 or 1 = gas outside limits)	Set if gas concentration exceeds full-scale range. Special state: value will be false in the event of a sensor fault	
3105	Sensor Underflow (0 or 1 = gas less than zero)	Set if gas concentration falls below zero	
3106	Calibration Due (0 or 1 = cal due)	Set if burning hours > calibration interval	

### 6.0.9 MGS Compatibility - Clear Special States

**NOTE:** System needs to be unlocked to set all registers in this section

Read/Force Coil (Function 01/05 Read/Write)

4000	Mute Buzzer	Sounder Mute	Boolean
4001	Calibration due	Clear Calibration Due Flag	

### 6.0.10 Integration - User Tasks

**NOTE:** System needs to be unlocked to set all registers in this section

Read/Force Coil (Function 01/05 Read/Write)

4100	Restart	Force application restart	Boolean
4101	Factory Reset	Restore system settings to defaults	
4102	Clear last faults	Clear any fault flags held in the last fault registers. Any active faults will remain set in the last fault register	
4103	Acknowledge latched alarms/faults	Acknowledge latched alarms/faults	
4104	Mute Buzzer	Mute Buzzer for 60 minutes	
4105	Immediate Zero Calibration	Calibrate zero now	
4106	Immediate Span Calibration	Calibrate span now	
4107	Auto Zero Calibration	Calibrate zero after auto calibration time	
4108	Auto Span Calibration	Calibrate span after auto calibration time	
4109	Clear calibration expired flag	Clear calibration due flag and rest burning hours to 0	
4110	Clear Maximum Temperature	Clear Maximum Temperature	
4111	Clear Maximum Gas Concentration	Clear Maximum Gas Concentration	
4112	BLE Advertising	0 = Disable, 1 = Enable	

## 7 Sensor Type Code

The Sensor Type Code is used by the operator to command the X30/X50 instrument to expect the entered sensor type code to match the sensor that is installed. If this does not match the installed sensor, the unit will enter a fault state. The sensors Sensor Type Code can be read via address 1124 above. The user can change this via address 2150. This setting is also accessible via the XGD App when configuring sensor type.

<b>Gas</b>	<b>Range</b>	<b>Type</b>	<b>Sensor Type Code</b>
Broadband Group 1	1,000 ppm	SC	4101
Broadband Group 2	1,000 ppm	SC	4102
Broadband Group 3	1,000 ppm	SC	4103
Broadband Group 4	1,000 ppm	SC	4104
CO <sub>2</sub>	5,000 ppm	IR	4097
CO <sub>2</sub>	10,000 ppm	IR	4098
CO <sub>2</sub>	20,000 ppm	IR	4099

