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ModBus® protocol™ is a trademark of Schneider Automation Inc.
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Revision History:
September 13, 2005   Version 1.0   Corresponds to software version 2.09 of the 820 Controller.

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Although every effort is made to ensure accuracy, the specifications of this product and the content herein are subject to change without notice.

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Warnings and Cautionary Statements

**CAUTION:** For safety reasons, this equipment must be operated and serviced by qualified personnel only.

**WARNING:** Failure to perform certain procedures or note certain conditions may impair the performance of this product. For maximum safety and optimal performance, please read and follow the procedures and conditions listed below.

- To ensure continued accuracy and safe operation of the 820 Controller, the two analog input signals should be re-calibrated at least annually. The two 4-20 mA analog outputs should also be regularly calibrated. A calibration procedure and regular schedule should be part of each company’s on-going quality plan.

- Analog inputs of the 820 Controller are rated for standard 4-20 mA analog signals. Transmitters and sensors that do not deliver a standard 4-20 mA current are not supported directly. Such non-compliant sensors, however, may be used (indirectly), but must be transformed first into the standard 4-20 mA signal before they are wired to the 820 Controller. Failure to connect a standard 4-20 mA input signal to the 820 Controller may cause serious damage to the unit and may void the product warranty.

- Never cover or insert foreign objects into the alarm signal opening. The opening must remain clear and free of foreign objects, otherwise any alerts made during an alarm state may not be heard or identified.

- Ensure proper wiring connections before supplying power to the 820 Controller. Wiring connectors are located on the back of the 820 Controller. Any mistake in system wiring may cause operational errors or serious damage to the instrument. Review the user manual carefully before changing the wiring. If any questions arise, contact qualified product engineers immediately for assistance with the wiring and installation.

- Contact your service representative immediately if you suspect that the 820 Controller is working abnormally (for example, no audible alarms, no diagnostic LEDs, no display, etc.).
Mission Statement

Design – Manufacture – Sell:

Highest quality products for the preservation of life and property

Provide:

Best Customer Service

In practical terms, that means developing both portable instruments and fixed-point systems for detecting, measuring and monitoring a wide variety of gases, including toxic and combustible gases, as well as oxygen.

From research and development through final manufacturing, we never forget that human lives depend on what we do. That workers all over the world enter confined spaces, face the risk of asphyxiation, poisoning or explosion, and depend on our instruments to ensure their safety. That's why every one of our products is designed and manufactured with just one question in mind: “Would you bet your life on it?”

Message from the President

Dear Valued Customer,

Thank you for buying and using Industrial Scientific’s 820 Controller fixed gas monitoring system. Your 820 Controller can be relied upon for dependable service, day after day. It has been designed, manufactured, tested and proven under the most scrutinizing conditions possible. With the minimal care and maintenance described in this manual, it will provide you with years of reliable monitoring. I am most concerned that you be pleased with the performance of your 820 Controller in the months and years ahead. I urge you to call us with any questions or comments you may have. Often times a phone call and a question can save you hours of frustration. Please never hesitate to contact me at 1-800-DETECTS (338-3287). All of us at Industrial Scientific appreciate the opportunity to serve you.

Sincerely,

Kent D. McElhattan
President & CEO
Industrial Scientific Corporation
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# # #
INTRODUCTION

1.1. Overview of the 820 Controller

The 820 Controller is a 2-channel analog controller designed by Industrial Scientific. Used in gas detection and gas monitoring applications, it is appropriate for both industrial and commercial applications that require signal monitoring and alarm capabilities using one or two analog input signals (standard 4-20 mA inputs). The controller simultaneously monitors both input sensors and displays their values on a two-line display located on the front panel. A built-in signal pass-through feature forwards the two analog inputs to two isolated analog outputs (standard 4-20 mA outputs), allowing the values of the input signals to be passed to other control devices such as a Programmable Logic Controller (PLC) or a Distributed Control System (DCS). The 820 is shown in Figure 1-1.

Figure 1-1. The 820 Two-Channel Analog Signal Controller (Front and Back Views)

The 820 Controller offers an easy-to-navigate local user interface for configuration and control. Every parameter (including alarm values) can be changed by using the 4 keys on the front panel. A second interface can connect the 820 Controller with any ModBus RTU master device so that it can be managed via digital network. For example, the 820 Controller can transfer its 4-20 mA signals to an 810 Controller via the digital ModBus network. Resource sharing over the ModBus network provides signal reliability and convenience to the end user.
A variety of gas types are pre-programmed into the 820 Controller. Default values for high and low alarms are pre-programmed for each gas type, providing benchmark values to simplify the programming process even further. However, the operator is always able to adjust these defaults to desired values.

As a supplement to the monitoring feature of the 820 Controller (which shows the two sensor readings on the display panel), programmable alarm features are also available. The 820 Controller offers a built-in audible alarm as well as visual alarms (via the diagnostic panel LEDs) and relay outputs for the following conditions:

- High alarm condition on channel 1 input
- High alarm condition on channel 2 input
- Low alarm condition on channel 1 input
- Low alarm condition on channel 2 input
- Fault alarm.

When a sensor’s value extends beyond the programmed alarm limits for that input channel, an alarm condition occurs. When an alarm condition occurs, the 820 Controller performs the following actions:

- activates the audible alarm
- flashes the Gas Alarm LED on the front panel
- activates the appropriate relays (if configured).

Five programmable 5 A relay outputs are available on the 820 Controller (refer to Figure 1-2). These relays correspond to the various alarm conditions discussed previously. Each relay is a single-pole, single-throw (SPST) relay. The high and low alarm relays (relays 1-4) are configured as normally open (NO). The system relay (relay 5) is configured as normally closed (NC). In addition, each relay on the 820 Controller can be configured to operate in one of three possible operational states (normal, latch, or inactive). These operational states, assignments, and associations are summarized in Table 1-1.

![Figure 1-2. Rear View of the 820 Controller Showing Relay Screw Terminals](image-url)
Table 1-1. Relay Assignments and Channel Associations

<table>
<thead>
<tr>
<th>Alarm Type</th>
<th>Input</th>
<th>Relay #</th>
<th>Relay Type</th>
<th>Modes of Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Channel 1</td>
<td>Relay 1</td>
<td>SPST NO</td>
<td>Normal</td>
</tr>
<tr>
<td>High Alarm</td>
<td></td>
<td></td>
<td></td>
<td>Latch</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inactive</td>
</tr>
<tr>
<td></td>
<td>Channel 2</td>
<td>Relay 2</td>
<td>SPST NO</td>
<td>Normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Latch</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inactive</td>
</tr>
<tr>
<td>Low Alarm</td>
<td>Channel 1</td>
<td>Relay 3</td>
<td>SPST NO</td>
<td>Normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Latch</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inactive</td>
</tr>
<tr>
<td></td>
<td>Channel 2</td>
<td>Relay 4</td>
<td>SPST NO</td>
<td>Normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Latch</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inactive</td>
</tr>
<tr>
<td>Fault</td>
<td>System</td>
<td>Relay 5</td>
<td>SPST NC</td>
<td>Normal</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Latch</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Inactive</td>
</tr>
</tbody>
</table>

A 4-alarm record is maintained for each input channel of the 820 Controller. Each alarm record table is accessible from the local user interface. Each is a FIFO (first-in-first-out) queue that holds information about the four most recent alarm conditions. Instructions on accessing the alarm record table are provided later in this document.

1.2. Typical Applications

Though the 820 Controller is very versatile, there are four general applications:

- Local Monitor and Alarm Applications
- Sensor Sharing Applications (PLCs, DCSs, etc.)
- ModBus Master/Slave Application Using the 810 Controller
- ModBus Remote Control Host Applications.

These applications are outlined in the following sections.
1.2.1. Local Monitor and Alarm Applications

The 820 Controller supports basic monitoring and alarming applications. Highlights of this application include the following:

- Simplest configuration
- No networking
- Minimal wiring and setup
- Up to two sensors (e.g., iTrans™ or AirAware™) for controlling up to two zones
- Up to five programmable relay outputs.

A sample architecture drawing is shown in Figure 1-3.

---

**Figure 1-3. Sample Architecture 1: Local Monitor and Alarm Application**
1.2.2. Isolated Signal Pass-Through Applications

The 820 Controller supports signal pass-through applications. Highlights of this application include the following:

- The isolated output signals act as inputs to a PLC or DCS
- A standard (isolated) 4-20 mA signal is available for PLCs and DCSs
- Sensor sharing reduces costs
- Up to two sensors (e.g., iTrans™ or AirAware™) for controlling up to two zones
- Up to five programmable relay outputs.

A sample architecture drawing is shown in Figure 1-4.

![Figure 1-4. Sample Architecture 2: Isolated Signal Pass-Through Application]
1.2.3. **ModBus Master/Slave Applications Using the 810 Controller**

The 820 Controller supports Master/Slave applications over a ModBus network. Highlights of this application include the following:

- Uses digital ModBus network to share data among similar devices
- Takes advantage of 810s and 820s being compatible and “network-ready”
- Up to two sensors (e.g., iTrans™ or AirAware™) for controlling up to two zones
- Up to five programmable relay outputs
- The isolated output signals act as inputs to a PLC or DCS
- A standard (isolated) 4-20 mA signal is available for PLCs and DCSs
- Sensor sharing reduces costs.

A sample architecture drawing is shown in Figure 1-5.

![Figure 1-5. Sample Architecture 3: ModBus Master/Slave Application](image)
1.2.4. ModBus Remote Control Host Applications

The Controller supports remote control host applications over a ModBus network. Highlights of this application include the following:

- More elaborate application
- Uses digital ModBus network to share data with a host system
- May require ModBus protocol programming at host front end
- Up to two sensors (e.g., iTrans™ or AirAware™) for controlling up to two zones
- Up to five programmable relay outputs
- The isolated output signals act as inputs to a PLC or DCS
- A standard (isolated) 4-20 mA signal is available for PLCs and DCSs
- Sensor sharing reduces costs.

A sample architecture drawing is shown in Figure 1-6.

![ModBus Network](image)

Figure 1-6. Sample Architecture 4: ModBus Remote Control Host Application
1.3. Features

This chapter provides an overview of some of the key features of the 820 Controller. Details of these features are provided later in this document.

- Rugged, industrial-grade chassis
- Two 4-20 mA input channels for monitoring
- Two isolated 4-20 mA output channels (current signal output) reflect the input channels
- ModBus RTU protocol support via an RS-485 port
- Easy-to-use local user interface for monitoring, alerts, and programming
- Password protection for security
- Audible and visual alarms
- Five programmable relays for alarm and fault conditions
- Programmable relay “latch” feature for alarm and fault conditions
- Easy-to-read display (4×2 LED matrix)
- Programmable high and low alarm limits for each input channel
- Default high and low alarm limit set points (benchmarked for various gases)
- Real-time clock for time-stamping and date-stamping alarm records
- Separate alarm record tables for each input sensor
- Fault relay
- Power LED flashes when supply power is above or below the acceptable range

1.4. Ordering Information

Table 1-2 lists part numbers for ordering the 820 Controller and other components that might be used with 820 Controller applications.

<table>
<thead>
<tr>
<th>Part Number</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>7810-4700</td>
<td>820 Analog Controller with mounting brackets and manual</td>
</tr>
<tr>
<td>68100056-ABCDE</td>
<td>AirAware™ Monitor (Consult ordering matrix for all variations)</td>
</tr>
<tr>
<td>7814635-ABCDEFG</td>
<td>iTrans™ Monitor (Consult ordering matrix for all variations)</td>
</tr>
<tr>
<td>78104692-40</td>
<td>810 Controller (4-Channel Controller)</td>
</tr>
<tr>
<td>78104692-80</td>
<td>810 Controller (8-Channel Controller)</td>
</tr>
<tr>
<td>78104692-160</td>
<td>810 Controller (16-Channel Controller)</td>
</tr>
<tr>
<td>78104692-41</td>
<td>810 Controller (4-Channel Controller, 16 Relays)</td>
</tr>
<tr>
<td>78104692-81</td>
<td>810 Controller (8-Channel Controller, 16 Relays)</td>
</tr>
<tr>
<td>78104692-161</td>
<td>810 Controller (16-Channel Controller, 16 Relays)</td>
</tr>
<tr>
<td>18106385</td>
<td>820 Controller manual</td>
</tr>
</tbody>
</table>
1.5. Warnings and Cautionary Statements

**CAUTION:** For safety reasons, this equipment must be operated and serviced by qualified personnel only.

**WARNING:** Failure to perform certain procedures or note certain conditions may impair the performance of this product. For maximum safety and optimal performance, please read and follow the procedures and conditions listed below.

- To ensure continued accuracy and safe operation of the 820 Controller, the two analog input signals should be re-calibrated at least annually. The two 4-20 mA analog outputs should also be regularly calibrated. A calibration procedure and regular schedule should be part of each company’s on-going quality plan.

- Analog inputs of the 820 Controller are rated for standard 4-20 mA analog signals. Transmitters and sensors that do not deliver a standard 4-20 mA current are not supported directly. Such non-compliant sensors, however, **may** be used (*indirectly*), but must be transformed first into the standard 4-20 mA signal before they are wired to the 820 Controller. Failure to connect a standard 4-20 mA input signal to the 820 Controller may cause serious damage to the unit and may void the product warranty.

- Never cover or insert foreign objects into the alarm signal opening. The opening must remain clear and free of foreign objects, otherwise any alerts made during an alarm state may not be heard or identified.

- Ensure proper wiring connections before supplying power to the 820 Controller. Wiring connectors are located on the back of the 820 Controller. Any mistake in system wiring may cause operational errors or serious damage to the instrument. Review the user manual carefully before changing the wiring. If any questions arise, contact qualified product engineers immediately for assistance with the wiring and installation.

- Contact your service representative immediately if you suspect that the 820 Controller is working abnormally (for example, no audible alarms, no diagnostic LEDs, no display, etc.).
### 1.6. Specifications

Specifications for the 820 Controller are listed in Table 1-3.

**Table 1-3. Specifications for the 820 Controller**

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>4.25&quot; × 5.40&quot; × 5.03&quot; (108 mm × 138 mm × 128 mm)</td>
</tr>
<tr>
<td>Weight</td>
<td>1.25 pounds (567 grams)</td>
</tr>
<tr>
<td>Enclosure</td>
<td>ABS composite, rack mountable</td>
</tr>
</tbody>
</table>
| Power              | 24 VDC (20 VDC to 26 VDC), 300 mA  
  **Note:** The 820 Controller has no internal power supply. It must get power from an external DC source. |
| Display            | 15-segment LED matrix (4×2 display) |
| Keypad             | 5-button keypad (MODE, ↑, ↓, ←, and ALARM SILENCE):  
  • MODE (to switch modes or cancel current operation)  
  • Up Arrow (↑) (to scroll up)  
  • Down Arrow (↓) (to scroll down)  
  • Enter (←) (to accept values or confirm operations)  
  • ALARM SILENCE (to shut off the audible alarm) |
| Sensor Inputs      | 2 standard 4-20 mA current inputs |
| Outputs            | 5 programmable alarm relay outputs:  
  • 2 low alarms (1 per input channel), SPST, NO  
  • 2 high alarms (1 per input channel), SPST, NO  
  • 1 fault alarm (1 per 820 Controller), SPST, NC  
  5 A at 30 VDC |
| Analog             | 2 standard 4-20 mA (isolated) analog outputs, 300 Ω maximum  
  Isolated, but reflect the two sensor input values (pass-through) |
| Diagnostics/Alarms | Visual  
  3 LEDs (red gas alarm, yellow fault alarm, green power status) |
|                    | Audible  
  Gas alarm signal |
| Networking         | RS-485 port (incoming and outgoing connectors) for ModBus RTU slave protocol |
| Response Time      | < 10 seconds |
| Temperature Range  | -40° F to 122° F (-40° C to 50° C) |
| Humidity Range     | 10% to 90% relative humidity (non-condensing) |
2.1. Unpacking the 820 Controller

NOTE: Before unpacking the 820 Controller, ensure that the work area is clean and dust-free.

To unpack the 820 Controller, open the front flap of the box and lift it upwards, revealing the molded packing material. Remove the top layer of the packing material to reveal the 820 Controller and mounting brackets. Remove the items from the bottom layer of molded packing material. Refer to Figure 2-1.

Figure 2-1. Unpacking the 820 Controller

The shipping box should contain the items listed in Table 2-1.

Table 2-1. Shipping Contents

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>820 Controller</td>
</tr>
<tr>
<td>2</td>
<td>Metal mounting brackets</td>
</tr>
<tr>
<td>1</td>
<td>Product manual</td>
</tr>
</tbody>
</table>

After unpacking, if any item is missing, contact either your local distributor of Industrial Scientific products, or call Industrial Scientific Corporation at 1-800-DETECTS (1-800-338-3287) in the United States and Canada, or 412-788-4353.
2.2. Inspecting the 820 Controller

After unpacking the controller, examine it carefully for any obvious signs of damage. If any damage is found, contact either your local distributor of Industrial Scientific products, or call Industrial Scientific Corporation at 1-800-DETECTS (1-800-338-3287) in the United States and Canada, or 412-788-4353.
3.1. Introduction

The 820 Controller consists of several basic hardware components. These components are illustrated in Figure 3-1 and are explained in detail in the sections that follow.

![Figure 3-1. Basic Hardware Components and Connectors of the 820 Controller](image)

3.2. Enclosure

3.2.1. General Information

The enclosure of the 820 Controller is made of a black ABS composite material that is designed to withstand the rigors of industrial applications. The dimensions of the enclosure are 4.25” × 5.40” × 5.03” (108 mm × 138 mm × 128 mm).
3.2.2. Mounting Information

The enclosure of the 820 Controller is rack mountable in standard 128 mm (5.00”) racks using the metal mounting brackets provided. The mounting brackets clip into keyed cutouts on the top and bottom of the enclosure and provide an adjustable screw that can secure the controller to a mounting rack. Refer to Figure 3-2.

![Figure 3-2. Mounting Clip Positioned on the Top Cutouts of the 820 Controller](image)

3.2.3. Release Clips for Internal Access

**WARNING:** Access to the inside of the controller must be limited to trained service personnel and authorized Industrial Scientific technicians only.

The enclosure protects the delicate internal electronics of the 820 Controller. Two release clips are located at the front of the 820 Controller (at the top and bottom center of the front panel). Simultaneously pressing these release clips unlatches the front panel from the rest of the enclosure. The location of the top release clip is shown in Figure 3-3 and Figure 3-4.

![Figure 3-3. Top Release Clip for Internal Access (Qualified Personnel Only)](image)
WARNING: There are no user-serviceable parts inside the 820 Controller. Access by unqualified or unauthorized personnel could cause damage to 820 Controller and could void the warranty.

3.3. Display

The display of the 820 Controller consists of a 4×2 matrix (4 columns and 2 rows) of 15-segment light emitting diodes (LEDs) located on the front panel of the device. This display is an integral part of the local user interface that may be used to monitor values, configure parameters, and operate the 820 Controller. The display is illustrated in Figure 3-5.
3.4. Keypad

The keypad of the 820 Controller consists of 5 individual keys:

- Mode Key
- Up Arrow Key (↑)
- Down Arrow Key (↓)
- Enter/Return Key (↵)
- Alarm Silence Key.

These keys, in conjunction with the display, complete the local user interface. The keys and their locations on the front panel are shown in Figure 3-6 and their functions are summarized in Table 3-1.

![Figure 3-6. The 820 Controller’s Keypad](image)

<table>
<thead>
<tr>
<th>Key</th>
<th>Name</th>
<th>Description/Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Mode" /></td>
<td>Mode</td>
<td>This key is used to change between the different operating modes of the controller (for example, startup mode, normal mode, and parameter setup mode). It can also be used to cancel the current operation.</td>
</tr>
<tr>
<td><img src="image" alt="Up Arrow" /></td>
<td>Up Arrow</td>
<td>This key is used to scroll information up on the display or increment numerical values.</td>
</tr>
<tr>
<td><img src="image" alt="Down Arrow" /></td>
<td>Down Arrow</td>
<td>This key is used to scroll information down on the display or decrement numerical values.</td>
</tr>
<tr>
<td><img src="image" alt="Enter/Return" /></td>
<td>Enter/Return</td>
<td>This key is used to accept values or confirm operations.</td>
</tr>
<tr>
<td><img src="image" alt="Alarm Silence" /></td>
<td>Alarm Silence</td>
<td>This key is used to shut off the audible alarm.</td>
</tr>
</tbody>
</table>
3.5. Diagnostic Panel

The diagnostic panel of the 820 Controller consists of 3 multicolor LEDs with the following functions:

- Gas Alarm (red LED)
- Fault Alarm (yellow LED)
- Power Status (green LED).

These indicators are color-coded, are labeled, and are located in the lower left corner of the 820 Controller (see Figure 3-7). Their functions are summarized in Table 3-2.

![Figure 3-7. The 820 Controller’s Diagnostic Panel LEDs](image)

**Table 3-2. Summary of Diagnostic Panel LEDs**

<table>
<thead>
<tr>
<th>LED</th>
<th>State</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALARM</td>
<td>Off</td>
<td>There are no active gas alarms based on gas input sensor readings and alarm limit parameter settings.</td>
</tr>
<tr>
<td></td>
<td>On</td>
<td>There are active gas alarms based on gas input sensor readings and alarm limit parameter settings. This may also indicate a past gas alarm condition which may now be within normal limits (for latched sensor configurations).</td>
</tr>
<tr>
<td>FAULT</td>
<td>Off</td>
<td>There are no active controller faults.</td>
</tr>
<tr>
<td></td>
<td>On</td>
<td>There are active controller faults.</td>
</tr>
<tr>
<td>POWER</td>
<td>Off</td>
<td>Power is not being supplied to the controller.</td>
</tr>
<tr>
<td></td>
<td>On</td>
<td>Power is being supplied to the controller, and is within the acceptable range (between 20 VDC and 26 VDC).</td>
</tr>
<tr>
<td></td>
<td>Flashing</td>
<td>The 24 VDC supply power is outside the acceptable range (below 20 VDC or above 26 VDC).</td>
</tr>
</tbody>
</table>
3.6. Alarm Annunciator

An audible alarm annunciator is located on the front panel of the 820 Controller, above the red gas alarm LED. It provides an additional warning (in the form of an audible alert) when a gas alarm occurs. Refer to Figure 3-8.

![Figure 3-8. Front Panel Opening for the Alarm Annunciator](image)

**WARNING:** Never cover or insert foreign objects into the alarm signal opening. The alarm signal opening must remain clear and free of foreign objects, otherwise any alerts made during an alarm state may not be heard or identified.

3.7. Mounting Clip Cutouts

Keyed cutouts are located on the top and bottom of the 820 Controller. These slots (located on the top and bottom of the enclosure) are used to accommodate the two mounting brackets that are included with the 820 Controller. The cutouts on the top of the enclosure are shown in Figure 3-9.

![Figure 3-9. Mounting Bracket Cutouts on Top of the 820 Controller Enclosure](image)
3.8. Wiring Connectors

All wiring connections are made at the connection panel located on the back of the 820 Controller. The connectors of the 820 Controller are shown in Figure 3-10 (on page 3-8). A wiring connector summary is provided in Table 3-3. Refer to the chapter on wiring for additional information.

Table 3-3. Wiring Connector Summary

<table>
<thead>
<tr>
<th>Connector Name</th>
<th>Function</th>
</tr>
</thead>
<tbody>
<tr>
<td>Port Out</td>
<td>+24 VDC supply power connection</td>
</tr>
<tr>
<td>485A</td>
<td>ModBus network connections (Same as Port In)</td>
</tr>
<tr>
<td>485B</td>
<td>Supply power ground connection</td>
</tr>
<tr>
<td>Relay 1</td>
<td>Relay connections for channel 1 high limit alarms</td>
</tr>
<tr>
<td>N.O.</td>
<td></td>
</tr>
<tr>
<td>Common</td>
<td></td>
</tr>
<tr>
<td>Relay 2</td>
<td>Relay connections for channel 2 high limit alarms</td>
</tr>
<tr>
<td>N.O.</td>
<td></td>
</tr>
<tr>
<td>Common</td>
<td></td>
</tr>
<tr>
<td>Relay 3</td>
<td>Relay connections for channel 1 low limit alarms</td>
</tr>
<tr>
<td>N.O.</td>
<td></td>
</tr>
<tr>
<td>Common</td>
<td></td>
</tr>
<tr>
<td>Relay 4</td>
<td>Relay connections for channel 2 low limit alarms</td>
</tr>
<tr>
<td>N.O.</td>
<td></td>
</tr>
<tr>
<td>Common</td>
<td></td>
</tr>
<tr>
<td>Relay 5</td>
<td>Relay connections for system fault alarms</td>
</tr>
<tr>
<td>N.C.</td>
<td></td>
</tr>
<tr>
<td>Common</td>
<td></td>
</tr>
<tr>
<td>Port In</td>
<td>+24 VDC supply power connection</td>
</tr>
<tr>
<td>485A</td>
<td>ModBus network connections (Same as Port Out)</td>
</tr>
<tr>
<td>485B</td>
<td>Supply power ground connection</td>
</tr>
<tr>
<td>Devices</td>
<td>Channel 1 sensor input (4-20 mA input), “plus” side</td>
</tr>
<tr>
<td>Ch 1</td>
<td></td>
</tr>
<tr>
<td>Ch 2</td>
<td>Channel 2 sensor input (4-20 mA input), “plus” side</td>
</tr>
<tr>
<td>Ch 1 +</td>
<td>Ground connection for Channel 1 and Channel 2 sensor inputs</td>
</tr>
<tr>
<td>Ch 1 -</td>
<td></td>
</tr>
<tr>
<td>Ch 2 +</td>
<td>Isolated analog output connections (4-20 mA) based on channel 1 sensor input</td>
</tr>
<tr>
<td>Ch 2 -</td>
<td></td>
</tr>
<tr>
<td>Signal Out</td>
<td>Isolated analog output connections (4-20 mA) based on channel 2 sensor input</td>
</tr>
<tr>
<td>Ch 1 +</td>
<td></td>
</tr>
<tr>
<td>Ch 1 -</td>
<td></td>
</tr>
<tr>
<td>Ch 2 +</td>
<td>Isolated analog output connections (4-20 mA) based on channel 2 sensor input</td>
</tr>
<tr>
<td>Ch 2 -</td>
<td></td>
</tr>
<tr>
<td>Ground</td>
<td>Chassis ground for the 820 Controller</td>
</tr>
</tbody>
</table>
NOTE: The 820 Controller has no internal power supply. It must get power from an external DC source. Refer to Chapter 4: System Wiring for more information.

#  #  #
4.1. Introduction

This chapter outlines the steps required for wiring the 820 Controller. These steps include the following:

- Pre-Wiring Check List
- Mounting the 820 Controller
- Wiring the Chassis Ground
- Wiring the Input Sensors
- Wiring the Relay Outputs
- Wiring the Isolated Signal Outputs
- Wiring the ModBus Network
- Wiring the Supply Power.

Each of these steps is outlined in the sections that follow.

4.2. Pre-Wiring Check List

In preparation of making all of the necessary input, output, and power connections to the 820 Controller, ensure that the following conditions have been met.

___ 1. Select an appropriate mounting location. The location should be easily accessible, clearly visible, and must have access to reliable source power.

___ 2. Determine location(s) of auxiliary devices such as sensors, external alarm devices, PLCs, DCSs, etc. Also locate the routes for existing wiring/conduit or determine routes for necessary wiring. Wiring for all connected devices should meet at the 820 Controller and be properly labeled.

___ 3. Gather all of the necessary tools that may be needed during the installation and wiring of the 820 Controller. This includes a flat head screwdriver, wire strippers, appropriate lengths and proper gauges of wires, fork connectors, crimping tool, and antioxidant for coating wires (to ensure secure electrical connections).

___ 4. Gather all of the necessary hardware components that have not yet been installed. This includes sensors, transformers, power supplies, alarm devices, etc.

___ 5. Review the specifications of all devices that will be attached to the 820 Controller. Ensure that all components are compatible with and properly rated for use with the 820 Controller. This includes sensors, alarm devices, PLCs, DCSs, etc.

___ 6. For advanced ModBus applications, it may be necessary to work with a third party to ensure proper compatibility of devices sharing the ModBus network.

___ 7. Review and observe all electrical codes and safety protocols for your location.
Recommendations: Use 18 AWG shielded cable for wiring the 820 Controller. The number of conductors varies from application to application. Refer to the individual field device manuals for additional wiring information.

Recommendations: When using shielded cable, the shield must be electrically connected to earth ground at either the controller or at the field device, but not both.

4.3. Mounting the 820 Controller

Using the guidelines specified in the previous section, mount the 820 Controller using the mounting hardware that is provided or mounting hardware that you provide. Be sure that the location is easily accessible, clearly visible, and has access to reliable source power. After the device is installed, it must be removed temporarily in order to begin making electrical connections which are located at the back of the 820 Controller. After the wiring is completed, the device can be re-secured to its mounting location.

4.4. Wiring the Chassis Ground

The chassis ground of the 820 Controller is used to provide a safe electrical path to earth ground if a short circuit occurs. This ground is also used as a common ground that is used internally by the 820 Controller.

Using an appropriate gauge of wire, connect one end to the chassis ground terminal (labeled with a ground symbol and shown in Figure 4-1), and the other end to the closest ground point at the location. It is important to keep the length of the ground wire to a minimum.

Recommendations: Use 18 AWG shielded cable with green insulation for the chassis ground connection. Fork connectors should be installed on all 820 Controller wiring to provide secure connections. Apply a small amount of antioxidant to the bare wire before crimping a fork connector to the wire. Also, apply a small amount of antioxidant to the fork connector (or bare wire) before making the connection to the screw terminal.

![Figure 4-1. Wiring for the Chassis Ground Screw Terminal](image-url)
4.5. Wiring the Input Sensors (Devices)

The 820 Controller supports either 1 or 2 input sensors (or “Devices”). These devices must be standard 4-20 mA transmitters, preferably for gas monitoring applications (e.g., iTrans™ or AirAware™).

Generally, a 4-20 mA device requires 4 electrical connections: power leads (for example, +24 VDC and GND) to provide power for the device, and the current outputs for the device. There may be variations, so always refer to the support documentation for your particular device. Based on these general sensor leads, a standard wiring diagram for the input devices is shown in Figure 4-2.

Three screw terminals are assigned to the input devices. These screw terminals (labeled “DEVICES”) are shown as “CH_1” (for channel 1) and “CH_2” (for channel 2). Each input device shares a common ground terminal (shown as “GND”). Refer to Figure 4-2.

![Figure 4-2. Wiring for the Input Sensor (Devices) Screw Terminals](image)

**Recommendations:** Use 18 AWG shielded cable. Fork connectors should be installed on all 820 Controller wiring to provide secure connections. Apply a small amount of antioxidant to the bare wire(s) before crimping a fork connector to the wire. Also, apply a small amount of antioxidant to the fork connector (or bare wire) before making the connections to the input device’s screw terminals.
4.6. Wiring the Relay Outputs

Five programmable 5 A relay outputs are available on the 820 Controller. These relays correspond to the various alarm conditions. In addition, each relay can be configured to operate in one of three possible operational states (normal, latch, or inactive). These operational states, assignments, and associations are summarized in Table 4-1.

Table 4-1. Relay Assignments and Channel Associations

<table>
<thead>
<tr>
<th>Alarm Type</th>
<th>Input</th>
<th>Relay #</th>
<th>Relay Type</th>
<th>Modes of Operation</th>
</tr>
</thead>
<tbody>
<tr>
<td>High Alarm</td>
<td>Channel 1</td>
<td>Relay 1</td>
<td>SPST NO</td>
<td>Normal</td>
</tr>
<tr>
<td></td>
<td>Channel 2</td>
<td>Relay 2</td>
<td>SPST NO</td>
<td>Latch</td>
</tr>
<tr>
<td></td>
<td>Channel 1</td>
<td>Relay 3</td>
<td>SPST NO</td>
<td>Inactive</td>
</tr>
<tr>
<td>Low Alarm</td>
<td>Channel 2</td>
<td>Relay 4</td>
<td>SPST NO</td>
<td>Normal</td>
</tr>
<tr>
<td></td>
<td>System</td>
<td>Relay 5</td>
<td>SPST NC</td>
<td>Latch</td>
</tr>
<tr>
<td></td>
<td>System</td>
<td>Relay 5</td>
<td>SPST NC</td>
<td>Inactive</td>
</tr>
</tbody>
</table>

Each relay output has two screw terminals. Each pair of screw terminals corresponds to a particular alarm, and is either a normally open (NO) type relay (relays 1-4) or a normally closed (NC) type relay (relay 5). Refer to Table 4-1. When an alarm condition occurs (parameters to define such conditions are detailed later in this manual), the associated relay is closed, completing the circuit. Each pair of relay terminals can be connected to (and, therefore, can control) any circuit up to the 5 A at 30 VDC or 5 A at 250 VAC specification. Typical applications include auxiliary annunciators or alarm devices that supplement the display, the diagnostic panel of LEDs, and the built-in audible annunciator.

NOTE: The fault relay (relay 5) is the only relay that is normally closed. It creates an open circuit when activated. For a “normal operation” signal (for example, a green light that is always on to show a non-fault condition), wire relay 5 like relays 1-4. As relay 5 is a normally closed relay, a non-fault condition means the circuit is closed, and a fault condition means the relay is open. For relay 5 to control an alarm warning device (e.g., red light, additional audible fault warning, etc.), additional wiring must be provided.
The procedure for wiring relay outputs 1-4 is the same on the 820 Controller. With an annunciator or alert circuit in place, simply use the relay contacts as a dry switch. Be sure that the annunciator or alert circuit does not exceed the specifications noted earlier. A sample architecture for wiring a single relay output pair is shown in Figure 4-3.

The relay outputs require programming in addition to the wiring being done in this section. Relay outputs must be enabled, limits must be programmed, and modes of operation must be configured. These steps are outlined in the commissioning chapter of this manual.

**Figure 4-3. Sample Wiring for Relay Output Screw Terminals (Relays 1-4)**

**Recommendations:** Use 18 AWG shielded cable. Fork connectors should be installed on all 820 Controller wiring to provide secure connections. Apply a small amount of antioxidant to the bare wire(s) before crimping a fork connector to the wire. Also, apply a small amount of antioxidant to the fork connector (or bare wire) before making the connections to the relay screw terminals.
4.7. Wiring the Isolated Signal Outputs

The 820 Controller simultaneously monitors both input sensors and displays their values on a two-line display located on the front panel. A built-in signal pass-through feature forwards the two analog inputs to two isolated analog outputs (standard 4-20 mA outputs), allowing the values of the input signals to be used as standard 4-20 mA inputs to any device that uses such inputs (for example, a Programmable Logic Controller [PLC] or a Distributed Control System [DCS]). Refer to Figure 4-4.

The 4-20 mA output signals are labeled CH_1+ and CH_1- for output channel 1 positive and negative (respectively), and CH_2+ and CH_2- for output channel 2 positive and negative (respectively). These two analog outputs are isolated from their corresponding inputs and from each other.

![Figure 4-4. Wiring for the Signal Out Screw Terminals](image)

**Recommendations:** Use 18 AWG shielded cable. Fork connectors should be installed on all 820 Controller wiring to provide secure connections. Apply a small amount of antioxidant to the bare wire(s) before crimping a fork connector to the wires. Also, apply a small amount of antioxidant to the fork connectors (or bare wires) before making the connections to the signal out screw terminals.
4.8. Wiring the ModBus Network

ModBus is an open architecture protocol for digital communications using a two-wire RS-485 interface. The 820 Controller (and 810 Controller) has built-in ModBus protocol support as well as screw terminals for incoming and outgoing RS-485 connections.

For applications that use the ModBus network, the RS-485 Port In and Port Out screw terminals may be used. The Port In and Port Out terminals are connected to each other internally. However, two sets of terminals are included to simplify the wiring process (i.e., the ModBus network can pass into the unit on one side and out of the unit – to the next network device – on the other side). Refer to Figure 4-5. For ModBus protocol information, refer to Table 6-1 (on page 6-2).

**Recommendations:** Use 18 AWG shielded cable. Fork connectors should be installed on all 820 Controller wiring to provide secure connections. Apply a small amount of antioxidant to the bare wire(s) before crimping a fork connector to the wires. Also, apply a small amount of antioxidant to the fork connectors (or bare wires) before making the connections to the RS-485 (ModBus) screw terminals.

![Figure 4-5. Wiring for the ModBus (RS-485) Screw Terminals](image)

**Important:** Maintain “A”-to-“A” and “B”-to-“B” connectivity throughout the ModBus RS-485 network.

**Important:** All devices on the ModBus network must share a common ground. When wiring the ModBus connections, use either the PORT_IN GND screw terminal or the PORT_OUT screw terminal screw terminal.
4.9. Wiring the Supply Power

NOTE: The 820 Controller has no internal power supply. It must get power from an external DC source.

The 820 Controller requires a 24 VDC (300 mA) supply to operate. Minor fluctuations in the supply power are tolerated, however, the green power status LED will flash if the supply voltage drops below 20 VDC or rises above 26 VDC.

To supply power to the 820 Controller, connect +24 VDC and GND wires from a dedicated 24 VDC power source to either the PORT_IN screw terminals (+24V and GND, respectively), or the PORT_OUT screw terminals (+24V and GND, respectively). Refer to Figure 4-6.

![Figure 4-6. Wiring Supply Power Using the PORT_IN or PORT_OUT Screw Terminals](image)

Internally, both +24V terminals (PORT_IN and PORT_OUT) are wired together, as are both GND screw terminals. Therefore, power can be provided to either side of the 820 Controller. This feature facilitates the wiring of multiple 820 Controllers with a single power supply. Refer to Figure 4-7.

Recommendations: Use 18 AWG shielded cable. Fork connectors should be installed on all 820 Controller wiring to provide secure connections. Apply a small amount of antioxidant to the bare wire(s) before crimping a fork connector to the wires. Also, apply a small amount of antioxidant to the fork connectors (or bare wires) before making the connections to the supply power screw terminals.
Figure 4-7. Wiring Multiple 820 Controllers with a Single Power Supply

The +24V and GND screw terminals of the PORT_OUT terminal block may be used as 24 VDC supply power for input devices or auxiliary output devices, provided the maximum current draw does not exceed 300 mA.

**Important:** If powering field devices from the same power supply as the 820 Controller, be sure to verify that the power supply is capable of handling the additional load.

# # #
5.1. Introduction

The 820 Controller has an easy-to-use local interface consisting of a 4×2 LED display panel and a set of 4 keys. Through this interface, the operator can program the controller and commission it for operation.

The three diagnostic LEDs and the audible alarm could also be considered part of the user interface in the strictest sense, however, these components have much simpler operation and are discussed in detail in Chapter 3: Hardware Overview and Chapter 6: Operation.

5.2. Display

As discussed in Chapter 3: Hardware Overview, the display of the 820 Controller consists of a 4×2 matrix (4 columns and 2 rows) of 15-segment light emitting diodes (LEDs) located on the front panel of the device. This display is an integral part of the local user interface that may be used to monitor values, configure parameters, and operate the 820 Controller. The display is illustrated in Figure 5-1.

![Figure 5-1. The 820 Controller’s Display: A 4×2 Matrix of 15-Segment LEDs](image)

The display panel shows 2 rows of numbers. The contents of these rows depends on the current mode of operation of the controller. For example, diagnostic information is displayed during startup mode, current input sensor values are displayed during normal working mode, and parameter name, channel number, current value, and a timer are displayed during parameter setup mode. Samples of these displays are shown in Figure 5-2. Detailed discussion of these displays is provided in Chapter 7: General Operation.
In Normal Working Mode, the top line of the display indicates the gas value of channel 1 and the bottom line indicates the value of channel 2. The unit of the reading can be defined as parts per million (ppm), %LEL, or %vol. The display reading has a 3-digit value. Based on gas type and configuration, it may also have one decimal digit. The reading values correspond to the associated input signals. Refer to Figure 5-2.

In Parameter Setup Mode, the top line indicates the option and its original value. The display has a 3-digit value. The bottom line indicates the channel number and the remainder time (in seconds) before a timeout occurs. Refer to Figure 5-2.

5.3. Using the Keypad Interface

The five keys on the front panel, in conjunction with the display, complete the local user interface. Generally, the MODE key is used to change between the different operating modes of the controller (for example, startup mode, normal mode, and parameter setup mode). The up and down arrow keys are used to scroll information on the display or increment/decrement numerical values, and the Enter/Return key is used to accept values or confirm operations. The keys and their locations on the front panel are shown in Figure 5-3 and their functions are summarized in Table 5-1.
### Table 5-1. Summary of Keypad Functions

<table>
<thead>
<tr>
<th>Key</th>
<th>Name</th>
<th>Description/Function</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image" alt="Mode" /></td>
<td>Mode</td>
<td>This key is used to change between the different operating modes of the controller (for example, startup mode, normal mode, and parameter setup mode). It can also be used to cancel the current operation.</td>
</tr>
<tr>
<td><img src="image" alt="Up Arrow" /></td>
<td>Up Arrow</td>
<td>This key is used to scroll information up on the display or increment numerical values.</td>
</tr>
<tr>
<td><img src="image" alt="Down Arrow" /></td>
<td>Down Arrow</td>
<td>This key is used to scroll information down on the display or decrement numerical values.</td>
</tr>
<tr>
<td><img src="image" alt="Enter/Return" /></td>
<td>Enter/Return</td>
<td>This key is used to accept values or confirm operations.</td>
</tr>
<tr>
<td><img src="image" alt="Alarm Silence" /></td>
<td>Alarm Silence</td>
<td>This key is used to shut off the audible alarm.</td>
</tr>
</tbody>
</table>

### 5.4. Restricted Access: The Password Protection Feature

The user interface provides complete access to configuration parameters of the 820 Controller. While this may be convenient, it also presents security and safety concerns. To maintain its ease-of-use while providing a degree of security, the local user interface has a password protection feature.

Password authentication is intended to:

- reduce accidental parameter changes
- deter unauthorized access.

**NOTE:** The default password for the 820 Controller is 1234.

A password prompt is displayed anytime the operator attempts to make changes to the controller by accessing a secured area of the controller. This includes attempts to access the Parameter Setup Mode (discussed later in this manual). A sample password prompt is shown in Figure 5-4.
Figure 5-4. Password Prompt and Default Password Displays

#  #  #
6.1. Introduction

**NOTE:** The ModBus interface is an optional interface of the 820 Controller. If the controller you are using is a stand-alone device, this chapter may be skipped.

The 820 Controller has a ModBus serial line protocol for communications to ModBus master devices. Some important facts about the ModBus serial line protocol and interface used by the 820 Controller include the following.

- The ModBus interface uses a master/slave protocol.
- The 820 Controller is a ModBus slave device.
- Only one master may be connected to the bus at any given time.
- One to 247 slaves may be connected to the same serial bus.
- Every device on the network (master and slave) must have a unique address.
- The master unit always initiates ModBus communications.
- The master unit initiates only one MODBUS transaction at a time.
- Slave units never transmit data without first receiving a request from the master unit.
- Slave units never communicate with each other.
- Only one unit on the bus is permitted to communicate at any given time.
- A common conductor must connect all devices on the ModBus network.
- The 820 Controller uses a 2-wire electrical interface that conforms to the TIA/EIA-485 (formerly RS-485) physical interface standard.

**Important:** To ensure proper serial communications, be sure to maintain consistent polarity of the balanced pair throughout the length of the ModBus network. That is, all 485A lines must be connected, and all 485B lines must be connected. Never cross 485A lines and 485B lines. Also, a “common” conductor must connect all devices on the ModBus network.

**Important:** When commissioning master and slave units on a ModBus network, it is critical to ensure that every device on the ModBus network must have a unique address. Otherwise, abnormal behavior of the entire serial bus can occur.

Additional ModBus characteristics for the 820 Controller are listed in Table 6-1.
### Table 6-1. Summary of ModBus Characteristics for the 820 Controller

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hardware</td>
<td>2-wire mode (not 4-wire)</td>
</tr>
<tr>
<td>Electrical Standard</td>
<td>TIA/EIA-485</td>
</tr>
<tr>
<td>Transmission Mode</td>
<td>RTU mode (not ASCII)</td>
</tr>
<tr>
<td>Message Coding System</td>
<td>8-bit</td>
</tr>
<tr>
<td>Start Bits</td>
<td>1</td>
</tr>
<tr>
<td>Data Bits</td>
<td>8 (LSB sent first)</td>
</tr>
<tr>
<td>Parity Bits</td>
<td>0</td>
</tr>
<tr>
<td>Stop Bits</td>
<td>2</td>
</tr>
<tr>
<td>Baud Rate</td>
<td>9600</td>
</tr>
<tr>
<td>Maximum Number of Slave Devices</td>
<td>247</td>
</tr>
<tr>
<td>Modbus Address Range for Slave Devices</td>
<td>1-247</td>
</tr>
</tbody>
</table>

### 6.2. ModBus Device Communications – Same Manufacturer

The 820 Controller and the 810 Controller are completely compatible and may be connected on the ModBus network to allow sensor sharing. Having a common manufacturer ensures compatibility and simplifies installation and commissioning.

ModBus applications that use an 810 Controller as a master, and one or more 820 Controllers as slaves simply daisy-chain the 485A and 485B balanced pair from one device to the next as illustrated in Chapter 4: System Wiring. A sample architecture diagram is shown in Figure 6-1.

![Figure 6-1. Sample ModBus Master/Slave Application Architecture](attachment:modbus_network_diagram.png)
6.3. ModBus Device Communications – Different Manufacturer

When connecting ModBus remote terminal units (RTUs) of different manufacturers to the same ModBus network, it is prudent to verify network protocol conformity between devices. Refer to the technical specifications of the RTU devices to ensure that all devices on the network are using the same ModBus standards and conventions. A sample architecture diagram is shown in Figure 6-2.

![Sample ModBus Remote Control Host Architecture](image)

Figure 6-2. Sample ModBus Remote Control Host Architecture

6.4. ModBus Register List

The integration of a ModBus-compatible host device into a ModBus network of 820 Controllers requires a detailed understanding of ModBus protocol in general and, more specifically, the register addresses used by the 820 Controllers. These addresses are provided in Table 6-2.

<table>
<thead>
<tr>
<th>Addr</th>
<th>Inst R/W</th>
<th>Host R/W</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
</table>
| 40101| R/W      | R/W      | MSB = $01 to $FF  
LSB = $01 to $F7 | **Sensor Type**  
Holds the sensor instrument type code and ModBus address. The most significant byte (MSB) holds a value indicating the type of instrument (see below). The least significant byte (LSB) holds a value which is the ModBus address of the sensor.  
MSB = Instrument type code  
$01 = BBIR (broad band infrared)  
$03 = BBIR (broad band infrared)  
$04 = TOX (toxic) |
### Address Information

<table>
<thead>
<tr>
<th>Addr</th>
<th>Inst R/W</th>
<th>Host R/W</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
</table>
|      |          |          |       | $05 = OXY (oxygen)  
          |          |          | $06 = AAW (toxic)  
          |          |          | $07 = CAT (catalytic)  
          |          |          | LSB = MODBUS sensor address $01 to $F7  
          |          |          | (1 to 247) | |
| 40102 | W       | R       | $0000 to $FFFF | **Gas Reading**  
          |          |          | Holds the gas reading in PPM or percent depending  
          |          |          | upon the sensor in the instrument. The range is  
          |          |          | from $0000 to $FFFF and represents a signed  
          |          |          | decimal value range from -32768 to +32767.  
          |          |          | Examples:  
          |          |          | +5 PPM = register value of $0005  
          |          |          | -5 PPM = reg value of $FFFF | |
| 40103 | R*      | R/W*    | MSB = $01 to $FF  
          |          |          | LSB = $01 to $FF | **Gas Type**  
          |          |          | Holds the decimal place holder and the gas type  
          |          |          | code. The most significant byte (MSB) holds the  
          |          |          | number of decimal places to be used in calculations  
          |          |          | for this gas. This decimal locator applies to all  
          |          |          | subsequent values of gas readings within other  
          |          |          | registers. This can be read by the instrument. The  
          |          |          | least significant byte (LSB) holds a code which  
          |          |          | identifies the gas type. This can be read and written  
          |          |          | by the host.  
          |          |          | MSB = Decimal place holder  
          |          |          | $01 to $FF  
          |          |          | LSB = Gas type code  
          |          |          | $01 to $FF  
          |          |          | $01 CO Carbon Monoxide  
          |          |          | $02 H2S Hydrogen Sulfide  
          |          |          | $03 SO2 Sulfur Dioxide  
          |          |          | $04 NO2 Nitrogen Dioxide  
          |          |          | $05 Cl2 Chlorine  
          |          |          | $06 ClO2 Chlorine Dioxide  
          |          |          | $07 HCN Hydrogen Cyanide  
          |          |          | $08 PH3 Phosphine  
          |          |          | $09 H2 Hydrogen  
          |          |          | $0C NO Nitric Oxide  
          |          |          | $0D NH3 Ammonia  
          |          |          | $0E HCl Hydrogen Chloride  
          |          |          | $14 O2 Oxygen  
          |          |          | $15 CH4 Methane  
          |          |          | $16 LEL Lower Explosive Limit  
          |          |          | (Combustible Gases) |
### Status Bits
Holds 16 bits of status for various parameters in the instrument. A bit value of “1” indicates that the associated fault condition is present.

<table>
<thead>
<tr>
<th>Bit</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>current loop open</td>
</tr>
<tr>
<td>14</td>
<td>current loop shorted</td>
</tr>
<tr>
<td>13</td>
<td>power fault</td>
</tr>
<tr>
<td>12</td>
<td>5 volt fault</td>
</tr>
<tr>
<td>11</td>
<td>missing sensor</td>
</tr>
<tr>
<td>10</td>
<td>(not defined)</td>
</tr>
<tr>
<td>9</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>zero fault</td>
</tr>
<tr>
<td>4</td>
<td>calibration fault</td>
</tr>
<tr>
<td>3</td>
<td>over-range</td>
</tr>
<tr>
<td>2</td>
<td>failed sensor</td>
</tr>
<tr>
<td>1</td>
<td>high alarm</td>
</tr>
<tr>
<td>0</td>
<td>low alarm</td>
</tr>
</tbody>
</table>

**Examples:**
- Missing sensor = Bit 11 is set = $0800
- Power fault and failed sensor = Bits 13 and 2 set = $2004

### Last Alarm Date (mmdd)
Holds the month and day when the instrument had the last alarm.

- High byte = $01 to $0C
- Low byte = $01 to $1F

**Examples:**
- Dec 25 is represented as $0C19
- June 31 is represented as $061F

### Last Alarm Date (00yy)
Holds the last two digits of the year when the instrument was last in alarm. The first two digits are assumed to be “20”.

- High byte = $00
### ModBus Interface

**820 Controller Fixed Monitoring System**

<table>
<thead>
<tr>
<th>Addr</th>
<th>Inst R/W</th>
<th>Host R/W</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Low byte = $02 to $63</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>Examples:</strong> 2002 is represented by $02 2099 is represented by $63</td>
</tr>
<tr>
<td>40117</td>
<td>R</td>
<td>R/W</td>
<td>MSB = $01 to $0C, LSB = $01 to $1F</td>
<td><strong>RTC Month and Day</strong>  Holds the month and day to which the real time clock (RTC) calendar should be set. The most significant byte (MSB) represents the month from $01 to $0C (1-12). The least significant byte (LSB) represents the day of the month from $01 to $1F (1-31).  <strong>Examples:</strong> December 25 = $0C19 June 31 = $061F</td>
</tr>
<tr>
<td>40118</td>
<td>R</td>
<td>R/W</td>
<td>$0002 to $0063</td>
<td><strong>RTC Year (00yy)</strong>  Holds the year to which the real time clock (RTC) should be set. The most significant byte (MSB) is always $00. The least significant byte (LSB) represents the two-digit year (within the 21st century), from $02 (which represents 2002) to $063 (which represents 2099).  <strong>Examples:</strong> 2002 = $02 (+ base year of 2000) = $0002 2010 = $10 (+ base year of 2000) = $000A 2099 = $99 (+ base year of 2000) = $0063</td>
</tr>
<tr>
<td>40119</td>
<td>R</td>
<td>R/W</td>
<td>MSB = $00 to $18, LSB = $00 to $3C</td>
<td><strong>RTC Hours and Minutes</strong>  Holds the hours and minutes to which the RTC should be set. The most significant byte (MSB) represents the hour from $00 to $18 (00-24). The least significant byte (LSB) represents the minutes from $00 to $3C (00 to 60). Note that the seconds default to zero ($00) each time the hours and minutes are set.  <strong>Examples:</strong> 13:05 = $0D05 24:00 = $1800</td>
</tr>
</tbody>
</table>
### 6.5. ModBus Resources

ModBus is a public protocol that can be freely adopted by any developer or manufacturer desiring to implement it. While a detailed discussion of ModBus protocol is beyond the scope of this manual, there are a number of up-to-date resources available on the internet for those wishing to investigate ModBus further. The most complete resource is www.modbus.org.

<table>
<thead>
<tr>
<th>Addr</th>
<th>Inst R/W</th>
<th>Host R/W</th>
<th>Range</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>40124</td>
<td>R</td>
<td>R/W</td>
<td>$0000 to $FFFF</td>
<td><strong>Low Alarm Display Setting</strong>&lt;br&gt;Holds the value of the gas reading at which the low alarm display will activate.</td>
</tr>
<tr>
<td>40125</td>
<td>R</td>
<td>R/W</td>
<td>$0000 to $FFFF</td>
<td><strong>High Alarm Display Setting</strong>&lt;br&gt;Holds the value of the gas reading at which the high alarm display will activate.</td>
</tr>
<tr>
<td>40126</td>
<td>R</td>
<td>R/W</td>
<td>$0000 to $03E8</td>
<td><strong>Cal Gas Value</strong>&lt;br&gt;Holds the value of the calibration gas to be used on the instrument. The range is from $0000 to $03E8 (0 to 10000).</td>
</tr>
<tr>
<td>40127</td>
<td>R/W</td>
<td>R</td>
<td>$0000 to $FFFF</td>
<td><strong>Loop High Scaling</strong>&lt;br&gt;Holds a value which indicates the gas reading represented by a 20 mA loop output signal. The range is from $0000 to $FFFF.</td>
</tr>
<tr>
<td>40130</td>
<td>R/W</td>
<td>R</td>
<td>$0000 to $FFFF</td>
<td><strong>Loop Low Scaling</strong>&lt;br&gt;Holds a value which indicates the gas reading represented by a 4 mA loop output signal. The range is from $0000 to $FFFF.</td>
</tr>
</tbody>
</table>
7.1. Introduction

This chapter provides information on the general operation of the 820 Controller. The modes of operation are explained in detail in this section.

7.2. Modes of Operation

The 820 Controller has 4 modes of operation:

- Startup Mode
- Normal Working Mode
- Parameter Setup Mode
- System Setup Mode (factory use only).

Each mode of operation is discussed in the sections that follow.

7.3. Startup Mode

After the 820 Controller is powered on (connected to a 24 VDC power supply) or reset, it enters startup mode. Startup mode on the 820 Controller is a self-check state. In this mode, the controller starts a series of diagnostic tests during which it checks the software version number, verifies the input signals, tests every segment of the display panel, checks the diagnostic LEDs (Alarm, Fault, and Power), and activates the built-in audible alarm. At this time, a “Self Test” message is displayed. Refer to Figure 7-1.

After the self-check and system initialization is finished, the LED will display the software version for approximately 5 seconds. Refer to Figure 7-1.

Figure 7-1. Display During Startup Mode: Self Test Screen
After the self test screen is displayed (approximately 5 seconds), the system checks the analog signals of the two input devices (sensor 1 and sensor 2). The display will show the gas type associated with each channel. If an input channel is disabled (by the user), the display will show “OFF”, which means the signal of the associated channel is not being used. In this case, the controller will not monitor this channel. Figure 7-2 shows channel 1 configured as a carbon monoxide sensor (“CO”), and shows channel 2 as disabled (“OFF”).

A list of sensor types recognized by the 820 Controller is provided in Table 7-1. This table also lists the corresponding displays that are shown during startup mode, and the gas type numbers in both hexadecimal (shown with a “$” prefix) and decimal (in parentheses).

### Table 7-1. Sensor Types and Displays

<table>
<thead>
<tr>
<th>Display</th>
<th>Symbol</th>
<th>Sensor Type</th>
<th>Gas Type #</th>
<th>Display</th>
<th>Symbol</th>
<th>Sensor Type</th>
<th>Gas Type #</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>CO</td>
<td>Carbon Monoxide</td>
<td>$01 (1)</td>
<td>C12</td>
<td>Cl₂</td>
<td>Chlorine</td>
<td>$06 (6)</td>
</tr>
<tr>
<td>H₂S</td>
<td>H₂S</td>
<td>Hydrogen Sulfide</td>
<td>$02 (2)</td>
<td>CH4</td>
<td>CH₄</td>
<td>Methane</td>
<td>$07 (7)</td>
</tr>
<tr>
<td>NO₂</td>
<td>NO₂</td>
<td>Nitrogen Dioxide</td>
<td>$03 (3)</td>
<td>LEL</td>
<td>n/a</td>
<td>Lower Explosive Limit</td>
<td>$08 (8)</td>
</tr>
<tr>
<td>SO₂</td>
<td>SO₂</td>
<td>Sulfur Dioxide</td>
<td>$04 (4)</td>
<td>ClO₂</td>
<td>ClO₂</td>
<td>Chlorine Dioxide</td>
<td>$09 (9)</td>
</tr>
<tr>
<td>O₂</td>
<td>O₂</td>
<td>Oxygen</td>
<td>$05 (5)</td>
<td>H₂</td>
<td>H₂</td>
<td>Hydrogen</td>
<td>$0C (12)</td>
</tr>
</tbody>
</table>

**NOTE:** During startup mode, the 820 Controller does not monitor input signals and does not issue alarms.

At this point, the self-check is complete, and the 820 Controller switches from startup mode to normal working mode.
7.4. Normal Working Mode

7.4.1. Overview

After the 820 Controller completes its self check, it enters normal working mode. In this state, the 820 Controller monitors the two analog input channels and displays their respective readings. If something abnormal happens during this monitoring process, the 820 Controller will issue the appropriate alarm. At the same time, the two 4-20 mA output channels will output separate and isolated 4-20 mA analog signals that are equivalent to the corresponding input values.

In Normal Working Mode, the controller may be in one of four states:

- Calibration State
- Normal Watch State
- Alarm State
- Fault State.

These states are described in Table 7-2.

Table 7-2. Descriptions of Operation States in Normal Working Mode

<table>
<thead>
<tr>
<th>State</th>
<th>Description</th>
<th>Display Characteristics</th>
<th>Sample Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>Normal Watch State</td>
<td>Normal working state</td>
<td>Channel 1 value on top. Channel 2 value on bottom. Solid display.</td>
<td><img src="image" alt="Sample Display" /></td>
</tr>
<tr>
<td>Alarm State</td>
<td>An input signal is above or below its programmed alarm value</td>
<td>Channel 1 value on top. Channel 2 value on bottom. Display flashes if in alarm.</td>
<td><img src="image" alt="Sample Display" /></td>
</tr>
<tr>
<td>Fault State</td>
<td>An input signal is invalid</td>
<td>Channel 1 value on top. Channel 2 value on bottom. “FAUL” is displayed if an input signal is invalid.</td>
<td><img src="image" alt="Sample Display" /></td>
</tr>
<tr>
<td>Calibration State</td>
<td>An input signal is 3 mA indicating either the field device is calibrating or in power-up mode</td>
<td>CAL is displayed</td>
<td><img src="image" alt="Sample Display" /></td>
</tr>
</tbody>
</table>
7.4.2. Calibration State

The 820 Controller enters the calibration state:

- if a field device is calibrating
- upon power-up.

Upon power-up, the 820 Controller enters calibration mode automatically. To signal the 820 Controller that a field device is calibrating, the field device drops its input signal to 3 mA. The 820 Controller is programmed to treat a 3 mA input signal as a field device calibration and not a fault state. During calibration state, CAL is displayed on the front of the 820 Controller. Refer to Figure 7-3.

![Figure 7-3. Sample Display During Calibration State](image)

7.4.3. Normal Watch State

After the power-up and self-check is finished, the controller enters normal working mode. At this time, the controller starts to watch the signals of each input channel and displays the gas readings on the front panel of the controller. This is the normal watch state. Refer to Figure 7-4. Also, if a resistance (load) is connected to the output signal screw terminals, the 820 Controller will output a standard, isolated, 4-20mA current signal that is equivalent to the corresponding input channel.

**NOTE:** The display shows the values of the 2 input channels. If one channel is disabled by user, it will show “OFF”, indicating the channel is closed. The controller does not watch a disabled channel. Even if the signal is restored, it will still display “OFF” until the channel is re-opened.
7.4.4. Alarm State

If an input sensor reading rises above or drops below the programmed limits for the input channel, the controller enters the alarm state (a high or low limit alarm is generated). When in the alarm state, the corresponding line of the display blinks the current value of the input, indicating that the associated input is in an alarm state. See Figure 7-5. Simultaneously, the 820 Controller activates the audible alarm. In addition, red alarm LED will be lighted to show that the controller is in the alarm state. If a resistance (load) is connected to the output signal screw terminals, the 820 Controller will output a standard, isolated, 4-20mA current signal that is equivalent to the corresponding input channel. Finally, the corresponding relay output will be activated (closed) based on the type of alarm, and an alarm entry is made in the alarm record table for the associated channel.

NOTE: For oxygen sensors, the 820 Controller assumes a nominal oxygen value for normal operation. The 820 Controller will generate appropriate alarms for readings above the high-limit alarm set point or readings below the low-limit alarm set point.
7.4.5. Fault State

If an abnormality occurs (for example, an invalid input signal), the controller enters the fault state (a fault alarm is generated). Examples of invalid input signals include values of less than 3 mA (or even an open circuit) or values above 20 mA (or even a short circuit) for a 4-20 mA input device. Inputs at these extremes are beyond the testing range, and are considered to be illegal. In such cases, the controller assumes that the input sensor does not exist (or has failed), and the system enters a fault state. At this time, the corresponding channel will show a flashing “FAUL” in the display (see Figure 7-6) and the controller will issue an audible alert. In addition, the fault relay output (relay output #5) responds as programmed, the fault LED flashes, and a fault entry is made in the alarm record table for the associated channel. Whatever the input signal is missing or over-range, the corresponding 4-20 mA output will produce an illegal current signal.

NOTE: An input value of 3 mA indicates that the field device is calibrating. As a result, the 820 Controller will indicate calibration state (see Figure 7-3).

![Channel 1 Fault Detected]

Figure 7-6. Sample Display During a Sensor 1 Fault State (Top Row is Flashing)

Although a variety of “units” may be assigned to input sensors for easy human reference, the controller uses (and expects) values between 4 mA and 20 mA. Generally, as the input values extend to these outer limits (and beyond), the 820 Controller passes through different states of operation. Actions of increasing importance are initiated by the controller as it passes through these states. These actions include audible alerts being activated, LEDs flashing, the display blinking, alarm record table entries being added, auxiliary relay circuits being energized, etc. An analysis of these states and actions is shown in Figure 7-7.
7.4.6. Power Supply Monitor

The power supply is detected when the 820 Controller is operating. If the controller detects that the 24 VDC supply voltage is within acceptable operating limits (20 VDC to 26 VDC), then the green power light is on. If the supply voltage is outside acceptable limits (lower than 20 VDC or higher than 26 VDC), the green power LED will blink.

**CAUTION:** If the 820 Controller is permitted to operate with supply power that is outside acceptable operating limits, irreparable damage may occur to the controller. If the power LED flashes, shut down the controller immediately and correct the supply power problem.

7.4.7. Alarm Logs

820 Controller can log up to 4 records of alarms for each channel. When an alarm occurs, it is automatically recorded to the appropriate alarm history table within the memory of the 820 Controller. The table is a first-in-first-out (FIFO) queue. After four alarms occur, a fifth alarm causes the oldest alarm to be discarded. Only the four most recent alarms are saved in the alarm table for each channel.

To view the alarm record, simultaneously press the up arrow key and the enter key ("↑" + "↵") to look through alarm records of channel 1. Press the down arrow key and the enter key ("↓" + "↵") to look through alarm records of channel 2.

The top line of the display indicates the time and date of the alarm or fault. The format is given in "yyyy-mm-dd, hh-mm" format, where:
General Operation     820 Controller Fixed Monitoring System

\[ yyyy \] is the year displayed as 4 digits (e.g., 2005)
\[ mm \] is the 2-digit month (01=January, 02=February, etc.)
\[ dd \] is the 2-digit day of the month (01-31)
\[ hh \] is the 2-digit hour (00=midnight, 01=1:00 AM, 12=noon, 13=1:00 PM, 23=11:00 PM, etc.)
\[ mm \] is the 2-digit minute (00-59).

The bottom line of the display indicates the channel and record number. A sample alarm record is shown in Figure 7-8.

NOTE: Use the up and down arrow keys to scroll the alarm display.

Figure 7-8. Sample Alarm Record

7.5. Parameter Setup Mode

7.5.1. Introduction

Parameter setup mode is the third of four modes of operation. This mode is used to configure the 820 Controller for operation by adjusting the values of operating parameters that are stored in the memory of the controller. Modifications made to these parameter can change the operating behavior of the controller, therefore access is secured using a password and should be limited to only qualified personnel.

7.5.2. The Password Prompt

CAUTION: Access to the parameter setup menu is protected by a 4-digit password. This password helps to prevent unauthorized or accidental changes to the system operating parameters. Access to the parameter setup mode should only be given to qualified personal. Unauthorized access can result in improper parameter settings, undesirable operation, and an unsafe environment.

To access the parameter setup mode, press the MODE button. The 820 Controller will request a password for security (see Figure 7-9). The password is a 4-bit decimal number. The default password is “1234” (see Figure 7-9). Press “↑” or “↓” to input each number, and then press the
enter key ("\n") to move to the next digit. After the fourth digit is entered, the 820 Controller enters Setup Mode. If the password input is not correct, or if a timeout occurs, the system will exit and return to normal working mode.

Figure 7-9. Password Prompt and Default Password for Entering Parameter Setup Mode

7.5.3. Parameter Access

You can change parameters by pressing the 4 keys on front panel. The following parameters can be set from the parameter setup menu:

- High alarm values for channels 1 and 2
- Low alarm values for channels 1 and 2
- Test range limit for channels 1 and 2
- Operating modes for relays 1 through 5 (see Table 4-1 on page 3-4)
- The detected gas type for channels 1 and 2 (see Table 7-1 on page 7-2).

The 820 Controller contains configuration parameters for both input channels. To select which channel you want to configure, press the up arrow or down arrow keys ("\n" or "\n"), and then press the enter key ("\n") to confirm your selection. Refer to Figure 7-10.

After the desired channel is selected, the display will show the first of a list of parameters for that channel that can be modified. Refer to Figure 7-11. The first line indicates the setup option ("L" means low limit, "H" means high limit) and original value (200). The second line shows the channel indicator ("1." means channel 1, "2" means channel 2) and the time remainder (counting down in seconds) before the operation times out.

Figure 7-10. Selecting the Desired Channel for Parameter Access
Figure 7-11. Sample Display of a Parameter Ready to Be Modified
7.5.4. Changing Alarm Values

After the desired channel is selected, use the up and down arrow keys to locate the desired alarm parameter to be changed. “L.” means low alarm option and “H.” means high alarm option. When the desired parameter appears on the display, press the ENTER key (“<CR>”) to change the value. Refer to Figure 7-12 for sample displays of high and low alarm displays.

![Figure 7-12. Sample Low and High Alarm Displays](image)

Press the up or down arrow keys ("↑" or "↓") to change the displayed value to the desired value. When the display shows the desired new value, press the ENTER key ("<CR>") to confirm the change. You can press the MODE key to cancel the operation or wait until the timer times out. In these cases, the parameter value returns to its previous programmed value.

**Important:** The high alarm value cannot exceed the maximum measuring range, and the low alarm value cannot exceed the high alarm value.

7.5.5. Changing a Sensor’s Gas Type: The Gas Type Setup Menu

After the desired channel is selected, you use the up and down arrow keys ("↑" and "↓") to locate the Gas Type Setup Menu. Press the ENTER key ("<CR>") to confirm this selection. Refer to Figure 7-13.

![Figure 7-13. Sample Display of Gas Type Setup Menu](image)
820 Controller supports 4-20 mA sensors that monitor the environment for the types of gas listed and described in Table 7-3.

Press “↑” or “↓” to select the gas type you want to assign to the previously selected input (channel 1 or channel 2), and then press the ENTER key (“↵”) to confirm. The 820 Controller saves this gas type information and also defines the test range and default alarm values accordingly. You can cancel this operation by pressing MODE to return to the previous menu. A sample gas type selection display is shown in Figure 7-14. A list of gas parameter options is shown in Table 7-3.

To deactivate a channel’s input sensor, you must select the “OFF” type from the list. Refer to Figure 7-15. When this is done, the 820 Controller no longer watches the input signal. In Normal Watching Mode, the display will show “OFF” for the associated channel. Refer to Figure 7-15.
### Table 7-3. Gas Parameters

<table>
<thead>
<tr>
<th>Gas Name</th>
<th>Abbr</th>
<th>Test Range</th>
<th>Resolution</th>
<th>Default Low Alarm</th>
<th>Default High Alarm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Carbon Monoxide</td>
<td>CO</td>
<td>0-999 ppm with all sensor modules</td>
<td>1 ppm</td>
<td>35 ppm</td>
<td>70 ppm</td>
</tr>
<tr>
<td>Hydrogen Sulfide</td>
<td>H₂S</td>
<td>0-999 ppm with all sensor modules</td>
<td>1 ppm</td>
<td>10 ppm</td>
<td>20 ppm</td>
</tr>
<tr>
<td>Nitrogen Dioxide</td>
<td>NO₂</td>
<td>0-99.9 ppm with all sensor modules</td>
<td>0.1 ppm</td>
<td>3 ppm</td>
<td>6 ppm</td>
</tr>
<tr>
<td>Sulfur Dioxide</td>
<td>SO₂</td>
<td>0-99.9 ppm with all sensor modules</td>
<td>0.1 ppm</td>
<td>2 ppm</td>
<td>4 ppm</td>
</tr>
<tr>
<td>Oxygen</td>
<td>O₂</td>
<td>0-30% by volume with all sensor modules</td>
<td>0.1% of volume</td>
<td>19.5% of volume</td>
<td>23.5% of volume</td>
</tr>
<tr>
<td>Chlorine</td>
<td>Cl₂</td>
<td>0-99.9 ppm with all sensor modules</td>
<td>0.1 ppm</td>
<td>0.5 ppm</td>
<td>1 ppm</td>
</tr>
<tr>
<td>Methane</td>
<td>CH₄</td>
<td>0-100% by volume with all sensor modules</td>
<td>0.1% of volume</td>
<td>1.0% of volume</td>
<td>1.5% of volume</td>
</tr>
<tr>
<td>LEL</td>
<td>LEL</td>
<td>0-100% LEL (combustible gases)</td>
<td>1% LEL</td>
<td>10% LEL</td>
<td>20% LEL</td>
</tr>
<tr>
<td>Chlorine Dioxide</td>
<td>ClO₂</td>
<td>0-2.0 ppm with all sensor modules</td>
<td>0.1 ppm</td>
<td>0.1 ppm</td>
<td>0.2 ppm</td>
</tr>
<tr>
<td>Hydrogen</td>
<td>H₂</td>
<td>0-999 ppm with all sensor modules</td>
<td>1 ppm</td>
<td>50 ppm</td>
<td>100 ppm</td>
</tr>
</tbody>
</table>

**7.5.6. Changing the Test Range Limit of a Channel: The Set Test Range Limit Menu**

You can change the test range limit of a sensor used by the 820 Controller if an appropriate pre-defined sensor range is not available in Table 7-3. After the desired channel is selected, the display will show the first of a list of parameters for that channel that can be modified. Press “↑” or “↓” to select the *set test range limit* parameter for the previously selected input (channel 1 or channel 2), and then press the ENTER key (“↵”) to confirm. Refer to Figure 7-16.

The first line indicates the test range option (“S” means Set Test Range) and original value (999). The second line shows the channel indicator (“1.” means channel 1, “2” means channel 2) and the time remainder (counting down in seconds) before the operation times out. Press the ENTER key (“↵”) to change the value.
Press the up or down arrow keys ("↑" or "↓") to change the displayed value to the desired value. When the display shows the desired new value, press the ENTER key ("↵") to confirm the change. Refer to Figure 7-17.

You can press the MODE key to cancel the operation or wait until the timer times out. In these cases, the parameter value returns to its previous programmed value.

![Figure 7-16. Sample Display of Change Test Range Menu](image1)

![Figure 7-17. Sample Test Range Display: New Value of 900 PPM](image2)

7.5.7. Clearing the Records of a Channel: The Clear Record Menu

Each channel has a 4-record history of alarms that have occurred. This alarm record can be cleared by selecting the desired channel and accessing the **Clear Record Menu**. From the Clear Record Menu, you can clear all the records associated with this channel. The Clear Record Menu is shown in Figure 7-18.

![Figure 7-18. Display Showing The Clear Record Menu](image3)

From this menu, press the ENTER key ("↵") to clear the channel’s records, or press the MENU key to exit this menu.
7.5.8. Changing Relay Settings: The Relay Setting Menu (R)

The 5 alarm relays in the 820 Controller can be programmed to operate in specific ways. For each relay, you can configure one of three possible modes of operation:

- Normal Mode
- Latch Mode
- Inactive Mode.

**Normal Mode** – In this mode, an alarm causes the corresponding relay to close. It will re-open after the alarm state no longer exists (i.e., the condition returns to normal). The relay does not close again until the next associated alarm occurs.

**Latch Mode** – In this mode, once an alarm occurs, the associated relay closes and remains closed (“latched”) until the relay is inactivated by the user or until the system restarts. The relay does not re-open if the sensor reading returns to normal.

**Inactive Mode** – In this mode, the relay output remains inactive (open) regardless of the alarm state. Even if an alarm occurs, the relay remains inactive.

Press the Enter key (“↵”) to display the Relay Setting Menu (“R.”). Each channel has 3 relays:

- “R.LOW” is low alarm relay
- “R.HI” is high alarm relay
- “R.FAU” is fault alarm relay.

These are shown in Figure 7-19.

**NOTE:** Although the Fault Relay (“R.FAU”) appears twice (once for each channel), there is really only one fault relay and its operation mode is shared between channel 1 and channel 2.

![Figure 7-19. Relay Parameters (Low, High, and Fault) for Channel 1](image)

After locating the desired relay parameter to modify, press the ENTER key (“↵”) to modify it. Press “↑” or “↓” to change modes of operation for the selected relay.

- “NOR” means Normal Mode
- “LAT” means Latched Mode
- “OFF” means Disabled Mode (make the relay inactive).

Press the ENTER key (“↵”) to confirm your choice, or press the MODE key to cancel this operation. Sample displays are shown in Figure 7-20.
7.5.9. Initiating a Self Test: The Display Test Option

Using the up or down arrow keys ("↑" or "↓"), select the Display Test option (see Figure 7-21).

At the Display Test screen, press the ENTER key ("↵") to initiate a self-test program to identify if the 820 Controller is working properly, including the diagnostic LEDs, the display, and the audible alarm.

7.5.10. Restarting the Controller: The 820 Restart Option

Using the up or down arrow keys ("↑" or "↓"), select the Restart option. The display will show “820 REST” for 820 restart. See Figure 7-22.
At the restart display, press the ENTER key ("↵") to initiate a restart of the 820 Controller without shutting down the power.

7.5.11. Setting the Time and Date: The Set Time Menu

The 820 Controller has a real-time clock that it uses to provide time and date stamps on alarms and faults that occur. Setting the system time and date is accomplished from the Set Time Menu. Using the up or down arrow keys ("↑" or "↓"), select the Set Time Menu and then press the ENTER key ("↵"). The year display is shown. Refer to Figure 7-23.

![Figure 7-23. Set Time Display and the Year Display](image)

At this point, either press the ENTER key ("↵") to select the “Year” parameter for editing, or use the up or down arrow keys ("↑" or "↓") to select a different time and date parameter. The list of time and date parameters include:

- **YEAR** Year (4-digit year, e.g., 2005)
- **MON** Month (2-digit month, where 01=Jan, 02=Feb, etc.)
- **DATE** Date (2-digit date, 01-31)
- **WDAY** Weekday (Sun, Mon, Tue, etc.)
- **HOUR** Hour (2-digit military time, 00-23, where 00=midnight, 01=1:00 AM, 12=noon, 13=1:00 PM, 14=2:00 PM, etc.)
- **MINU** Minute (2-digit minute, 00-59).

When the desired parameter is displayed, press the ENTER key ("↵") to edit the value of that parameter. To edit, use the up or down arrow keys ("↑" or "↓") to change the value, and the ENTER key ("↵") to accept the change. Press the MODE key to exit without changing.

7.6. System Setup Mode (System Settings Menu)

7.6.1. Introduction

The 820 Controller may require additional higher-level parameters to be configured. These special parameters are located in the System Settings Menu and do the following:

- 4-20mA input calibration
- 4-20mA output calibration
- ModBus address setting.
These parameters need to be configured under the following circumstances:

- Before the controller’s initial use
- To recalibrate the inputs and/or outputs after extended use
- To set or change the ModBus address (the unique network ID) of the controller.

CAUTION: The system setup menu should be accessed only at the factory or by the manufacturer’s product engineer. System setup mode is not intended for use by any other person. The system setup menu is password protected to prevent unauthorized access.

7.6.2. Entering System Setup Mode

To access system setup mode, simultaneously press the MODE, “↑” and “↓” keys all at the same time. The 820 Controller will display a password prompt for security. The password is a 4-digit decimal number. Press the “↑” or “↓” keys to input each number, and then press the ENTER key (“↵”) to confirm. If the password input is incorrect, or if a timeout occurs, the controller will exit System Setup Mode. Otherwise, the system setup screen is displayed. Refer to Figure 7-24.

NOTE: The default password for the 820 Controller is 1234.

![Figure 7-24. The System Setup Display]

Important: System Setting can be only used by manufacturer. Other users are forbidden to access.

Press the “↑” or “↓” keys to select the desired option (4-20mA input calibration, 4-20mA output calibration, or ModBus address setting). When the desired option is displayed, press the ENTER key (“↵”) to select the option.
7.6.3. 4-20mA Input Calibration

The analog circuitry of every 820 Controller is slightly different. Likewise, the external environment is different in every 820 Controller application. For these reasons, input circuit calibrations are necessary in order to maintain precise monitoring. The input calibration display is shown Figure 7-25.

![Figure 7-25. The Calibrate Input Display](image)

To begin the input calibration process, connect a current meter to the input circuit and adjust the input current to 20 mA to accomplish 4-20 mA input calibration. Next, connect the channel 1 input circuit to a current source, such as a regulated DC power supply, and connect a current meter to them. Set the input current source to 20.0 mA and press the ENTER key (“↵”) to start the input calibration. The display will show “Good” if the calibration is successful, or it will show “FAIL” if the calibration has failed. Refer to Figure 7-26.

![Figure 7-26. Sample Calibration Displays](image)

After channel 1 is calibrated, the controller will tell you to calibrate channel 2. Follow the same instructions for the second calibration.

7.6.4. 4-20mA Output Calibration

For the same reasons that input calibrations are necessary, output calibrations are also necessary. This is necessary before initial use of the controller, or after extended use. The output calibration occurs at three points over the output range:

- 4 mA
- 14 mA
- 20 mA.

The output calibration display is shown Figure 7-27.

![Figure 7-27. The Calibrate Output Display](image)

To begin the output calibration process, connect a resistance (not more than 300 Ω) and a current meter to the output port. The display on the meter should indicate the output current reading. Select the desired channel to be calibrated and press the ENTER key (“↵”) to confirm. Refer to Figure 7-28.

![Figure 7-28. Output Calibration Displays](image)

“4MA” means we are now calibrating the 4 mA output signal. “1.” means we are now calibrating channel 1. “29” indicates the remainder time before a timeout occurs. Press the “↑” or “↓” key to select the desired current (4 mA in this case) and press the ENTER key (“↵”) to confirm. At this time, the 820 Controller will output a 4 mA current on the selected output channel.

Using the value shown on the current meter, press “↑” or “↓” keys on the controller to increase or decrease the actual output current of the controller (see Figure 7-29). When the reading value is equal to calibration value, press the ENTER key (“↵”) to confirm.
NOTE: The second line on the display (see Figure 7-29) is not the output current. It is an internal calibration constant. The actual calibration must be based on the reading on the current meter.

Figure 7-29. Sample Display During 4 mA Output Current Adjustment

After completing the 4 mA calibration, perform similar calibrations on the other two calibration points (14 mA and 20 mA). Sample displays for these other calibration points are shown in Figure 7-30.

Figure 7-30. Sample Displays During 14 mA and 20 mA Output Current Adjustments

7.6.5. ModBus Address Settings for Input Channels

The 820 Controller can be connected to a serial RS-485 network using ModBus RTU protocol. A network host (that is, a master) can access the 2 analog input channels of the 820 Controller. In public ModBus networking architectures, each input channel on the 820 Controller appears as an independent sensor that is connected to the ModBus network directly. Consequently, they have their own ModBus address.
NOTE: In ModBus network architectures, each input sensor of the 820 Controller has a unique ModBus network address. Each input sensor is treated as a separate ModBus network slave device (RTU).

From the System Setup Mode, press the “↑” or “↓” keys to select the ModBus Addressing option. Press the ENTER key (“↵”) to select this option. Refer to Figure 7-31.

NOTE: ModBus addresses are given in hexadecimal format. To differentiate between hexadecimal and decimal numbers, hexadecimal numbers are always have a prefix “0x”. For a list of decimal and hexadecimal equivalents, refer to Appendix B.

By default, the 820 Controller assigns ModBus addresses 0x60 and 0x61 to input channels 1 and 2, respectively. To change these addresses, press the ENTER key (“↵”) to access the ModBus address setting menu. Refer to Figure 7-32.

The first line shows the ModBus address (in hexadecimal) of sensor 1. The second line shows the ModBus address (in hexadecimal) of sensor 2. Press the “↑” or “↓” keys to change each bit of the address, and press the ENTER key (“↵”) to confirm.
After addresses are provided, the 820 Controller verifies that the two addresses are legal. To be a legal ModBus address, it must be between 0x01 and 0xf7, and it must be unique on the exiting ModBus network. If the setting is legal, “Good” is shown in the associated line of the display (top is channel 1, bottom is channel 2). Refer to Figure 7-33. If the setting is illegal, the display will show “FAIL” for the illegally addressed channel.

Figure 7-33. Display Showing Valid ModBus Addresses for Sensors 1 (Top) and 2 (Bottom)
8.1. Introduction

This chapter provides a check list of steps necessary to commission the 820 Controller for operation. Details of these steps have been discussed earlier in this document. Refer to Chapter 4: Wiring and Chapter 7: General Operation for details.

8.2. Verify Wiring

___ 1. Ensure that all wiring is securely tightened in the appropriate screw terminals of the controller. Refer to Figure 8-1.

___ 2. Verify proper continuity of all network connections.

___ 3. Verify the polarity of the power connection.

Figure 8-1. Wiring Connections of the 820 Controller
8.3. Checking Power Status
   1. With power applied to the controller, verify that the green power LED is on steady (and not blinking. This indicates that the supply power is ON and is within acceptable limits.

8.4. Setting the Time and Date
   1. Access the Set Time option of the Parameter Setup Menu. Set the proper time and date for the alarm and fault entries in the alarm record tables.

8.5. Configuring Input Devices
   1. Verify the configuration of sensor types in the Parameter Setup Menu.
   2. Verify that alarm limit settings for channels 1 and 2 are set appropriately for your particular application.

8.6. Configuring Relay Outputs
   1. Verify proper mode of operation for each of the 5 relay outputs, based on your particular application.

8.7. Set Sensor Addresses for ModBus Applications
   1. If input sensor values are shared over a ModBus network, verify that the default sensor addresses should be 0x60 and 0x61. If different addresses are required, you must have them changed by authorized personnel.
   2. An authorized technician can verify that the ModBus addresses for channels 1 and 2 are valid (between 0x01 and 0xf7) and unique to the network.

8.8. Perform Self Test
   1. Access the Self Test option of the Parameter Setup Menu. Perform the self test to ensure that components are functioning properly.
   2. If input or output calibration is necessary, contact authorized personnel.

#  #  #
9.1. Introduction
This chapter provides troubleshooting information for the 820 Controller.

9.2. Recalibration
Calibration of the 820 Controller should be performed prior to installation. In addition, routine re-calibration of the analog inputs and analog outputs is vital in maintaining safe and reliable monitoring. Recalibration can be performed by authorized personnel using external hardware and the System Setup Mode of the 820 Controller.

9.3. Diagnosing Common Problems
Table 9-1 lists common problems that you may experience during commissioning or operation of the 820 Controller.

Table 9-1. Diagnosing Common Problems

<table>
<thead>
<tr>
<th>Problem</th>
<th>Likely Cause(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Display is blank…</td>
<td>• No power to controller (power LED will be off).</td>
</tr>
<tr>
<td></td>
<td>• Incorrect power (power LED will be flashing).</td>
</tr>
<tr>
<td>Power LED is flashing…</td>
<td>• Incorrect power (below 20 VDC or above 26 VDC).</td>
</tr>
<tr>
<td>ModBus network not functioning as expected…</td>
<td>• Possible non-unique RTU addresses.</td>
</tr>
<tr>
<td></td>
<td>• Inconsistent polarity on the RS-428 network wiring.</td>
</tr>
<tr>
<td></td>
<td>• A common ground is not connected to all RTUs.</td>
</tr>
<tr>
<td>Relay outputs do not function on alarms…</td>
<td>• Relay mode may be disabled.</td>
</tr>
<tr>
<td>Relay outputs do not return to normal state after input condition returns to normal…</td>
<td>• Relay may be in latch mode.</td>
</tr>
</tbody>
</table>
Troubleshooting

820 Controller Fixed Monitoring System

INDUSTRIAL SCIENTIFIC
Version 1.0 (p/n: 18106385)
10.1. Warranty

Industrial Scientific fixed system products are warranted to be free from defects in material and workmanship for a period of eighteen (18) months from the date of shipment, or one (1) year from the date of first use, whichever occurs first, except where otherwise stated in writing in Industrial Scientific literature accompanying the product.

The above warranty does not include sensors, pumps, or filters, all of which are warranted to be free from defects in material and workmanship for one year from the date of shipment, except where otherwise stated in writing in Industrial Scientific literature accompanying the product.

10.2. Limitation of Liability

Industrial Scientific makes no other warranties, either expressed or implied, including but not limited to the warranties of merchantability or fitness for particular purpose.

Should the product fail to conform to the above warranty, buyer’s only remedy and Industrial Scientific’s only obligation shall be, at Industrial Scientific’s sole option, replacement or repair of such non-conforming goods or refund of the original purchase price of the non-conforming goods. In no event will Industrial Scientific be liable for any other special, incidental or consequential damages, including loss of profit or loss of use, arising out of the sale, manufacture or use of any products sold hereunder whether such claim is pleaded in contract or in tort, including strict liability in tort.

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SPECIFICATIONS SUBJECT TO CHANGE

#  #  #
ACRONYMS AND ABBREVIATIONS

This appendix contains acronyms and abbreviations that are used within this document.

Table A-1. Acronyms and Abbreviations

<table>
<thead>
<tr>
<th>Abbr</th>
<th>Definition</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Ampere</td>
</tr>
<tr>
<td>AAW</td>
<td>toxic</td>
</tr>
<tr>
<td>ABS</td>
<td>acrylonitrile butadiene styrene</td>
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<tr>
<td>ASCII</td>
<td>American Standard Code for Information Interchange</td>
</tr>
<tr>
<td>BBIR</td>
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<td>chemical</td>
</tr>
<tr>
<td>Cl₂</td>
<td>chlorine</td>
</tr>
<tr>
<td>ClO₂</td>
<td>chlorine dioxide</td>
</tr>
<tr>
<td>CO</td>
<td>carbon monoxide</td>
</tr>
<tr>
<td>DC</td>
<td>direct current</td>
</tr>
<tr>
<td>DCS</td>
<td>distributed control system</td>
</tr>
<tr>
<td>DISP</td>
<td>display</td>
</tr>
<tr>
<td>F</td>
<td>Fahrenheit</td>
</tr>
<tr>
<td>FAQ</td>
<td>frequently asked questions</td>
</tr>
<tr>
<td>FAUL</td>
<td>fault</td>
</tr>
<tr>
<td>FIFO</td>
<td>first-in-first-out</td>
</tr>
<tr>
<td>GND</td>
<td>ground</td>
</tr>
<tr>
<td>H₂</td>
<td>hydrogen</td>
</tr>
<tr>
<td>H₂S</td>
<td>hydrogen sulfide</td>
</tr>
<tr>
<td>Abbr</td>
<td>Definition</td>
</tr>
<tr>
<td>------</td>
<td>------------</td>
</tr>
<tr>
<td>HCl</td>
<td>hydrogen chloride</td>
</tr>
<tr>
<td>HCN</td>
<td>hydrogen cyanide</td>
</tr>
<tr>
<td>ISC</td>
<td>Industrial Scientific Corporation</td>
</tr>
<tr>
<td>LAT</td>
<td>latch mode</td>
</tr>
<tr>
<td>LED</td>
<td>light emitting diode</td>
</tr>
<tr>
<td>LEL</td>
<td>lower explosive limit (combustible gases)</td>
</tr>
<tr>
<td>LSB</td>
<td>least significant bit</td>
</tr>
<tr>
<td>mA</td>
<td>milliamperes</td>
</tr>
<tr>
<td>MINU</td>
<td>minute</td>
</tr>
<tr>
<td>mm</td>
<td>millimeter</td>
</tr>
<tr>
<td>MON</td>
<td>month</td>
</tr>
<tr>
<td>NC</td>
<td>normally closed</td>
</tr>
<tr>
<td>NEMA</td>
<td>National Electrical Manufacturers Association</td>
</tr>
<tr>
<td>NH₃</td>
<td>ammonia</td>
</tr>
<tr>
<td>NO</td>
<td>normally open, Nitric Oxide</td>
</tr>
<tr>
<td>NO₂</td>
<td>nitrogen dioxide</td>
</tr>
<tr>
<td>NOR</td>
<td>normal mode</td>
</tr>
<tr>
<td>O₂</td>
<td>oxygen</td>
</tr>
<tr>
<td>OXY</td>
<td>oxygen</td>
</tr>
<tr>
<td>PH₃</td>
<td>phosphene</td>
</tr>
<tr>
<td>PLC</td>
<td>programmable logic controller</td>
</tr>
<tr>
<td>ppm</td>
<td>parts per million</td>
</tr>
<tr>
<td>R.HI</td>
<td>high alarm relay</td>
</tr>
<tr>
<td>R.FAU</td>
<td>fault relay</td>
</tr>
<tr>
<td>R.LOW</td>
<td>low alarm relay</td>
</tr>
<tr>
<td>REST</td>
<td>restart</td>
</tr>
<tr>
<td>RTC</td>
<td>real time clock</td>
</tr>
<tr>
<td>RTU</td>
<td>remote terminal unit</td>
</tr>
<tr>
<td>SO₂</td>
<td>sulfur dioxide</td>
</tr>
<tr>
<td>SPST</td>
<td>single-pole, single-throw</td>
</tr>
<tr>
<td>TOX</td>
<td>toxic</td>
</tr>
<tr>
<td>V</td>
<td>Volts</td>
</tr>
<tr>
<td>WDAY</td>
<td>weekday</td>
</tr>
</tbody>
</table>

# # #
This appendix lists the decimal equivalents of hexadecimal numbers. ModBus device addresses are entered in hexadecimal format. This table provides a cross reference if only decimal addresses are known. Hexadecimal numbers are shown in 0x00 format on the left. Decimal equivalents are shown on the right. Refer to Table B-1.

### Table B-1. Decimal and Hexadecimal Equivalents

<table>
<thead>
<tr>
<th>Hexadecimal</th>
<th>Decimal</th>
</tr>
</thead>
<tbody>
<tr>
<td>0x00 = 000</td>
<td>0</td>
</tr>
<tr>
<td>0x01 = 001</td>
<td>1</td>
</tr>
<tr>
<td>0x02 = 002</td>
<td>2</td>
</tr>
<tr>
<td>0x03 = 003</td>
<td>3</td>
</tr>
<tr>
<td>0x04 = 004</td>
<td>4</td>
</tr>
<tr>
<td>0x05 = 005</td>
<td>5</td>
</tr>
<tr>
<td>0x06 = 006</td>
<td>6</td>
</tr>
<tr>
<td>0x07 = 007</td>
<td>7</td>
</tr>
<tr>
<td>0x08 = 008</td>
<td>8</td>
</tr>
<tr>
<td>0x09 = 009</td>
<td>9</td>
</tr>
<tr>
<td>0x0A = 010</td>
<td>10</td>
</tr>
<tr>
<td>0x0B = 011</td>
<td>11</td>
</tr>
<tr>
<td>0x0C = 012</td>
<td>12</td>
</tr>
<tr>
<td>0x0D = 013</td>
<td>13</td>
</tr>
<tr>
<td>0x0E = 014</td>
<td>14</td>
</tr>
<tr>
<td>0x0F = 015</td>
<td>15</td>
</tr>
<tr>
<td>0x10 = 016</td>
<td>16</td>
</tr>
<tr>
<td>0x11 = 017</td>
<td>17</td>
</tr>
<tr>
<td>0x12 = 018</td>
<td>18</td>
</tr>
<tr>
<td>0x13 = 019</td>
<td>19</td>
</tr>
<tr>
<td>0x14 = 020</td>
<td>20</td>
</tr>
<tr>
<td>0x15 = 021</td>
<td>21</td>
</tr>
<tr>
<td>0x16 = 022</td>
<td>22</td>
</tr>
<tr>
<td>0x17 = 023</td>
<td>23</td>
</tr>
<tr>
<td>0x18 = 024</td>
<td>24</td>
</tr>
<tr>
<td>0x19 = 025</td>
<td>25</td>
</tr>
<tr>
<td>0x1A = 026</td>
<td>26</td>
</tr>
<tr>
<td>0x1B = 027</td>
<td>27</td>
</tr>
<tr>
<td>0x1C = 028</td>
<td>28</td>
</tr>
<tr>
<td>0x1D = 029</td>
<td>29</td>
</tr>
<tr>
<td>0x1E = 030</td>
<td>30</td>
</tr>
<tr>
<td>0x1F = 031</td>
<td>31</td>
</tr>
</tbody>
</table>

# # #
This appendix provides a graphical representation of the local flowchart interface. The flowchart is shown in Figure C-1.
Figure C-1. Local Interface Flowchart

# # #
This appendix lists information associated with gases, gas sensors, and the 820 Controller. Refer to Table D-1.

Table D-1. Gas Parameters

<table>
<thead>
<tr>
<th>Gas Name</th>
<th>Abbr</th>
<th>ModBus Gas Ref #</th>
<th>Test Range</th>
<th>Resolution</th>
<th>Cal Gas</th>
<th>Default Low Alarm</th>
<th>Default High Alarm</th>
</tr>
</thead>
<tbody>
<tr>
<td>carbon monoxide</td>
<td>CO</td>
<td>$01 (1)</td>
<td>0-999 ppm</td>
<td>1 ppm</td>
<td>100 ppm</td>
<td>35 ppm</td>
<td>70 ppm</td>
</tr>
<tr>
<td>hydrogen sulfide</td>
<td>H₂S</td>
<td>$02 (2)</td>
<td>0-999 ppm</td>
<td>1 ppm</td>
<td>25</td>
<td>10 ppm</td>
<td>20 ppm</td>
</tr>
<tr>
<td>sulfur dioxide</td>
<td>SO₂</td>
<td>$03 (3)</td>
<td>0-99.9 ppm</td>
<td>0.1 ppm</td>
<td>5</td>
<td>2 ppm</td>
<td>4 ppm</td>
</tr>
<tr>
<td>nitrogen dioxide</td>
<td>NO₂</td>
<td>$04 (4)</td>
<td>0-99.9 ppm</td>
<td>0.1 ppm</td>
<td>5</td>
<td>3 ppm</td>
<td>6 ppm</td>
</tr>
<tr>
<td>chlorine</td>
<td>Cl₂</td>
<td>$05 (5)</td>
<td>0-99.9 ppm</td>
<td>0.1 ppm</td>
<td>10</td>
<td>0.5 ppm</td>
<td>1 ppm</td>
</tr>
<tr>
<td>chlorine dioxide</td>
<td>ClO₂</td>
<td>$06 (6)</td>
<td>0-2.0 ppm</td>
<td>0.01 ppm</td>
<td>1</td>
<td>0.1 ppm</td>
<td>0.2 ppm</td>
</tr>
<tr>
<td>hydrogen cyanide</td>
<td>HCN</td>
<td>$07 (7)</td>
<td>0-30.0 ppm</td>
<td>0.1 ppm</td>
<td>10</td>
<td>5 ppm</td>
<td>10 ppm</td>
</tr>
<tr>
<td>phosphine</td>
<td>PH₃</td>
<td>$08 (8)</td>
<td>0-1.00 ppm</td>
<td>0.01 ppm</td>
<td>0.5</td>
<td>0.3 ppm</td>
<td>0.6 ppm</td>
</tr>
<tr>
<td>hydrogen</td>
<td>H₂</td>
<td>$09 (9)</td>
<td>0-999 ppm</td>
<td>1 ppm</td>
<td>100</td>
<td>50 ppm</td>
<td>100 ppm</td>
</tr>
<tr>
<td>nitric oxide</td>
<td>NO</td>
<td>$0C (12)</td>
<td>0-99.9 ppm</td>
<td>0.1 ppm</td>
<td>25</td>
<td>25 ppm</td>
<td>50 ppm</td>
</tr>
<tr>
<td>ammonia</td>
<td>NH₃</td>
<td>$0D (13)</td>
<td>0-200 ppm</td>
<td>1 ppm</td>
<td>25</td>
<td>25 ppm</td>
<td>50 ppm</td>
</tr>
<tr>
<td>Gas Name</td>
<td>Abbr</td>
<td>ModBus Gas Ref #</td>
<td>Test Range</td>
<td>Resolution</td>
<td>Cal Gas</td>
<td>Default Low Alarm</td>
<td>Default High Alarm</td>
</tr>
<tr>
<td>------------------</td>
<td>------</td>
<td>------------------</td>
<td>--------------------------</td>
<td>------------</td>
<td>---------</td>
<td>-------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>hydrogen chloride</td>
<td>HCl</td>
<td>$0E$ (14)</td>
<td>0-30.0 ppm</td>
<td>0.1 ppm</td>
<td>10</td>
<td>5 ppm</td>
<td>10 ppm</td>
</tr>
<tr>
<td>oxygen</td>
<td>O₂</td>
<td>$14$ (20)</td>
<td>0-30% by volume</td>
<td>0.1% of volume</td>
<td>20.9%</td>
<td>19.5% of volume</td>
<td>23.5% of volume</td>
</tr>
<tr>
<td>methane</td>
<td>CH₄</td>
<td>$15$ (21)</td>
<td>0-100% by volume</td>
<td>0.1% of volume</td>
<td>25%</td>
<td>1.0% of volume</td>
<td>1.5% of volume</td>
</tr>
<tr>
<td>LEL</td>
<td>LEL</td>
<td>$16$ (22)</td>
<td>0-100% LEL (combustible gases)</td>
<td>1% LEL</td>
<td>25% LEL</td>
<td>10% LEL</td>
<td>20% LEL</td>
</tr>
</tbody>
</table>

#  #  #
Index

Locator page numbers appear in regular type faces for standard index references (e.g., 3-7). Boldface index references (e.g., 3-3) correspond to information found in photos or illustrations. Italic index references (e.g., 3-3) correspond to information found in tables.

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