



Model IR400

Infrared Point Detector for
Hydrocarbon Gas Applications
Modbus programming guide



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Instruction Manual Modbus **12-10**

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MANIR400M

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1.0 MODBUS RTU

1.1 Serial Communications Protocol for IR400

The default Modbus setup from the factory is 9600 baud, 8-n-1 format. The default Modbus ID is 1. These defaults can be restored at any time by connecting the CAL_IO wire (brown) to power supply common and then turn on the power to the IR400. After 10 seconds the CAL_IO wire should be disconnected from the power-supply.

1.1.1 Baud Rate

The Baud Rate is a selectable setting via the Modbus Communications Interface. The selectable baud rates are 19200, 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 IR400.
02	Illegal Data Address	The data address received in the query is not an allowable address for the IR400.
03	Illegal Data Value	A value contained in the query data field is not an allowable value for the IR400.
04	Slave Device Failure	An unrecoverable error occurred while the IR400 was attempting to perform the requested action.
05	Acknowledge	The IR400 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 IR400 is engaged in processing a long-duration program command. The master should retransmit the message later when the slave is free.

Table 7: IR400 Exception Codes

1.3 IR400 Command Register Locations

Register Address (Hex)	Parameter	Function	Data Type	Data Range	Access
0000H	Analog Output	0-20 mA analog output	Numeric Value	0-65535 Dec, (scale to range 0-21.7mA)	R
0001h	Operating Mode	Set/View operating mode	Bit Map	See Table 9	R/W
0002h	Error Status	View present error	Bit Map	See Table 10	R
0003h	Gas ID	Type of gas	Numeric Value	See The register can be written with the index numbers 0 to 7 or with the Gas ID. The Gas ID codes will not change in future versions and are consistent across General Monitors products. To read the Gas ID use register 0x008D. Table 11	R/W
0004H	Model Number	View Model ID	Numeric Value	2104 , etc	R
0005h	Software Rev	Software Revision ID	2 ASCII characters	A, B, etc.	R
0006h	Gain	Shows detector gain	Numeric Value	0-5000	R
0007h	Cal IO type	Set/View Cal IO type	code	0 – LED switch, 1 –manual solenoid , 2 - ARGC	R/W
0008h	Solenoid state	Turn solenoid ON/OFF, read solenoid state	Code	10 – ON, 20 – OFF, 30 – disabled	R/W
0009h	Modbus unit address	Set/View Modbus address	Numeric Value	1-247 decimal	R/W
000Ah	Adjusted ratio	Adjusted ratio	Numeric Value	0-65535	R
000Bh	Modbus Baud	Set/View Baud Rate	Code	0, 1, 2, 3	R/W

	Rate	(2400, 4800, 9600 19200)			
000Ch	Modbus Data Format	Set/View Data Format (8N1, 8E1, 801, 8N2)	Code	0, 1, 2, 3	R/W
000Dh	Priority fault	Main fault for the unit	Bit Map	See Table 10	R
000Eh	% of full scale	Read gas concentration in % of Full Scale	Numeric Value	-9 – (+)106%	R
000Fh	Full scale, hi	Read hi word of full scale	Numeric Value	0	R
0010h	Full scale, lo	Read lo word of full scale	Numeric Value	100 %	R
0011h	Gas measurement units	Read gas measurement units	Code	0 - % lel, 1 –ppm	R
0012h	PPM value, hi	Read hi word of gas concentration in ppm	Numeric Value	0-65535	R
0013h	PPM value, low	Read low word of gas concentration in ppm	Numeric Value	0-65535	R
0014h	Duplicate detector gain	For GM usage	Numeric Value	0-5000	R
0015h	Reserved	N/A	N/A	N/A	R
0016h	Hazard Watch Mode	Set/View Hazard Watch Mode	Code	0 – disabled, 1 - enabled	R/W
0017h	Reserved	N/A	N/A	N/A	R
0018h	Alarm level	Set/View Alarm level for event logging	Numeric Value	5-95	R/W
0019h	Warn level	Set/View Warn level for event logging	Numeric Value	5-95	R/W
001Ah	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
001Bh	Reserved	N/A	N/A	N/A	R
001Ch	Reserved	N/A	N/A	N/A	R
001Dh	Reserved	N/A	N/A	N/A	R
001Eh	Reserved	N/A	N/A	N/A	R
001Fh	Reserved	N/A	N/A	N/A	R
0020h	Total Receive Errors	Number of Receive errors	Numeric Value	0-65535 decimal	R
0021h	Reserved	N/A	N/A	N/A	R
0022h	Function code errors	Number of function code errors.	Numeric Value	0-65535 decimal	R

0023h	Starting Register Address errors	Number of Starting Register Address errors.	Numeric Value	0-65535 decimal	R
0024h	Reserved	N/A	N/A	N/A	N/A
0025h	CRC errors HI	Number of CRC HI errors	Numeric Value	0-65535 decimal	R
0026h	CRC errors LO	Number of CRC LO errors	Numeric Value	0-65535 decimal	R
0027h	Overflow errors	Number of Overflow errors	Numeric Value	0-65535 decimal	N/A
0028h	Reserved	N/A	N/A	N/A	N/A
0029h	Framing errors	Number of framing errors	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	Reserved	N/A	N/A	N/A	N/A
002Dh	Clear Comm. errors	Clears communication errors	Numeric Value	See description	W
002E-008Ch	Reserved	N/A	N/A	N/A	N/A
008D	Gas ID #	Read unique Gas Identification Number	Numeric Value	See table for register 0x0003	R
008E – 00AF	Reserved	N/A	N/A	N/A	N/A
00B0h	Reset Events	Clears events of resets event flag	Numeric Value	0- Clear Events, 1 – Resets Event Happened flag	W
00B1h	Run Time hi	High word of Run Time in Seconds	Numeric Value	0-65535 decimal	R/W
00B2h	Run Time low	Low word of Run Time in Seconds	Numeric Value	0-65535 decimal	R/W
00B3h	Real Time Clock Year, Month	Read/Set year and month of RTC	Numeric Value	1 –99 year, 1– 12 month	R/W
00B4h	Real Time Clock Day, Hour	Read/Set day and hour of RTC	Numeric Value	1 – 31 day, 0 – 23 hour	R/W
00B5h	Real Time Clock Minute, Second	Read/Set minutes and seconds of RTC	Numeric Value	0 – 59 minutes 0 – 59 seconds	R/W
00B6h	Power Cycled Flag	Time Reset After power Cycled	Numeric Value	0 = Time not Reset, 1 = Time Reset	R
00B7h	Event Index	Index of Logged Events	Numeric Value	0 - 9	R/W
00B8h	Running Time Hi	Running Time Hi for Warning Event log entries	Numeric Value	0 - 65535	R

00B9h	Running Time Low	Running Time Low for Warning Event log entries	Numeric Value	0 - 65535	R
00Bah	Clock Time Hi	Hi byte = year, Lo byte month: Warning clock time	Numeric Value	1 –99 year, 1–12 month	R
00BBh	Clock Time Mid	Hi byte = Day, Lo byte Hour: Warning clock time	Numeric Value	1 – 31 day, 0 – 23 hour	R
00BCh	Clock Time Low	Hi byte = Minute, Lo byte second: Warning clock time	Numeric Value	0 – 59 minutes 0 – 59 seconds	R
00BDh	Reserved	Reserved	Numeric Value	0	R
00BEh	Reserved	Reserved	Numeric Value	0	R
00BFh	Warning Event Count	Total Warning Event Count	Numeric Value	0 - 65535	R
00C0h	Running Time Hi	Running Time Hi for Alarm Event log entries	Numeric Value	0 - 65535	R
00C1h	Running Time Low	Running Time Low for Alarm Event log entries	Numeric Value	0 - 65535	R
00C2h	Clock Time Hi	Hi byte = year, Lo byte month: Alarm clock time	Numeric Value	1 –99 year, 1–12 month	R
00C3h	Clock Time Mid	Hi byte = Day, Lo byte Hour: Alarm clock time	Numeric Value	1 – 31 day, 0 – 23 hour	R
00C4h	Clock Time Low	Hi byte = Minute, Lo byte second: Alarm clock time	Numeric Value	0 – 59 minutes 0 – 59 seconds	R
00C5h	Reserved	Reserved	Numeric Value	0	R
00C6h	Reserved	Reserved	Numeric Value	0	R
00C7h	Alarm Event Count	Total Alarm Event Count	Numeric Value	0 - 65535	R
00C8h	Running Time Hi	Running Time Hi for Fault Event log entries	Numeric Value	0 - 65535	R
00C9h	Running Time Low	Running Time Low for Fault Event log entries	Numeric Value	0 - 65535	R
00CAh	Clock Time Hi	Hi byte = year, Lo byte month: Fault clock time	Numeric Value	1 –99 year, 1–12 month	R
00CBh	Clock Time Mid	Hi byte = Day, Lo	Numeric	1 – 31 day,	R

		byte Hour: Fault clock time	Value	0 – 23 hour	
00CCh	Clock Time Low	Hi byte = Minute, Lo byte second: Fault clock time	Numeric Value	0 – 59 minutes 0 – 59 seconds	R
00CDh	Fault Code	See	Numeric Value	0	R
00CEh	Reserved	Reserved	Numeric Value	0	R
00CFh	Fault Event Count	Total Fault Event Count	Numeric Value	0 - 65535	R
00D0h	Running Time Hi	Running Time Hi for Maintenance Event log entries	Numeric Value	0 - 65535	R
00D1h	Running Time Low	Running Time Low for Maintenance Event log entries	Numeric Value	0 - 65535	R
00D2h	Clock Time Hi	Hi byte = year, Lo byte month: Maintenance clock time	Numeric Value	1 –99 year, 1–12 month	R
00D3h	Clock Time Mid	Hi byte = Day, Lo byte Hour: Maintenance clock time	Numeric Value	1 – 31 day, 0 – 23 hour	R
00D4h	Clock Time Low	Hi byte = Minute, Lo byte second: Maintenance clock time	Numeric Value	0 – 59 minutes 0 – 59 seconds	R
00D5h	Reserved	Reserved	Numeric Value	0	R
00D6h	Reserved	Reserved	Numeric Value	0	R
00D7h	Maintenance Event Count	Total Maintenance Event Count	Numeric Value	0 - 65535	R
00D8h	Running Time Hi	Running Time Hi for Calibration Event log entries	Numeric Value	0 - 65535	R
00D9h	Running Time Low	Running Time Low for Calibration Event log entries	Numeric Value	0 - 65535	R
00DAh	Clock Time Hi	Hi byte = year, Lo byte month: Calibration clock time	Numeric Value	1 –99 year, 1–12 month	R
00DBh	Clock Time Mid	Hi byte = Day, Lo byte Hour: Calibration clock time	Numeric Value	1 – 31 day, 0 – 23 hour	R

00DCh	Clock Time Low	Hi byte = Minute, Lo byte second: Calibration clock time	Numeric Value	0 – 59 minutes 0 – 59 seconds	R
00DDh	Calibration code	Calibration code	Numeric Value	1 – zero, 2 - calibration	R
00DEh	Reserved	Reserved	Numeric Value	0	R
00DFh	Calibration Event Count	Total Calibration Event Count	Numeric Value	0 - 65535	R

Table 8: List of Modbus Registers

1.4 IR400 Command Register Details

1.4.1 Analog

A read returns a value, which is proportional to the 0-20mA output current. The current is based on a 16-bit value. The master scaling is 0 - 65535 Decimal which corresponds to the IR400 scaling which is 0 - 21.7mA.

1.4.2 Operating Mode (Read/Write)

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 9: 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 decimal	40 hex 64 decimal	20 hex 32 decimal	10 hex 16 decimal	8 hex 8 decimal	4 hex 4 decimal	2 hex 2 decimal	1 hex 1 decimal

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 decimal	4000 hex 16384 decimal	2000 hex 8192 decimal	1000 hex 4096 decimal	800 hex 2048 decimal	400 hex 1024 decimal	200 hex 512 decimal	100 hex 256 decimal

1.4.2.1 Mode Descriptions (0x0001)

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. Writing 1 to mode register allows to abort zero/calibration/gas check, if gas concentration is less than 5% of Full Scale

CAL Mode: Calibration in progress at 50% LEL. Can write 0x0002 only during CAL pending mode, which lasts 30 sec

Zero Mode: Zeroing of the IR400 in progress. Writing 0x0004 to mode register sends the unit to zero mode.

CAL Pending: If 0x0002 is written to mode register during this stage, the unit starts calibration, otherwise the unit returns to run mode in 30 seconds.

Apply Gas: Waiting for 50% LEL gas to proceed with calibration

Remove Gas (CAL finished): IR400 calibration has finished, remove gas.

Startup Mode: IR400 is initializing during powerup.

Gas Check Mode: IR400 gas check is in progress

Zero and CAL Mode: Zeroing directly following by calibration. Writing 0x4000 to mode register will send the unit to zeroing mode, then to calibration, bypassing calibration pending stage.

1.4.3 Status Error (0x0002)

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 10: Bitmap for Status Error Delayed

Bit Position	3	2	1	0
Error	IR High	Beam Block	Clean Windows (Negative Gas Reading)	Partial Beam Block
Bit Value	8 hex / 8 decimal	4 hex / 4 decimal	2 hex / 2dec	1 hex / 1 decimal

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

Bit Position	11	10	9	8
Error	Heater problem	Ref. Lamp Problem	Active Lamp Prob.	Test forgotten (remove gas)
Bit Value	800 hex / 2048 decimal	400 hex / 1024 decimal	200 hex / 512 decimal	100 hex / 256 decimal

Bit Position	16	15	14	13
Error	EEPROM Error	Excess Neg. Gas Reading	Misc. fault	Clipping fault
Bit Value	8000 hex / 32768 decimal	4000 hex / 16384 decimal	2000 hex / 8192 decimal	1000 hex / 4096 decimal

1.4.4 Gas Selection (0x0003)

Reads/Sets gas selection for the detector. This register is compatible with IR2100 Modbus. The register can be written with the index numbers 0 to 7 or with the Gas ID. The Gas ID codes will not change in future versions and are consistent across General Monitors products. To read the Gas ID use register 0x008D.

Table 11. Gas Selection Codes

Index	Gas Type	Gas ID
0	Methane	100 ISO / 114 IEC
1	Propane	101 ISO / 115 IEC
2	N Butane	104 ISO / 120 IEC
3	Hexane	103 ISO / 121 IEC
4	% by volume Methane	106
5	Special Order	Unique for Each Gas
6	Ethane	102 ISO / 116 IEC
7	Pentane	105 ISO / 117 IEC

1.4.5 Model Type (0x0004)

A Read returns the model type for the detector, which is 2104 in Decimal format.

1.4.6 Software Rev (0x0005)

A read returns the software revision of the IR400 in 2 ASCII characters. The most significant byte is the first character, the least significant byte is the second character. For example, if this register reads 0x2042 then the first digit is 0x20 (a space character) and the second is 0x42 (the character B). So in this example the firmware version is " B".

1.4.7 Gain (0x0006)

A read returns the value of the gain. The difference between the initial value and the present value indicates the dirt on the windows. This register is provided for compatibility with the IR2100. A new register 0x0054 gives a beam block percentage which is scaled in a much more convenient way.

1.4.8 Calibration IO type (0x0007)

When the Cal IO type is set to LED Magnet switch, LED is blinking during zeroing/calibration and when the unit is in fault. Solenoid is disabled. If it is set to manual solenoid or ARGC, the LED driver is disabled from blinking error codes etc. It then can be used to drive a solenoid. A write command enables/disables the normal LED function. The solenoid function cannot be used until the LED function is disabled.

Function	Value (Decimal)
Magnet LED Switch	0
Manual solenoid	1
AGRG	2

Table 12: Cal IO types

Cal IO type can't be change is solenoid is ON.

1.4.9 Solenoid On/Off (0x0008)

This feature is used for Calibration and Gas check. If Cal IO type is Magnet LED Switch, solenoid is disabled.

A write command can be used only if Cal IO type is set to manual solenoid. In case of ARGC solenoid turns on and off automatically.

Function	Value (Decimal)	Access
On	10	Read/Write
Off	20	Read/Write
Normal Operation	30	Read

Table 13: Solenoid On/Off

Exception – If a value other than 10 or 20 is used in write command, then the Exception Code 03 is returned.

1.4.10 Address (0x0009)

A read returns the address of the IR400. A write changes the address to the requested address. The range of the address is 1 to 247.

NOTE: By grounding the RESET input during power-up cycle (10 seconds), the Address will default to 1.

1.4.11 Baud Rate (0x000B)

A read returns the baud rate of the IR400. A write changes the baud rate to the requested baud rate. After the baud rate has been changed to the addressed unit, the Modbus communications will cease because the baud rate has changed; therefore the master will have to change its baud rate to the slave's new baud rate in order to re-start the communications. The factory default is 9600.

Baud Rate Codes

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

This function is indicated on the Low Data Byte and the High Data Byte is not used.

Exception – If the baud rate is not in range an Illegal data value (03) is returned.

NOTE: By grounding the magnetic switch (holding a magnet over the switch) input during power-up cycle (10 seconds), the IR400 Baud Rate will default to 19600.

1.4.12 Data Format (0x000C)

A read returns the data format of the IR400. A write will change the data format to the requested data format. After the data format has been changed, the addressed unit may cease or start producing Comm. errors because the data format has changed; therefore, the master will have to change its data format to the slave's new data format in order to re-start or provide proper communications.

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

Table 14: Data Format

This function is indicated on the Low Data Byte and the High Data Byte is not used.

NOTE: By grounding the magnetic switch input during power-up cycle (10 seconds), the IR400 Data Format will default to 8-N-1.

Exception – If the baud rate is not in range an Illegal data value (03) is returned.

1.4.13 Priority Fault (0x000D)

A read returns the primary fault currently happening on the device. See Table 10.

1.4.14 Hazard Watch Options (0x0016)

A read returns the state enabled or disabled. A write of (1) enables Hazard Watch mode. A write of (0) disables Hazard Watch mode.

1.4.15 Alarm Level (0x0018)

Sets/reads minimum gas concentration level in % of Full Scale, when alarm event is logged

1.4.16 Warn Level (0x0019)

Sets/reads minimum gas concentration level in % of Full Scale, when warn event is logged

1.4.17 HART Configuration (0x001A)

0 in low byte means HART disabled, 1 – HART enabled. 0 in high byte means low current range (1.25 -20 mA), 1 - high current range (3.5 – 20mA).

1.4.18 Total Receive Errors (0x0020)

A read indicates the total Modbus Comm. Receive Errors that occurred in the slave device. The maximum count is 65,535; the counter will roll over to zero and begin counting again. The total errors are an accumulation of the individual Comm. errors listed below.

1.4.19 Function Code Errors (0x0022)

A read indicates the number of Function Code Errors that occurred in the slave device. The maximum count is 65,535 the counter will roll over to zero and begin counting again.

1.4.20 Starting Address Errors (0x0023)

The counter is incremented for illegal register address.

A read indicates the number of Starting Address Errors that occurred in the slave device. The maximum count is 65,535; the counter will roll over to zero and begin counting again.

1.4.21 CRC Hi Errors (0x0025)

A read indicates the number of CRC Hi Byte Errors that occurred in the slave device. The maximum count is 65,535; the counter will roll over to zero and begin counting again.

1.4.22 CRC Lo Errors (0x0026)

A read indicates the number of CRC Lo Byte Errors that occurred in the slave device. The maximum count is 65,535; the counter will roll over to zero and begin counting again.

1.4.23 Overrun Errors (0x0027)

A read indicates the number of Overrun Errors that occurred in the slave device. The maximum count is 65,535; the counter will roll over to zero and begin counting again.

1.4.24 Framing Errors (0x0029)

A read indicates the number of Framing Errors that occurred in the slave device. The maximum count is 65,535; the counter will roll over to zero and begin counting again.

1.4.25 Clear Communication Errors (0x002D)

A read or write resets all the Modbus Comm. Error counters to zero.

1.4.26 Beam Block Percentage (0x0054)

This register returns a value from 0-100. When the optical path of the IR400 is clear, the reading is 0% blocked. When the register reads near 100 the optical path is blocked and must be cleaned immediately. At 100% the IR400 indicates a fault condition and is no longer capable of detecting gas. This register can be used for predictive maintenance.

1.4.27 Gas ID (0x008D)

This register provides a way to read the unique Gas ID number for the currently selected gas. The table below shows the numbers for the gasses available in the IR400. This list will be extended as more gasses are made available and will be consistent across General Monitors' product range.

Gas ID number (decimal)	Gas Type
100	Methane
101	Propane
102	Ethane
103	Hexane
104	n-Butane
105	Pentane
106	% by volume Methane
108	Ethylene
109	Benzene
114	Methane IEC
115	Propane IEC
116	Ethane IEC
117	Pentane IEC
120	n-Butane IEC
121	Hexane IEC

1.4.28 Reset Events (0x00B0)

Writing 0 to this register clears all event counters, writing 1 – resets event happened flag.

1.4.29 Running Time in seconds hi word (0x00B1)

This sets/reads hi word of device running time in seconds. This value must be read/written prior to running time low byte (register 0x00B2).

1.4.30 Running Time in seconds lo word (0x00B2)

This sets/reads hi word of device running time in seconds. This value must be read/written after running time hi byte (register 0x00B1).

Table 15: Real Time Clock Time Format

Item Number	Description
1	Hi Byte =Year, Low Byte = Month
2	Hi Byte = Day, Low Byte = Hour
3	Hi Byte = Minute, Low Byte = Second

1.4.31 Real-time Clock Year, Month (0x00B3)

This is used to read/write the real time clock. The high byte will be the year minus 2000. The low byte will be a value from 1 to 12. To get or set real time, read or write year/month (0x00B3) first, then day/hour (0x00B4), then min/sec (0x00B5)

1.4.32 Real-time Clock Day, Hour (0x00B4)

This is used to read/write the real time clock. The high byte will be the day of the month from 1 to 31. The low byte will be the hour from 0 to 23. To get or set real time, read or write year/month (0x00B3) first, then day/hour (0x00B4), then min/sec (0x00B5)

1.4.33 Real-time Clock Minute, Second (0x00B5)

This is used to read/write the real time clock. The high byte will be the minute from 0 to 59 and the low byte will be the seconds from 0 to 59. To get or set real time, read or write year/month (0x00B3) first, then day/hour (0x00B4), then min/sec (0x00B5)

1.4.34 Power Cycle Flag (0x00B7)

This reads whether the time of day clock has been reset after a power has been re-cycled to the unit. If the time has been reset, this flag will be = 0; otherwise the flag will = 1.

1.4.35 Event Index (0x00B7)

This is used to indicate which of the stored events the user would like to read. There are 5 event logs: Warning events, Alarm events, Fault events, Calibration events and Maintenance events. Each of these event logs consist of 10 of their most recent occurrences. The user is able to read the logs of each of these by setting this event index followed by a reading of the desired event log. The event index is a number from 0 to 9. Zero refers to the most recent event and 9 refers to the least recent event stored in the log. For example to read time of the most recent Warning event in the Warning event log, set this register to 0 and then read registers 0xB8 and 0xB9 (for the running time in seconds) or read registers 0xBA, 0xBB, and 0xBC (for the clock time).

1.4.36 Warning Running Time in Seconds, Hi Word (0x00B8)

This register reads hi word of the running time in seconds when the warning event occurred. This time is in seconds since January 1, 2000.

1.4.37 Warning Running Time in Seconds, Low Word (0x00B9)

This register reads the low word of the running time in seconds when the warning event occurred. This time is in seconds since January 1, 2000.

The values from the above table should be read in order: first item 1, then item 2, & then item 3.

1.4.38 Warning Clock Time: Year, Month (0x00BA)

These registers are described in Table 15 as item number 1.

1.4.39 Warning Clock Time: Day, Hour (0x00BB)

These registers are described in Table 15 as item number 2.

1.4.40 Warning Clock Time: Minute, Second (0x00BC)

These registers are described in Table 15 as item number 3.

1.4.41 Total Warning Event Counter (0x00BF)

This reads the total number of warning events have been stored in the unit.

1.4.42 Alarm Running Time in Seconds, Hi Word (0x00C0)

This register reads the high word of the running time in seconds when the alarm event occurred. This time is in seconds since January 1, 2000.

1.4.43 Alarm Running Time in Seconds, Low Word (0x00C1)

This register reads the low word of the running time in seconds when the alarm event occurred. This time is in seconds since January 1, 2000.

1.4.44 Alarm Clock Time: Year, Month (0x00C2)

These registers are described in Table 15 as item number 1.

1.4.45 Alarm Clock Time: Day, Hour (0x00C3)

These registers are described in Table 15 as item number 2.

1.4.46 Alarm Clock Time: Minute, Seconds (0x00C4)

These registers are described in Table 15 as item number 3.

1.4.47 Total Alarm Event Counter (0x00C7)

This reads the total number of alarm events have been stored in the unit.

1.4.48 Fault Running Time in Seconds, Hi Word (0x00C8)

This register reads the high word of the running time in seconds when the fault event occurred. This time is in seconds since January 1, 2000.

1.4.49 Fault Running Time in Seconds, Low Word (0x00C9)

This register reads the low word of the running time in seconds when the fault event occurred. This time is in seconds since January 1, 2000.

1.4.50 Fault Clock Time: Year, Month (0x00CA)

These registers are described in Table 15 as item number 1.

1.4.51 Fault Clock Time: Day, Hour (0x00CB)

These registers are described in Table 15 as item number 2.

1.4.52 Fault Clock Time: Minute, Seconds (0x00CC)

These registers are described in Table 15 as item number 3.

1.4.53 Fault Code (0x00CD)

This register is described in Table 10.

1.4.54 Total Fault Event Counter (0x00CF)

This reads the total number of fault events have been stored in the unit.

1.4.55 Maintenance Running Time in Seconds, Hi Word (0x00D0)

This register reads the high word of the running time in seconds when the gas check event occurred. This time is in seconds since January 1, 2000.

1.4.56 Maintenance Running Time in Seconds, Low Word (0x00D1)

This register reads the low word of the running time in seconds when the gas check event occurred. This time is in seconds since January 1, 2000.

1.4.57 Maintenance Clock Time: Year, Month (0x00D2)

These registers are described in Table 15 as item number 1.

1.4.58 Maintenance Clock Time: Day, Hour (0x00D3)

These registers are described in Table 15 as item number 2.

1.4.59 Maintenance Clock Time: Minute, Seconds (0x00D4)

These registers are described in Table 15 as item number 3.

1.4.60 Total Maintenance Event Counter (0x00D6)

This reads the total number of gas check events have been stored in the unit

1.4.61 Calibration Running Time in Seconds, Hi Word (0x00D8)

This register reads the high word of the running time in seconds when the calibration event occurred. This time is in seconds since January 1, 2000.

1.4.62 Calibration Running Time in Seconds, Low Word (0x00D9)

This register reads the low word of the running time in seconds when the calibration event occurred. This time is in seconds since January 1, 2000.

1.4.63 Calibration Clock Time: Year, Month (0x00DA)

These registers are described in Table 15 as item number 1.

1.4.64 Calibration Clock Time: Day, Hour (0x00DB)

These registers are described in Table 15 as item number 2.

1.4.65 Calibration Clock Time: Minute, Seconds (0x00DC)

These registers are described in Table 15 as item number 3.

1.4.66 Calibration Code (0x00DD)

This returns 1 for zero events and 2 for calibration events.

1.4.67 Total Calibration Event Counter (0x00DF)

This reads the total number of calibration events have been stored in the unit.