Model IR4000M

Multi-Point Monitor
Modbus programming guide

Instruction Manual Modbus **07-08**

MANIR4000MM

Part No. **MANIR4000M Modbus**
Revision **A/07-08**

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1. MODBUS RTU

1.1 Serial Communications Protocol for IR4000M

The default Modbus setup from the factory is 19200 baud, 8-n-1 format. The default Modbus ID for CH1 is 1, and for CH2 it is 2.These settings can be changed through the user interface using the GMI magnet and selecting the SE menu item. Details can be found in the separate Model IR4000M user manual; section 4.

The factory default settings for Modbus can be restored by connecting the RELAY RESET terminal (TB2-7) to the power supply common and turning on power to the IR4000M. After 10 seconds, remove the connection between RELAY RESET and common.

1.1.1 Baud Rate

The Baud Rate is a selectable setting via the Modbus Communications Interface. The selectable baud rates are 9600, 4800, or 2400 bits per second.

1.1.2 Data Format

The Data Format is a selectable setting via the Modbus Communications Interface. The selectable data formats are as follows:

Data Bits	Parity	Stop Bit	Format
8	None	1	8-N-1
8	Even	1	8-E-1
8	Odd	1	8-O-1
8	None	2	8-N-2

Table 1: Data Format

1.1.3 Modbus Read Status Protocol (Query/Response)

1.1.3.1 Modbus Read Query Message

Byte	Modbus	Range	Referenced to IR400
1st	Slave Address	1-247* (Dec)	IR400 ID (Address)
2nd	Function Code	03	Read Holding Registers
3rd	Starting Address Hi**	00	Not Used by IR400
4th	Starting Address Lo**	00-FF (Hex)	IR400 Commands
5th	No. of Registers Hi	00	Not Used by IR400
6th	No. of Registers Lo	01	No. of 16 Bit Registers
7th	CRC Hi	00-FF (Hex)	CRC Hi Byte
8th	CRC Lo	00-FF (Hex)	CRC Lo Byte

Table 2: Modbus Read Query Message

*__NOTE:__ Address 0 is reserved for broadcast mode and will not be supported at this time.

**__NOTE:__ Start Address can be a maximum of 9999 Address Locations (0000-270E)

1.1.3.2 Modbus Read Response Message

Byte	Modbus	Range	Referenced to IR400
1st	Slave Address	1-247* (Dec)	IR400 ID (Address)
2nd	Function Code	03	Read Holding Registers
3rd	Byte Count	02	No. of Data Bytes
4th	Data Hi	00-FF (Hex)	IR400 Hi Byte Status Data
5th	Data Lo	00-FF (Hex)	IR400 Lo Byte Status Data
6th	CRC Hi	00-FF (Hex)	CRC Hi Byte
7th	CRC Lo	00-FF (Hex)	CRC Lo Byte

Table 3: Modbus Read Response Message

1.1.4 Modbus Write Command Protocol (Query/Response)

1.1.4.1 Modbus Write Query Message

Byte	Modbus	Range	Referenced to IR400
1st	Slave Address	1-247* (Dec)	IR400 ID (Address)
2nd	Function Code	06	Preset Single Register
3rd	Register Address Hi	00	Not Used by IR400
4th	Register Address Lo	00-FF (Hex)	IR400 Commands
5th	Preset Data Hi	00-FF (Hex)	IR400 Hi Byte Command Data
6th	Preset Data Lo	00-FF (Hex)	IR400 Lo Byte Command Data
7th	CRC Hi	00-FF (Hex)	CRC Hi Byte
8th	CRC Lo	00-FF (Hex)	CRC Lo Byte

Table 4: Modbus Write Query Message

*__NOTE:__ Address 0 is reserved for broadcast mode and will not be supported at this time.

**__NOTE:__ Start Address can be a maximum of 9999 Address Locations (0000-270E)

1.1.5 Modbus Write Response Message

Byte	Modbus	Range	Referenced to IR400
1st	Slave Address	1-247* (Dec)	IR400 ID (Address)
2nd	Function Code	06	Preset Single Register
3rd	Register Address Hi	00	Not Used by IR400
4th	Register Address Lo	00-FF (Hex)	IR400 Commands
5th	Preset Data Hi	00-FF (Hex)	IR400 Hi Byte Command Data
6th	Preset Data Lo	00-FF (Hex)	IR400 Lo Byte Command Data
7th	CRC Hi	00-FF (Hex)	CRC Hi Byte
8th	CRC Lo	00-FF (Hex)	CRC Lo Byte

Table 5: Modbus Write Response Message

1.2 Function Codes Supported

Function Code 03 (Read Holding Registers) will be used to read status from the slave unit.

Function Code 06 (Preset Single Register) will be used to write a command to the slave unit.

1.2.1 Exception Responses and Exception Codes

1.2.1.1 Exception Response

In a normal communications query and response, the master device sends a query to the IR400 and the IR400 receives the query without a communications error and handles the query normally within the master device's allowable timeout. The IR400 then returns a normal response to the master. An abnormal communications produces one of four possible events:

1. If the IR400 does not receive the query due to a communications error, then no response is returned from the IR400 and the master device will eventually process a timeout condition for the query.
2. If the IR400 receives the query, but detects a communication error (CRC, etc.), then no response is returned from the IR400 and the master device will eventually process a timeout condition for the query.
3. If the IR400 receives the query without a communications error, but cannot process the response to the master within the master's timeout setting, then no response is returned from the IR400 and the master device will eventually process a timeout condition for the query. In order to prevent this condition from occurring the maximum response time for the IR400 is 200 milliseconds. Therefore the MASTER'S Timeout Setting should be set to 200 milliseconds or greater.
4. If the IR400 receives the query without a communications error, but cannot process it due to reading or writing to a non-existent IR400 command register, then the IR400 will return an exception response message informing the master of the error.

The exception response message (ref. No. 4 above) has two fields that differentiate it from a normal response:

Byte	Modbus	Range	Referenced to IR400
1st	Slave Address	1-247* (Dec)	IR400 ID (Address)
2nd	Function Code	83 or 86 (Hex)	MSB is set with Function Code
3rd	Exception Code	01 - 06 (Hex)	Appropriate Exception Code (See Below)
4th	CRC Hi	00-FF (Hex)	CRC Hi Byte
5th	CRC Lo	00-FF (Hex)	CRC Lo Byte

Table 6: IR400 Exception Response Message

1.2.1.2 Exception Code

Exception Code Field: In a normal response, the IR400 returns data and status in the data field, which was requested in the query from the master. In an exception response, the IR400 returns an exception code in the data field, which describes the IR400 condition that caused the exception. Below is a list of exception codes that are supported by the IR400:

Code	Name	Description
01	Illegal Function	The function code received in the query is not an allowable action for the IR4000.
02	Illegal Data Address	The data address received in the query is not an allowable address for the IR4000.
03	Illegal Data Value	A value contained in the query data field is not an allowable value for the IR4000.
04	Slave Device Failure	An unrecoverable error occurred while the IR4000 was attempting to perform the requested action.
05	Acknowledge	The IR4000 has accepted the request and is processing it, but a long duration of time will be required to do so. This response is returned to prevent a timeout error from occurring in the master.
06	Device Busy	The IR4000 is engaged in processing a long-duration program command. The master should retransmit the message later when the slave is free.

Table 7: IR4000 Exception Codes

1.3 IR4000 Modbus Registers Summary Table

Register Address (Hex)	Parameter	Function	Data Type	Data Range	Access
0000H	**Analog Output**	0-20mA current output	Numeric Value	0-65535 Dec, (scale to range 0-21.7mA)	R
0001h	**Operating Mode**	Set/View operating mode	Bit Map	See register description	R/W
0002h	**Error Status**	View present error	Bit Map	See register description	R
0003h	**Misc. Fault**	For GMI use	N/A	N/A	R
0004H	**Model Number**	View Model ID	Numeric Value	4002, etc.	R
0005h	**Software Rev**	Software Revision	2 ASCII characters	A, B, etc.	R
0006h	**Display digits 2 and 3**	Shows present 2nd and 3rd display digits on IR4000 front panel.	2 ASCII characters	Hi byte – 2nd digit, Lo byte – 3rd digit	R
0007h	**Display LED digit 1 and Alarm / Warning LEDs**	Shows present front panel display digit 1, and Alarm / Warning lights	1 ASCII character and LEDs status	Hi byte – 1st digit, Lo byte : bit map bit 3 – low LED bit 4 - hi LED	R
0008h	**Line voltage**	Measured line voltage * 10	Numeric Value	0-65535	R
0009h	**No. of Units Online**	Defines no. of IR400 units connected	Numeric Value	1-8	R/W
000Ah	**No. of Votes**	Determines how many detectors must reach alarm setpoint to trigger alarm/warning	Numeric Value	1-8	R/W
000Bh	**Priority Fault**	Read main fault of the IR4000 device	Bit Map	See register 0x0002 description	R
000Ch	**HART configuration**	Hi byte – AO range; Lo byte – HART enabled/disabled	Hi byte – AO range; Lo byte – HART enabled/disabled	Hi byte: 0 – hi range, 1 – lo range, Low byte: 0 – disabled, 1 – HART enabled	R/W
000Dh	**Alarm Relay settings**	Read or change settings for alarm	Bit Map	See description	R/W

Register Address (Hex)	Parameter	Function	Data Type	Data Range	Access
000Eh	**Warning Relay settings**	Read or change settings for warning	Bit Map	See description	R/W
000Fh	**Address for CH1**	Set/View CH1 address	Numeric Value	1-247 decimal	R/W
0010h	**Baud Rate for CH1**	Set/View CH1 Baud Rate (2400, 4800, 9600 19200)	Code	0, 1, 2, 3	R/W
0011h	**Data Format for CH1**	Set/View CH1 Data Format (8N1, 8E1, 801, 8N2)	Code	0, 1, 2, 3	R/W
0012h	**Address for CH2**	Set/View CH2 address	Numeric Value	1-247 decimal	R/W
0013h	**Baud Rate for CH2**	Set/View CH2 Baud Rate (2400, 4800, 9600 19200)	Code	0, 1, 2, 3	R/W
0014h	**Data Format for CH2**	Set/View CH2 Data Format (8N1, 8E1, 801, 8N2)	Code	0, 1, 2, 3	R/W
0015h	**Reserved**	N/A	N/A	N/A	N/A
0016h	**Reset Alarm**	Resets latching alarms	Numeric Value	0	W
0017h	**Receive errors for CH1**	Number of CH1 total receive errors	Numeric Value	0-65535 decimal	R
0018h	**Function code errors for CH1**	Number of CH1 function code errors.	Numeric Value	0-65535 decimal	R
0019h	**Starting Register Address errors for CH1**	Number of CH1 Starting Register Address errors.	Numeric Value	0-65535 decimal	R
001Ah	**NVM region Faults**	View/Reset NVM pages fault	Bit map	See register description	R/W
001Bh	**CRC errors HI for CH1**	Number of CH1 CRC HI errors	Numeric Value	0-65535 decimal	R
001Ch	**CRC errors LO for CH1**	Number of CH1 CRC LO errors	Numeric Value	0-65535 decimal	R
001Dh	**Overrun errors for CH1**	Number of Overrun errors for CH1	Numeric Value	0-65535 decimal	R
001Eh	**Framing errors for CH1**	Number of framing errors for CH1	Numeric Value	0-65535 decimal	R
001Fh	**Parity errors for CH1**	Number of Parity errors for CH1	Numeric Value	0-65535 decimal	R
0020h	**Reserved**	N/A	N/A	N/A	R
0021h	**Receive errors for CH2**	Number of CH2 total receive errors	Numeric Value	0-65535 decimal	R
0022h	**Function code errors for CH2**	Number of CH2 function code errors.	Numeric Value	0-65535 decimal	R

Register Address (Hex)	Parameter	Function	Data Type	Data Range	Access
0023h	**Starting Register Address errors for CH2**	Number of CH2 Starting Register Address errors.	Numeric Value	0-65535 decimal	R
0024h	**Reserved**	N/A	N/A	N/A	N/A
0025h	**CRC errors HI for CH2**	Number of CH2 CRC HI errors	Numeric Value	0-65535 decimal	R
0026h	**CRC errors LO for CH2**	Number of CH2 CRC LO errors	Numeric Value	0-65535 decimal	R
0027h	**Overrun errors for CH2**	Number of Overrun errors for CH2	Numeric Value	0-65535 decimal	N/A
0028h	**Framing errors for CH2**	Number of framing errors for CH2	Numeric Value	0-65535 decimal	R
0029h	**Parity errors for CH2**	Number of Parity errors for CH2	Numeric Value	0-65535 decimal	R
002Ah	**Reserved**	N/A	N/A	N/A	N/A
002Bh	**Reserved**	N/A	N/A	N/A	N/A
002Ch	**Clear Comm errors for CH1**	Clears CH1 communication errors	Numeric Value	See parameter description	W
002Dh	**Clear Comm errors for CH2**	Clears CH2 communication errors	Numeric Value	See parameter description	W
002Eh	**Reserved**	N/A	N/A	N/A	N/A
002Fh	**Reset Events**	Clears events of resets event flag	Numeric Value	0 - Clear Events, 1 - Resets Event Happened flag	W
0030h	**Run Time hi**	High word of Run Time in Seconds	Numeric Value	0-65535 decimal	R/W
0031h	**Run Time low**	Low word of Run Time in Seconds	Numeric Value	0-65535 decimal	R/W
0032h	**Real Time Clock Year, Month**	Read/Set year and month of RTC	Numeric Value	1 –99 year, 1– 12 month	R/W
0033h	**Real Time Clock Day, Hour**	Read/Set day and hour of RTC	Numeric Value	1 – 31 day, 0 – 23 hour	R/W
0034h	**Real Time Clock Minute, Second**	Read/Set minutes and seconds of RTC	Numeric Value	0 – 59 minutes 0 – 59 seconds	R/W
0035h	**Power Cycled Flag**	Time Reset After power Cycled	Numeric Value	0 = Time not Reset, 1 = Time Reset	R
0036h	**Event Index**	Index of Logged Events	Numeric Value	0 - 9	R/W
0037h	**Running Time Hi**	Running Time Hi for Warning Event log entries	Numeric Value	0 - 65535	R

Register Address (Hex)	Parameter	Function	Data Type	Data Range	Access
0038h	**Running Time Low**	Running Time Low for Warning Event log entries	Numeric Value	0 - 65535	R
0039h	**Clock Time Hi**	Hi byte = year, Lo byte month: Warning clock time	Numeric Value	1 –99 year, 1– 12 month	R
003Ah	**Clock Time Mid**	Hi byte = Day, Lo byte Hour: Warning clock time	Numeric Value	1 – 31 day, 0 – 23 hour	R
003Bh	**Clock Time Low**	Hi byte = Minute, Lo byte second: Warning clock time	Numeric Value	0 – 59 minutes 0 – 59 seconds	R
003Dh	**Reserved**	Reserved	Numeric Value	0	R
003Ch	**Reserved**	Reserved	Numeric Value	0	R
003Eh	**Warning Event Count**	Total Warning Event Count	Numeric Value	0 - 65535	R
003Fh	**Running Time Hi**	Running Time Hi for Alarm Event log entries	Numeric Value	0 - 65535	R
0040h	**Running Time Low**	Running Time Low for Alarm Event log entries	Numeric Value	0 - 65535	R
0041h	**Clock Time Hi**	Hi byte = year, Lo byte month: Alarm clock time	Numeric Value	1 –99 year, 1– 12 month	R
0042h	**Clock Time Mid**	Hi byte = Day, Lo byte Hour: Alarm clock time	Numeric Value	1 – 31 day, 0 – 23 hour	R
0043h	**Clock Time Low**	Hi byte = Minute, Lo byte second: Alarm clock time	Numeric Value	0 – 59 minutes 0 – 59 seconds	R
0044h	**Reserved**	Reserved	Numeric Value	0	R
0045h	**Reserved**	Reserved	Numeric Value	0	R
0046h	**Alarm Event Count**	Total Alarm Event Count	Numeric Value	0 - 65535	R
0047h	**Running Time Hi**	Running Time Hi for Fault Event log entries	Numeric Value	0 - 65535	R
0048h	**Running Time Low**	Running Time Low for Fault Event log entries	Numeric Value	0 - 65535	R

Register Address (Hex)	Parameter	Function	Data Type	Data Range	Access
0049h	**Clock Time Hi**	Hi byte = year, Lo byte month: Fault clock time	Numeric Value	1 –99 year, 1– 12 month	R
004Ah	**Clock Time Mid**	Hi byte = Day, Lo byte Hour: Fault clock time	Numeric Value	1 – 31 day, 0 – 23 hour	R
004Bh	**Clock Time Low**	Hi byte = Minute, Lo byte second: Fault clock time	Numeric Value	0 – 59 minutes 0 – 59 seconds	R
004Ch	**Fault Code**	See Table 9	Numeric Value	0	R
004Dh	**Reserved**	Reserved	Numeric Value	0	R
004Eh	**Fault Event Count**	Total Fault Event Count	Numeric Value	0 - 65535	R
004Fh	**Running Time Hi**	Running Time Hi for Maintenance Event log entries	Numeric Value	0 - 65535	R
0050h	**Running Time Low**	Running Time Low for Maintenance Event log entries	Numeric Value	0 - 65535	R
0051h	**Clock Time Hi**	Hi byte = year, Lo byte month: Maintenance clock time	Numeric Value	1 –99 year, 1– 12 month	R
0052h	**Clock Time Mid**	Hi byte = Day, Lo byte Hour: Maintenance clock time	Numeric Value	1 – 31 day, 0 – 23 hour	R
0053h	**Clock Time Low**	Hi byte = Minute, Lo byte second: Maintenance clock time	Numeric Value	0 – 59 minutes 0 – 59 seconds	R
0054h	**Reserved**	Reserved	Numeric Value	0	R
0055h	**Reserved**	Reserved	Numeric Value	0	R
0056h	**Maintenance Event Count**	Total Maintenance Event Count	Numeric Value	0 - 65535	R
0057h	**Running Time Hi**	Running Time Hi for Calibration Event log entries	Numeric Value	0 - 65535	R
0058h	**Running Time Low**	Running Time Low for Calibration Event log entries	Numeric Value	0 - 65535	R

Register Address (Hex)	Parameter	Function	Data Type	Data Range	Access
0059h	**Clock Time Hi**	Hi byte = year, Lo byte month: Calibration clock time	Numeric Value	1 –99 year, 1– 12 month	R
005Ah	**Clock Time Mid**	Hi byte = Day, Lo byte Hour: Calibration clock time	Numeric Value	1 – 31 day, 0 – 23 hour	R
005Bh	**Clock Time Low**	Hi byte = Minute, Lo byte second: Calibration clock time	Numeric Value	0 – 59 minutes 0 – 59 seconds	R
005Ch	**Calibration code**	Calibration code	Numeric Value	1 – zero, 2 - calibration	R
005Dh	**Reserved**	Reserved	Numeric Value	0	R
005Eh	**Calibration Event Count**	Total Calibration Event Count	Numeric Value	0 - 65535	R
005Fh	Event happened flag	Read if any event happened	Code	0 – no events; 1-event happened	R
DETECTOR'S REGISTERS					
Detector 1 Registers					
0070h	Analog Output 1	0-20mA current output For IR400 unit 1	Numeric Value	0-65535 Dec (scale to range 0-21.7mA)	R
0071h	Mode 1	View operational mode for IR400 unit 1	Bit Map	See parameter description	R/W
0072h	Status Error 1	View present error for IR400 unit 1	Bit Map	See parameter description	R
0073h	Gas Choice 1	View gas chosen for IR400 unit 1	Code	0-8	R
0074h	Model 1	View model number for IR400 unit 1	Numeric Value	2200, etc.	R
0075h	Display 1	Show LED digits 2 and 3 for IR400 unit 1	2 ASCII characters	% LEL or Fault code F1 to FF or device status (SU, AC or CP)	R
0076h	% of Blockage 1	Show level of beam blockage for IR400 unit 1	Numeric Value	0-5000	R
0077h	Cal IO type 1	Show type of calibration input for IR400 unit 1	Code	0 – LED switch, 1 –manual solenoid , 2 - ARGC	R/W

Register Address (Hex)	Parameter	Function	Data Type	Data Range	Access
0078h	Solenoid State 1	Solenoid Enabled/Disabled for IR400 unit 1	Code	10 – Solenoid On 20 – Solenoid Off 30 – Solenoid disabled	R/W
0079h	Reserved	Reserved	N/A	N/A	N/A
007Ah	Reserved	Reserved	N/A	N/A	N/A
007Bh	Reserved	Reserved	N/A	N/A	N/A
007Ch	Reserved	Reserved	N/A	N/A	N/A
007Dh	Reserved	Reserved	N/A	N/A	N/A
007Eh	% of Full Scale	Show % of full scale for IR400 unit 1	Numeric Value	0 – 99	R
007Fh	Reserved	Reserved	N/A	N/A	N/A
Detector 2 Registers					
0080h	Analog Output 2	0-20mA current output For IR400 unit 2	Numeric Value	0-65535 Dec (scale to range 0-21.7mA)	R
0081h	Mode 2	View operational mode for IR400 unit 2	Bit Map	See parameter description	R/w
0082h	Status Error 2	View present error for IR400 unit 2	Bit Map	See parameter description	R
0083h	Gas Choice 2	View gas chosen for IR400 unit 2	Code	0-8	R
0084h	Model 2	View model number for IR400 unit 2	Numeric Value	2200, etc.	R
0085h	Display 2	Show LED digits 2 and 3 for IR400 unit 2	2 ASCII characters	% LEL or Fault code F1 to FF or device status (SU, AC or CP)	R
0086h	% of Blockage 2	Show level of beam blockage for IR400 unit 2	Numeric Value	0-5000	R
0087h	Cal IO type 2	Show type of calibration input for IR400 unit 2	Code	0 – LED switch, 1 –manual solenoid , 2 - ARGC	R/W
0088h	Solenoid State 2	Solenoid Enabled/Disabled for IR400 unit 2	Code	10 – Solenoid On 20 – Solenoid Off 30 – Solenoid disabled	R/W
0089h	Reserved	Reserved	N/A	N/A	N/A
008Ah	Reserved	Reserved	N/A	N/A	N/A
008Bh	Reserved	Reserved	N/A	N/A	N/A
008Ch	Reserved	Reserved	N/A	N/A	N/A
008Dh	Reserved	Reserved	N/A	N/A	N/A

Register Address (Hex)	Parameter	Function	Data Type	Data Range	Access
008Eh	% of Full Scale 2	Show % of full scale for IR400 unit 2	Numeric Value	0 – 99	R
008Fh	Reserved	Reserved	N/A	N/A	N/A
0090 - 009F	Detector 3 Registers				
00A0-00AF	Detector 4 Registers				
00B0-00BF	Detector 5 Registers				
00C0-00CF	Detector 6 Registers				
00D0-00DF	Detector 7 Registers				
00E0-00EF	Detector 8 Registers				

1.4 IR4000 Modbus Base Registers Details

1.4.1 Analog (0000h, Read-Only)

A Read returns a value that is proportional to the Analog output current. The value returned is a 16-bit binary value, in the range from 0-65535 decimal. The decimal value must be scaled in proportion to an Analog current value from 0-21.7mA.

1.4.2 Operating Mode (0001h, Read)

This register reports the current operating mode for the IR4000 base unit. A Read command to this register returns the present IR4000M mode, represented by the enabled bits. The following table shows the Mode associated with each bit in the 16-bit register.

Table 8 Bitmap for Mode

Bit	7	6	5	4	3	2	1	0
Mode	Not Used	Initial Mode (Start-up)	Detector Gas Check	Detector Calibra-tion	Detector Zeroing	Alarm l	Warning vel	Run Mode
Bit Value	**80 hex 128 dec**	**40 hex 64 dec**	**20 hex 32 dec**	**10 hex 16 dec**	**8 hex 8 dec**	**4 hex 4 dec**	**2 hex 2 dec**	**1 hex 1 dec**

Bit	15	14	13	12	11	10	9	8
Mode	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used	Not Used
Bit Value	**8000 hex 32768 dec**	**4000 hex 16384 dec**	**2000 hex 8192 dec**	**1000 hex 4096 dec**	**800 hex 2048 dec**	**400 hex 1024 dec**	**200 hex 512 dec**	**100 hex 256 dec**

1.4.2.1 Mode Descriptions

- **Run Mode.** Normal operation mode for all connected IR400 units, with LEL measurement taking place.
- **Warning Level.** The IR400s have equaled or exceeded the votes configured to trigger the relays for a Warning level gas.
- **Alarm Level.** The IR400s have equaled or exceeded the votes configured to trigger the relays for an Alarm level gas.
- **Detector Zeroing.** One or more detectors are zeroing
- **Detector Calibration.** One or more detectors are in calibration
- **Detector Gas Check.** One or more detectors are in gas check mode.
- **Startup Mode.** This tells the user the IR4000 is starting up. The detector takes typically 2 minutes to start.

1.4.3 Status Error (0002h, Read-Only)

A Read command returns the bit map for any Error that is presently occurring, The following table shows the errors that are represented by each bit in the register.

Table 9 Bitmap for IR4000 Status Error

Bit Position	3	2	1	0
Error	Low Line	Gas Left Fault	NVM Fault	Misc. Fault
Bit Value	8 hex / 8 dec	4 hex / 4 dec	2 hex / 2 dec	1 hex / 1 dec

Bit Position	7	6	5	4
Error	Detector Non-critical Fault	Detector Critical Fault	Fail to Complete Setup	Wire Shortage
Bit Value	80 hex / 128 dec	40 hex / 64 dec	20 hex / 32 dec	10 hex / 16 dec

Bit Position	11	10	9	8
Error	Comm. Error with Detector 4	Comm. Error with Detector 3	Comm. Error with Detector 2	Comm. Error with Detector 1
Bit Value	800 hex / 2048 dec	400 hex / 1024 dec	200 hex / 512 dec	100 hex / 256 dec

Bit Position	15	14	13	12
Error	Comm. Error with Detector 8	Comm. Error with Detector 7	Comm. Error with Detector 6	Comm. Error with Detector 5
Bit Value	8000 hex / 32768 dec	4000 hex / 16384 dec	2000 hex / 8192 dec	1000 hex / 4096 dec

1.4.4 Model Type (0004h, Read-Only)

A Read returns the model type for the base.

1.4.5 Software Revision (0005h, Read-Only)

A read returns the software revision of the IR4000, which is two ASCII characters.

1.4.6 Display LED Digits Two and Three (0006, Read-Only)

A Read returns the two rightmost ASCII character that would appear on the IR4000 front panel. Bits 8-15 hold the contents of the second ASCII character, and bits 0-7 hold the contents of the third ASCII character.

1.4.7 Display LED Digit One and Alarm/Warning LEDs (0007, Read-Only)

A Read returns the leftmost ASCII-coded digit from the IR4000 front panel, along with the status of the Alarm and Warning LEDs, as shown in the following table. Bits 8-15 hold the contents of the first ASCII digit, which is often the IR400 unit number. Bits 0-7 indicate the state of the Alarm and Warning LEDS, as follows:

- Bit 4 is set if the Alarm LED is ON
- Bit 3 is set if the Warning LED is ON

1.4.8 Number of Detectors Online (0009h, Read/Write)

Returns (via Read command) and sets (via Write command) the number of IR400 detectors connected to this IR4000. Writing to this register is equivalent to setting the Number of Detectors using the IR4000 menu options

1.4.9 Number of Votes (000Ah, Read/Write)

Returns (via Read command) and sets (via Write command) the "Number of Votes" required to trigger the Alarm and Warning relays that go to local alarm devices. Writing to this register is equivalent to setting the number of votes using the IR4000 menu options

NOTE: The default setting is one. Maximum number of votes is equal to number of detectors online

1.4.10 Alarm Relay Settings (000Dh, Read/Write)

A Read command returns the present Alarm settings of the IR4000. A Write command changes the settings to the requested values.. 1 in bit 12 means the output is Latching, a 0 means it is Non-Latching. A 1 in the 11th bit position means the output is normally Energized; a 0 means it is normally De-Energized. The lower byte is the alarm setpoint. The Alarm setpoint cannot be set below the Warning setpoint.

NOTE: The maximum alarm setting for the IR4000 is 60%.

Factory default is 60% FS, latching, de-energized.

1.4.10.1 Exceptions

Returns an Exception Code 03 (illegal data) in the Exception Response message if an illegal data is being written

1.4.11 Warning Relay Settings (000Eh, Read/Write)

A Read command returns the present Warning settings of the IR4000. A Write command changes the settings to the requested values.. 1 in bit 12 means the output is Latching, a 0 means it is Non-Latching. A 1 in the 11th bit position means the output is normally Energized; a 0 means it is normally De-Energized. The lower byte is the Warning setpoint.. The Warning setpoint cannot be set above the Alarm setpoint.

NOTE: The maximum Warning setting for the IR4000 is 60%.

Factory default is 30% FS, non-latching, de-energized.

1.4.11.1 Exceptions

Returns an Exception Code 03 (illegal data) in the Exception Response message if an illegal data is being written.

1.4.12 Set CH1 Address (000Fh, Read/Write)

A Read returns the Modbus Channel 1 address for the IR4000 unit. A Write changes the address to the requested address. The range of addresses you can specify is from 1 to 247 decimal.

1.4.12.1 Exceptions

If the ID is not within range, an exception response message is returned.

1.4.13 Baud Rate for CH1 (0010h, Read/Write)

A Read command returns the current baud rate setting the IR4000 Modbus Channel 1. A Write command changes the setting to the baud rate specified by the code (see table). The code is stored in the register's Low Data Byte; the High Data Byte is not used.

The factory default is 19,200.

Table 10. Baud Rate Codes

Code	Function	Access
03	19200	Read/Write
02	9600	Read/Write
01	4800	Read/Write
00	2400	Read/Write

1.4.13.1 Exceptions

If you try to Write a value that is not one of the codes shown above, an illegal data value (03) exception code is returned in the data field of an Exception Response message.

1.4.14 Data Format for CH1 (0011h, Read/Write)

A Read returns the current data format for Modbus Channel 1. A Write changes the setting to the data format specified by the code (see below). The code is stored in the register's Low Data Byte; the High Data Byte is not used.

Table 11. Data Format Codes

Code	Format	Data Bits	Parity	Stop Bits	Access
00	8-N-1	8	None	1	Read/Write
01	8-E-1	8	Even	1	Read/Write
02	8-O-1	8	Odd	1	Read/Write
03	8-N-2	8	None	2	Read/Write

1.4.14.1 Exceptions

If you specify a code that is not listed above, an illegal data value (03) exception code is returned in the data field of an Exception Response message.

1.4.15 Modbus Address for CH2 (0012h, Read/Write)

A Read returns the Modbus Channel 2 address of the unit. A Write changes the address to the requested address. The range of the addresses you can specify is from 1 to 247 decimal

1.4.16 Baud Rate for CH2 (0013h, Read/Write)

A Read command returns the current baud rate setting the IR4000 Modbus Channel 2. A Write command changes the setting to the baud rate specified by the code (see table). The code is stored in the register's Low Data Byte; the High Data Byte is not used.

The factory default is 19,200.

Table 12. Baud Rate Codes

Code	Function	Access
03	19200	Read/Write
02	9600	Read/Write
01	4800	Read/Write
00	2400	Read/Write

1.4.16.1 Exceptions

If you try to Write a value that is not one of the codes shown above, an illegal data value (03) exception code is returned in the data field of an Exception Response message.

1.4.17 Data Format for CH2 (0014h, Read/Write)

A Read returns the current data format for Modbus Channel 2. A Write changes the setting to the data format specified by the code (see below). The code is stored in the register's Low Data Byte; the High Data Byte is not used.

Table 13. Data Format Codes

Code	Format	Data Bits	Parity	Stop Bits	Access
00	8-N-1	8	None	1	Read/Write
01	8-E-1	8	Even	1	Read/Write
02	8-O-1	8	Odd	1	Read/Write
03	8-N-2	8	None	2	Read/Write

1.4.17.1 Exceptions

If you specify a code that is not listed above, an illegal data value (03) exception code is returned in the data field of an Exception Response message.

1.4.18 Reset Alarm (0016h, Read/Write)

A Write resets the latching Alarm and Warning relays.

1.4.19 Total Receive Errors for CH1 (0017h, Read-Only)

A Read returns the total number of Communication Receive Errors that occurred for Modbus Channel 1. The maximum count is 65,535 and then the counter will roll over to zero and begin counting again.

1.4.20 Function Code Errors for CH1 (0018h, Read-Only)

A Read returns the number of Function Code Errors that occurred for Modbus Channel 1. The maximum count is 65,535 and then the counter will roll over to zero and begin counting again.

1.4.21 Starting Register Address Errors Errors for CH1 (0019h, Read-Only)

A Read returns the number of Starting Register Address Errors that occurred for Modbus Channel 1. The maximum count is 65,535 and then the counter will roll over to zero and begin counting again.

1.4.22 NVM Faults (001Ah, Read/Wrire)

A Read command returns the bit map for any NVM faults that is presently occurring or had occurred in the past, The following table shows the errors that are represented by each bit in the register. Table 14. Bitmap for IR4000 NVM Errors

Bit Position	3	2	1	0
Error	Event region	HART region	User region	Critical region
Bit Value	8 hex / 8 dec	4 hex / 4 dec	2 hex / 2 dec	1 hex / 1 dec

If there is no Critical region error, NVM faults can be reset by writing 0 to this register. If any other value is written, data exception will be returned.

Critical region error means that flash memory is corrupted and the device needs to be send for repairing.

User region error means that power interruption happened when one of several of the following parameters had been set:

Addresses, Baud Rates and Data format for Modbus CH1 and CH2 (registers 0x0F – 0x14), alarm settings (register 0x0D), warn setting (register 0x0E), number of detectors (register 0x09), number of votes (register 0x0A), HART configuration (register 0x0C).

Check Setup menu or Modbus register values to make sure that these parameters have correct values.

HART region error means that power interruption happened when one of several of the following HART parameters had been set:

Message, tag, descriptor, date, tag, long tag, short address, final assemly number.

If you use HART, make sure that these parameters have correct values. If HART is not used, ignore the fault.

Event region error means that power interruption happened when an events were logged, and one or more events may not be logged or logged incorrectly.

1.4.23 CRC Hi Errors for CH1 (001Bh, Read-Only)

A Read indicates the number of RXD Cyclical Redundancy Check (CRC) High-Byte errors that occurred in the IR4000 for Modbus Channel H. The maximum count is 65,535, and then the counter will roll over to zero and begin counting again.

1.4.24 CRC Low Errors for CH1 (001Ch, Read-Only)

A Read indicates the number of RXD Cyclical Redundancy Check (CRC) Low-Byte errors that occurred in the IR4000 for Modbus Channel H. The maximum count is 65,535, and then the counter will roll over to zero and begin counting again.

1.4.25 Overrun Errors for CH1 (001Dh, Read-Only)

A Read indicates the number of Overrun errors that occurred in the slave device for Modbus Channel 1. The maximum count is 65,535, and then the counter will roll over to zero and begin counting again.

1.4.26 Framing Errors for CH1 (001Eh, Read-Only)

A Read indicates the number of Framing errors that occurred in the slave device for Modbus Channel 1. The maximum count is 65,535, and then the counter will roll over to zero and begin counting again.

1.4.27 Parity Errors for CH1 (001Fh, Read-Only)

A Read indicates the number of Framing errors that occurred in the slave device for Modbus Channel 1. The maximum count is 65,535, and then the counter will roll over to zero and begin counting again.

1.4.28 Total Receive Errors for CH2 (0021h, Read-Only)

A Read returns the total number of Communication Receive Errors that occurred for Modbus Channel 1. The maximum count is 65,535 and then the counter will roll over to zero and begin counting again.

1.4.29 Function Code Errors for CH2 (0022h, Read-Only)

A Read returns the number of Function Code Errors that occurred for Modbus Channel 1. The maximum count is 65,535 and then the counter will roll over to zero and begin counting again.

1.4.30 Starting Register Address Errors Errors for CH2 (0023h, Read-Only)

A Read returns the number of Starting Register Address Errors that occurred for Modbus Channel 1. The maximum count is 65,535 and then the counter will roll over to zero and begin counting again.

1.4.31 CRC Hi Errors for CH2 (0025h, Read-Only)

A Read indicates the number of RXD Cyclical Redundancy Check (CRC) High-Byte errors that occurred in the IR4000 for Modbus Channel H. The maximum count is 65,535, and then the counter will roll over to zero and begin counting again.

1.4.32 CRC Low Errors for CH2 (0026h, Read-Only)

A Read indicates the number of RXD Cyclical Redundancy Check (CRC) Low-Byte errors that occurred in the IR4000 for Modbus Channel H. The maximum count is 65,535, and then the counter will roll over to zero and begin counting again.

1.4.33 Overrun Errors for CH2 (0027h, Read-Only)

A Read indicates the number of Overrun errors that occurred in the slave device for Modbus Channel 1. The maximum count is 65,535, and then the counter will roll over to zero and begin counting again.

1.4.34 Framing Errors for CH2 (0028h, Read-Only)

A Read indicates the number of Framing errors that occurred in the slave device for Modbus Channel 1. The maximum count is 65,535, and then the counter will roll over to zero and begin counting again.

1.4.35 Parity Errors for CH2 (0029h, Read-Only)

A Read indicates the number of Framing errors that occurred in the slave device for Modbus Channel 1. The maximum count is 65,535, and then the counter will roll over to zero and begin counting again.

1.4.36 Clear Comm Errors for CH1 (002Ch, Read/Write)

A Write resets the counters to zero for all the IR4000 Modbus Channel 1 communications errors, including the errors listed above.

1.4.37 Clear Comm Errors for CH2 (002Dh, Read/Write)

A Write resets the counters to zero for all the IR4000 Modbus Channel 1 communications errors, including the errors listed above.

1.4.38 Enable HART or Modbus for CH2 (002Dh, Read/Write)

A Read or Set Channel 2 communication option: 0 – Modbus, 1 - HART

1.5 IR4000 Modbus Registers for IR400 Data

Registers 70h to EF hold the current values for data items that the IR4000 reads for each connected IR400 detector, up to a maximum of eight. Brief descriptions for the several data items are provided below.

1.5.1 Detector Analog Output (Read-Only)

A Read returns a value that is proportional to the analog output current. The value returned is a 16-bit binary value, in the range from 0-65535 decimal. The

decimal value must be scaled in proportion to an analog current value from 0-21.7mA.

1.5.2 Operating Mode (Read-Only)

This register reports on the current operating mode for the IR400 detector. A Read command returns the present IR400 mode, represented by the enabled bit. The following table shows the mode represented by each bit in the 16-bit register.

Table 15 Bitmap for Operating Mode Register (Read-Only Access)

Bit	7	6	5	4	3	2	1	0
Mode	Not Used	Initial Mode	Remove Gas (CAL Finished)	Apply Gas	CAL Pending	Zero Mode	CAL Mode	Run Mode
Bit Value	**80 hex 128 dec**	**40 hex 64 dec**	**20 hex 32 dec**	**10 hex 16 dec**	**8 hex 8 dec**	**4 hex 4 dec**	**2 hex 2 dec**	**1 hex 1 dec**

Bit	15	14	13	12	11	10	9	8
Mode	Not Used	Not Used	Not Used	Not Used	Not Used	Zero & CAL Mode	Gas Check Mode	Not Used
Bit Value	**8000 hex 32768 dec**	**4000 hex 16384 dec**	**2000 hex 8192 dec**	**1000 hex 4096 dec**	**800 hex 2048 dec**	**400 hex 1024 dec**	**200 hex 512 dec**	**100 hex 256 dec**

1.5.2.1 Mode Descriptions

A Read command returns the present IR400 mode, represented by the enabled bit. Descriptions of the modes are provided below.

- **Run Mode:** IR400 normal operation mode, with LEL measurement taking place.
- **CAL Mode:** Calibration in progress at 50% LEL.
- **Zero Mode:** Zeroing of the IR400 in progress.
- **CAL Pending:** Waiting for gas to be applied for calibration to proceed.
- **No Gas or Not Steady:** IR400 calibration not proceeding since gas not applied, or zeroing not successful.
- **Remove Gas (CAL finished):** IR400 calibration has finished, remove gas.
- **Initial Mode:** IR400 is initializing during powerup.
- **Gas Check Mode:** IR400 gas check is in progress (must apply gas or test film)
- **Zero and CAL Mode:** Zeroing of the IR400 is in progress, directly followed by calibration (once gas is applied).

1.5.3 Status Error (Read-Only)

A Read returns the bit map for any error that is presently occurring. The following table shows the errors that are represented by each bit in the register.

Table 16 Bitmap for Status Error Delayed

Bit Position	3	2	1	0
Error	IR High	IR Low	Clean Window (Negative Gas Reading)	IR Close to Low (External Gain)
Bit Value	8 hex / 8 dec	4 hex / 4 dec	2 hex / 2dec	1 hex / 1 dec

Bit Position	7	6	5	4
Error	Failed to Zero	Calibration Mode Fail	Low Line Condition	Wire Shortage
Bit Value	80 hex / 128 dec	40 hex / 64 dec	20 hex / 32 dec	10 hex / 16 dec

Bit Position	11	10	9	8
Error	Heater problem	Ref. Lamp Problem	Active Lamp Prob.	Gas Left
Bit Value	800 hex / 2048 dec	400 hex / 1024 dec	200 hex / 512 dec	100 hex / 256 dec

Bit Position	16	15	14	13
Error	EEPROM Error	Excess Neg. Drift	Misc Fault (Needs repair)	unused
Bit Value	8000 hex / 32768 dec	4000 hex / 16384 dec	2000 hex / 8192 dec	1000 hex / 4096 dec

1.5.4 Gas Selection (Read-Only)

A Read command to this register returns the present gas selection for the detector.

Table 17. Gas Selection Codes

Code (decimal or hex)	Gas Type
0	Methane
1	Propane
2	N-Butane
3	Hexane
4	% by volume Methane
5	Other
6	Ethane
7	Pentane

1.5.5 Model Type (Read-Only)

A Read returns the model type for the detector, which is 2104 for IR400.

1.5.6 Display (Read-Only)

A read returns two ASCII characters which can be displayed by IR4000, such as gas concentration, fault code or device status (AC, CP or SU)

1.5.7 Cal IO type (Read-Only)

A Read returns Calibration input type: 0 – for LED switch, 1 – for manual solenoid and 2 for ARCG (automatic solenoid)

1.5.8 Solenoid State (Read-Only)

A Read returns solenoid state of the unit : 10 – solenoid is On, 20 – solenoid is Off, 30 – solenoid is disabled (Cal IO type is LED switch).