General Monitors S5000 Modbus Specification

CE

MSA

The Safety Company

General Monitors, an MSA company
26776 Simpatica Circle
Lake Forest, CA 92630
USA
Phone: +1-949-581-4464

For your local MSA contacts please go to our website www.MSAsafety.com

Contents

US

US

Tables

US

1. Modbus Interface

1.1. Baud Rate

The baud rate is selectable via the Modbus Communications Interface. The selectable baud rates are as follows:

Table 1 Baud Rate

User Select	Baud Rates
0	2400 bits per second
1	4800 bits per second
2	9600 bits per second
3	19200 bits per second
4	38400 bits per second
5	115200 bits per second

1.2. Data Format

The data format is selectable via the Modbus Communications Interface. The selectable data formats are as follows:

Table 2 Data Format

User Select	Data Bits	Parity	Stop Bit	Format
0	8	None	1	8-N-1
1	8	Even	1	8-E-1
2	8	Odd	1	8-O-1
3	8	None	2	8-N-2

1.3. Modbus Read Status Protocol (Query/Response)

1.3.1 Modbus Read Query Message

Table 3 Modbus Read Query Message

Byte	Modbus	Range	Referenced to S5000
1st	Slave Address	1-247* (Decimal)	S5000 ID (Address)
2nd	Function Code	03	Read holding registers
3rd	Starting Address Hi**	00-01 (Hex)	S5000
4th	Starting Address Lo**	00-FF (Hex)	S5000 Commands
5th	No. of Registers Hi	00	Not used by S5000
6th	No. of Registers Lo	01	No. of 16 bit registers
7th	CRC Lo	00-FF (Hex)	CRC Lo byte
8th	CRC Hi	00-FF (Hex)	CRC Hi byte

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

**NOTE: Starting Address can be a maximum of 9999 Address Locations (0000-270E).

1.3.2 Modbus Read Response Message

Table 4 Modbus Read Response Message

Byte	Modbus	Range	Referenced to S5000
1st	Slave Address	1-247* (Decimal)	S5000 ID (Address)
2nd	Function Code	03	Read holding registers
3rd	Byte Count	02	No. of data bytes
4th	Data Hi	00-FF (Hex)	S5000 Hi byte status data
5th	Data Lo	00-FF (Hex)	S5000 Lo byte status data
6th	CRC Lo	00-FF (Hex)	CRC Lo byte
7th	CRC Hi	00-FF (Hex)	CRC Hi byte

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

1.4. Modbus Write Command Protocol

1.4.1 Modbus Write Query Message

Table 5 Modbus Write Query Message

Byte	Modbus	Range	Referenced to S5000
1st	Slave Address	1-247* (Decimal)	S5000 ID (Address)
2nd	Function Code	06	Preset single register
3rd	Register Address Hi	00-01 (Hex)	S5000
4th	Register Address Lo	00-FF (Hex)	S5000
5th	Preset Data Hi	00-FF (Hex)	S5000 Hi byte command data
6th	Preset Data Lo	00-FF (Hex)	S5000 Lo byte command data
7th	CRC Lo	00-FF (Hex)	CRC Lo byte
8th	CRC Hi	00-FF (Hex)	CRC Hi byte

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

**NOTE: Starting Address can be a maximum of 9999 Address Locations (0000-270E).

1.4.2   Modbus Write Response Message

Table 6 Modbus Write Response Message

Byte	Modbus	Range	Referenced to S5000
1st	Slave Address	1-247* (Decimal)	S5000 ID (address)
2nd	Function Code	06	Preset single register
3rd	Register Address Hi	00-01 (Hex)	S5000
4th	Register Address Lo	00-FF (Hex)	S5000 commands
5th	Preset Data Hi	00-FF (Hex)	S5000 Hi byte command data
6th	Preset Data Lo	00-FF (Hex)	S5000 Lo byte command data
7th	CRC Lo	00-FF (Hex)	CRC Lo byte
8th	CRC Hi	00-FF (Hex)	CRC Hi byte

1.5.   Function Codes Supported

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

- Function Code 04 allows multiple registers to be read. You can use 3 or 4 for multiple reads.

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

1.6.   Exception Responses and Exception Codes

1.6.1   Exception Response

In a normal communications query and response, the master device sends a query to the S5000 receives the query without a communications error and handles the query normally within the master device's allowable timeout. The S5000 then returns a normal response to the master. An abnormal communications query produces one of four possible events:

- If the S5000 does not receive the query due to a communications error, then no response is returned from the S5000 and the master device will eventually process a timeout condition for the query.

- If the S5000 receives the query, but detects a communication error (CRC, etc.), then no response is returned from the S5000 and the master device will eventually process a timeout condition for the query.

- If the S5000 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 S5000. 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 S5000 is 200 milliseconds. Therefore the master's timeout setting should be set to 200 milliseconds or greater.**

- If the S5000 receives the query without a communications error, but cannot process it due to reading or writing to a non-existent S5000 command register, then the S5000 will return an exception response message informing the master of the error.

US

Table 7 Exception Response Message

Byte	Modbus	Range	Referenced to S5000
1st	Slave Address	1-247* (Decimal)	S5000 ID (address)
2nd	Function Code	82-8E (Hex)	MSB is set with function code
3rd	Exception Code	01-0B (Hex)	Appropriate exception code (see below)
4th	CRC Lo	00-FF (Hex)	CRC Lo byte
5th	CRC Hi	00-FF (Hex)	CRC Hi byte

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

1.6.2 Exception Code

Exception Code Field: In a normal response, the S5000 returns data and status in the data field, which was requested in the query from the master. In an exception response, the S5000 returns an exception code in the data field, which describes the S5000 condition that caused the exception. Below is a list of exception codes that are supported by the S5000:

Table 8 Exception Codes

Code	Name	Description
01	Illegal Function	The function code received in the query is not an allowable action for the S5000.
02	Illegal Data Address	The data address received in the query is not an allowable address for the S5000.
03	Illegal Data Value	A value contained in the query data field is not an allowable value for the S5000.
04	Slave Device Failure	An unrecoverable error occurred while the S5000 was attempting to perform the requested action.
05	Acknowledge	The S5000 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 S5000 is engaged in processing a long-duration program command. The master should retransmit the message later when the slave is free.
08	Memory Parity Error	Specialized use in conjunction with function codes 20 and 21 and reference type 6, to indicate that the extended file area failed to pass a consistency check the serve attempted to read record file, but detected a parity error in the memory. The client can retry the request, but service may be required
0A	Gateway Path Unavailable	Specialized use in conjunction with gateways, indicates that the gateway was unable to allocate an internal communication path from the input port to the output port for processing the request. Usually means that the gateway is misconfigured or overloaded.
0B	Gateway Target Device Fail to respond	Specialized use in conjunction with gateways, indicates that no response was obtained from the target device. Usually means that the device is not present on the network.

1.7. S5000 Command Register Table

Table 9 Register Location

Parameter	Function	Type	Scale	Access	Register Address	Master I/O Address
Model ID	Modbus model ID	Value	0-65535	R	0000	40001
Software Rev	Software revision (major)	Value	1-9	R	0002	40003
SW Rev Sub	SW revision minor	Value	0-99	R	0003	40004
SW Rev Sub	SW revision sub-minor \	Value	0-9999	R	0004	40005
Serial Number	Indicate upper serial number	ASCII	2-Char	R	0005	40006
Serial Number	Indicate lower serial number	ASCII	2-Char	R	0006	40007
User Input	Set user input	Bit 0	0-1	W	0007	40008
Unit Critical Errors	System critical errors and faults	Bit Map		R	0008	40009
Non-Critical Error	System non-critical errors and faults	Bit Map		R	0009	40010
Sensor Installed/ Not Installed	Installed sensors	Bit 0	0:1	R	000A	40011
Unit Temperature	Indicate unit temperature	Value	Whole number	R	000B	40012
Reset Alarms	Reset all latched alarms	Bit 0	1	W	000C	40013
Relay Configuration	Relay configurations	Bits	16-Bit	R	000D	40014
Zone/Horn Configurations	Zone or horn configurations	Value		RW	000E	40015
Relay Status	Read current relays status	Bits		R	000F	40016
AO Current Setting	Change or read analog output Low current setting	Bits	Bit (0:2)	RW	0010	40017
Customized Cal AO Level	Change or read calibration analog output level	Value	0-xx	RW	0011	40018
Customized Fault AO Level	Change or read fault analog output level	Value	0-xx	RW	0012	40019
Spared				R	0013	40020
Customized Cleaning Mode AO Level	Change or read cleaning mode analog output level	Value	0-xx	RW	0014	40021
Hart En/De	Hart enable/disable	Bit:0	0:1	RW	0015	40022

Parameter	Function	Type	Scale	Access	Register Address	Master I/O Address
IR Touch En/De	IR Touch enable/disable	Bit:0	0:1	RW	0016	40023
Bluetooth En/De	Bluetooth enable/disable	Bit:0	0:1	RW	0017	40024
BCM Status	Return BCM status	Bits	0:15	RO	0018	40025
Modbus Address	Read or change settings for the Modbus address	Value	1:247	R/W	0019	40026
Modbus Baud Rate	Read or change settings for the Modbus baud rate	Value	(0-7)	R/W	001A	40027
Modbus Data Format	Read or change settings for the Modbus data format	Bit	(0-7)	R/W	001B	40028
Modbus Total Received Error	Read total # of received errors Write to reset the error counters (001C-0023)	Value	0-65535	R/W	001C	40029
Modbus Function Code Error	Read only, total # of function code error	Value	0-65535	R	001D	40030
Starting Address Error	Total # of starting address errors	Value	0-65535	R	001E	40031
No of Register Errors	Total # of register errors	Value	0-65535	R	001F	40032
Received CRC Err	Total # of RXD CRC errors	Value	0-65535	R	0020	40033
Parity Error	Total # of parity errors	Value	0-65535	R	0021	40034
Overrun Error	Total # of overrun errors	Value	0-65535	R	0022	40035
Framing Error	Total # of framing errors	Value	0-65535	R	0023	40036
Real Time Clock_ Year: Month	RTC year and month	Value	Y:0-99 M:1-12	RW	0024	40037
RTC Day: Hour	RTC day and hour	Value	D:0-31 H:0-23	RW	0025	40038
RTC Min: Sec	RTC minute and second	Value	M:0-59 S:0:59	RW	0026	40039
Average Interval	Read/write average interval	Value	1/8/24	RW	0027	40040
Avg Start Hour	Hour that the interval start	Value	1-24	RW	0028	40041
Sensor Swap Delay Enable	Change sensor missing timeout from 3 sec to 60 sec	Bit 0	0-1	RW	0029	40042

US

Parameter	Function	Type	Scale	Access	Register Address	Master I/O Address
Alternate Toxic Display Uni	Select ppm, mg/m^3 and µmol/mol	Bit	Bit 0:1	RW	002A	40043
Language	Language selection	Value	0-8	RW	002B	40044
Reset Factory Default	Reset the unit setting to factory default	Bit 0	1	Write	002C	40045
Reset Instrument	Reset the transmitter both channels	Bit 0	1	Write	002D	40046
Unit Tag#1	Unit tag ID	ASCII	2-Char	RW	002E	40047
Unit Tag#2	Unit tag ID	ASCII	2-Char	RW	002F	40048
Unit Tag#3	Unit tag ID	ASCII	2-Char	RW	0030	40049
Unit Tag#4	Unit tag ID	ASCII	2-Char	RW	0031	40050
Reset Event Ctr	Reset the event counters	Bit	Bit 0	Write	0032	40051
Event Index	Event index of logged event	Value	0-65535	R	0033	40052
Warn time Yr: Mo	Warning event log	Value	Y:0-99 M:1-12	R	0034	40053
Warn time Day: Hour	Warning event log	Value	D:1-31 H:0-23	R	0035	40054
Warn time Min: Second	Warning event log	Value	M:0-59 S:0-59	R	0036	40055
Warn Code	Detail warning event	Value	2x16Bit	R	0037-38	40056-57
Warn Event Count	Warning event count	Value	0-65535	R	0039	40058
Alarm time Yr: Mo	Alarm event log	Value	Y:0-99 M:1-12	R	003A	40059
Alarm time Day: Hour	Alarm event log	Value	D:1-31 H:0-23	R	003B	40060
Alarm time Min: Second	Alarm event log	Value	M:0-59 S:0-59	R	003C	40061
Alarm Code	Detail alarm event	Value	2x16Bit	R	003D-3E	40062-3
Alarm Event Count	Alarm event count	Value	0-65535	R	003F	40064
Fault time Yr: Mo	Fault event log	Value	Y:0-99 M:1-12	R	0040	40065
Fault time Day: Hour	Fault event log	Value	D:1-31 H:0-23	R	0041	40066
Fault time Min: Second	Fault event log	Value	M:0-59 S:0-59	R	0042	40067
Fault Code	Detail fault event	Value	2x16Bit	R	0043-44	40068-69
Fault Event Count	Fault event count	Value	0-65535	R	0045	40070
Maintenance time Yr : Mo	Maintenance event log	Value	Y:0-99 M:1-12	R	0046	40071

S5000 Modbus Specification

Parameter	Function	Type	Scale	Access	Register Address	Master I/O Address
Maintenance time Day : Hr	Maintenance event log	Value	D:1-31 H:0-23	R	0047	40072
Maintenance time Min : Sec	Maintenance event log	Value	D:1-31 H:0-23	R	0048	40073
Maintenance Code	Detail maintenance event	Value	2x16Bit	R	0049-4A	40074-75
Maintenance Event Count	Maintenance event count	Value	0-65535	R	004B	40076
Calibrate Time Yr : Mo	Calibration event log	Value	Y:0-99 M:1-12	R	004C	40077
Calibrate Time Day : Hr	Calibration event log	Value	D:1-31 H:0-23	R	004D	40078
Calibrate Time Min : Sec	Calibration event log	Value	D:1-31 H:0-23	R	004E	40079
Calibrate Code	Detail calibration event	Value	2x16Bit	R	004F-50	40080-81
Calibrate Event Count	Calibration event count	Value	0-65535	R	0051	40082
Restart Time Yr : Mo	Restart event log	Value	Y:0-99 M:1-12	R	0052	40083
Restart Time Day : Hr	Restart event log	Value	D:1-31 H:0-23	R	0053	40084
Restart Time Min : Sec	Restart event log	Value	D:1-31 H:0-23	R	0054	40085
Restart Code	Detail restart event	Value	2x16Bi	R	0055-56	40086-87
Restart Event Count	Restart event count	Value	0-65535	R	0057	40088
Spared Register	40089-400100					
	Sensor section start here					
Channel Select	Select the sensor channel	Value	(1-2)	RW	0064	40101
Analog Output	Current output in (µAmp)	Value	0-65535	R	0065	40102
Sensor Mode	Display sensor modes	Value	(0-19)	R	0066	40103
Sensor Status	Digital bus sensor only			R	0067	40104
Sensor Fault Hi	Sensor fault	Bitmap	0-32768	R	0068	40105
Sensor Fault Lo	Bitmap (32 bits)	Bitmap	0-32768	R	0069	40106
Sensor Type		See Table 23		R	006A	40107

US

Parameter	Function	Type	Scale	Access	Register Address	Master I/O Address
Gas Reading Hi	Gas reading in floating point IEEE745, 32 bit	Float	0-FFFF	R	006B	40108
Gas Reading Lo	Gas reading in floating point IEEE745, 32 bit	Float	0-FFFF	R	006C	40109
Gas Unit	Select gas unit types	Value	0-10	R	006D	40110
Full Scale (Custom) Hi	Gas reading in floating point IEEE745, 32 bit	Float	0-FFFF	RW	006E	40111
Full Scale (Custom) Lo	Gas reading in floating point IEEE745, 32 bit	Float	0-FFFF	RW	006F	40112
Span Value Hi	Calibration gas level in floating point IEEE745, 32 bit	Float	0-FFFF	RW	0070	40113
Span Value Lo	Calibration gas level in floating point IEEE745, 32 bit	Float	0-FFFF	RW	0071	40114
% of Actual Full Scale	Read actual sensor full scale	Value	0-100	R	0072	40115
Cal Command	Read or set for the calibration command	See Table 26		R/W	0074	40117
Alarm Latch Setting	Read or set for the alarm latch settings	Bit: 0 and 1	0:3	R/W	0075	40118
Alarm Set Point	Sensor alarm 2 set point	Value		RW	0076	40119
Warn Set Point	Sensor alarm 1 set point	Value		RW	0077	40120
Warn Direction	Read or set alarm 1 direction	Bit:0	0/1	RW	0078	40121
Sensor Temp	Sensor temperature (interior)	Value		RO	0079	40122
Extended Sensor Fault (Hi)	Extended sensor fault, Hi	Bitmap		R	007A	40123
Extended Sensor Fault (Low)	Extended sensor fault, Lo	Bitmap		R	007B	40124
Firmware Rev (Sensor)	Sensor revision			R	007C	40125
Sensor Drift	Sensor drift counts			R	007D	40126
Min Interval Hi	Minimum interval value	Float	IEEE	RO	007E	40127
Min Interval Lo	Minimum interval value	Float	IEEE	RO	007F	40128
Max Interval Hi	Maximum interval value	Float	IEEE	RO	0080	40129

Parameter	Function	Type	Scale	Access	Register Address	Master I/O Address
Max Interval Lo	Maximum interval value	Float	IEEE	R	0081	40130
Ave Interval Hi	Average interval value	Float	IEEE	RO	0082	40131
Ave Interval Lo	Average interval value	Float	IEEE	R	0083	40132
Gas Table	Read/set gas table			R/W	0084	40133
Data Sheet Reset	Reset the sensor data sheet	Bit	1	W	0085	40134
Sensor Disable	Enable/disable sensor	Bit	1/0	R/W	0086	40135
Gas ID Type	Gas ID type			R	0087	40136
Sensor Health	Remaining sensors life	Value	0-100	RO	0088	40137
Alarm Direction	Read or set alarm 2 direction	Bit:0	0/1	RW	0078	40138
Alarm En/Disable	Read or set alarm 2 output enable	Bit:0	0/1	RW	008A	40139
Warn En/Disable	Read or set alarm 1 output enable	Bit:0	0/1	RW	008B	40140
TruCal Enable	Sensor TrueCal Enable	Bit:0	0/1	R/W	008C	40141
Blockage Enable	Enable blockage function	Bit:0	0/1	RW	008D	40142
Sensor Alarms State	Current gas alarms states	Value	Low: S1 Hi: S2	RO	008E	40143
As Found Value Hi	Displayable as found value after calibration Hi	Float		RO	008F	40144
As Found Value Lo	Displayable as found value after calibration Lo	Float		RO	0090	40145
% Span Change	% of span change from precalibration to calibration	Value	0-100	RO	0091	40146
Spared Registers	(40147 to 40160)					
Long Tag 1	User tags	ASCII			00A0	40161
Long Tag 2		ASCII			00A1	40162
Long Tag 3		ASCII			00A2	40163
Long Tag 4		ASCII			00A3	40164
Long Tag 5		ASCII			00A4	40165
Long Tag 6		ASCII			00A5	40166
Long Tag 7		ASCII			00A6	40167

US

Parameter	Function	Type	Scale	Access	Register Address	Master I/O Address
Long Tag 8		ASCII			00A7	40168
Long Tag 9		ASCII			00A8	40169
Long Tag 10		ASCII			00A9	40170
Long Tag 11		ASCII			00AA	40171
Long Tag 12		ASCII			00AB	40172
Long Tag 13		ASCII			00AC	40173
Long Tag 14		ASCII			00AD	40174
Long Tag 15		ASCII			00AE	40175
Long Tag 16		ASCII			00AF	40176
Spared	40177-40254					

1.8. S5000 Command Register Details

System level section: In this section, most registers are related to the system information, system faults and alarms, system level relay and zone configuration, analog current configuration, modules switches, Modbus communication configuration, real time clock, system related calculation configuration, tag IDs and event logs.

1.8.1 Model ID (0x0000h)

A read returns a Model ID (5000).

1.8.2 Software Revision (0x0002, 0x0003, 0x0004h)

A read returns current firmware version of the S5000 in Major, Minor, Sub Minor.

1.8.3 Serial Number 32 Bit format (0x0005, 0x0006h)

A read returns 4-byte message containing the unit serial number, 05h is the most significant 2-byte and 06h is the least significant 2 byte.

1.8.4 User Input (0x0007h)

Writing "1" to this register will set the current state to next state.

1.8.5 System Critical Faults (0x0008h)

A read returns a bit map of current critical errors (if present).

Table 10 System Critical Faults

Bit	Fault Name	Fault Description
0	Low Supply Voltage Fault	The input power supply voltage is out of low end range.
1	RAM Checksum Fault	RAM test/check has failed.
2	Flash Checksum Fault	Flash checksum check has failed.
3	EEPROM Fault	EEPROM access or checksum check has failed.
4	Internal Circuit Fault	Internal circuitry fault or abnormal internal voltages (except battery)

Bit	Fault Name	Fault Description
5	Sensor 1 Fault	Sensor 1 is in fault condition.
6	Sensor 2 Fault	Sensor 2 is in fault condition.
7	Relay Fault	One or more relays are in fault condition.
8	Configuration Fault	System configuration fault
9	Reserved	
10	Reserved	
11	Reserved	
12	Reserved	
13	Reserved	
14	Reserved	
15	General System Error	Any other system level critical fault/error.

1.8.6   System Non-Critical Faults (0x0009h)

A read returns a bit map of current non-critical faults (if present).

Table 11 System Non-Critical Faults

Bit	Fault Name	Fault Description
0	EZ-Touch Switch Fault	EZ-Touch switch has been left closed for more than two minutes.
1	RTC Battery Low Fault	RTC backup battery low.
2	Display/UI Board Fault	Communication or the power supply to display/UI board has failed.
3	Fail to Complete Setup Fault	Base unit has been in setup mode for more than six minutes.
4	Bluetooth Module Fault	Communication to Bluetooth module has failed.
5	BCM Fault	Communication to BCM has failed. Or, BCM has reported failure.
6	HART Reference Volt	HART® reference voltage has failed.
7	HART	Communication to HART®
8	LEDs	LED control has failed.
9	Invalid EEPROM Event log	Invalid EEPROM access event log index
10	Invalid EEPROM BlueTooth	Invalid EEPROM access Bluetooth index
11	Magnetic Switch Fault	Magnetic switch has been left closed for more than two minutes.
12	Non-Critical Faults	Number of non-critical faults
13	Reserved	
14	Reserved	
15	Reserved	

US

1.8.7   Sensor Installed (0x000Ah)

A read returns a bit map of installed sensors, Bit 0: Sensor 1 and Bit 1: Sensor 2.

Table 12 Sensor Installed

Sensor	Bits		
Sensor 1	Bit: 0	Sensor #1 only: 0x0001h	Sensor #1 and #2: 0x0003
Sensor 2	Bit: 1	Sensor #2 only : 0x0002h	Sensor #1 and #2: 0x0003

1.8.8   System Temperature (0x000Bh)

A read returns a system temperature in Celsius.

1.8.9   Reset Alarms and Faults (0x000Ch)

This register is write-only (WO) and writing a "1" will reset the current alarms and faults.

1.8.10   Relay Configuration (0x000D h)

A read returns a relay's configuration bit map and writing to it configures the relay.

Table 13 Relay Configuration

Relay Configuration (0x0D h)	Bits	De-energized/Energized
Relay 1 (warn)	Bit: 0	0/1
Relay 2 (alarm)	Bit: 1	0/1

1.8.11   Zone/Horn Configuration (0x000Eh)

A read returns a zones/horn configuration selection and writing to it configures the zones/horn relays.

Table 14 Zone/Horn Configuration

One Zone	Two Zone	Horn
0	1	2

US

1.8.12 Relay Status (0x000Fh)

This is a read only register (RO). A read returns a current relay status bit map.

Table 15 Relay Status

Bit 0 to 2:

Relay Diagnostic Bits	Bit 0:2	Okay/Fault
Warn Relay	Bit: 0	0/1
Alarm Relay	Bit: 1	0/1
Fault Relay	Bit: 2	0/1

Bit 3 to 5:

Relay Latch/Unlatch Bits	Bit 3:5	Unlatch Latch/Fault
Warn Relay	Bit: 3	0/1
Alarm Relay	Bit: 4	0/1
Fault Relay	Bit: 5	0/1

Bit 7:

Relay Card Installed	Bit 7	Not/Installed
Relay Card	Bit: 7	0/1

1.8.13 Current Set Point Selection (Analog Output) (0x0010h)

A read returns the current selection of low analog output. Writing to the register will set the low analog output selection.

Table 16 Current Selection

Bit 0 to 2:

Analog Output	Value
3.5 with HART®	0x02
1.25 with HART®	0x03
Custom current (0x11-0x14 h)	0x04
Custom current 21ma, O2	0x05

1.8.14 Customized Current Output Level Calibration (0x0011h)

A read returns the customized calibration current output level and Write to the register will set the customized calibration current output level. The customized current level range is between 1250 uA to 3750 uA. Customized current selection is needed (0x0010h must be 0x04).

1.8.15 Customized Current Output Level Fault (0x0012h)

A read returns the customized fault current output level and Writing to the register will set the customized fault current output level. The customized current level range is between 2000 µA to 3750 µA.

1.8.16 Customized Cleaning Mode Current Output Level (0x0014h)

A read returns the current customized fault current output level and Writing to the register will set the customized fault current output level. The customized current level range is between 2000 µA to 3750 µA. The customized cleaning mode only works with IR400 unit.

1.8.17 HART® Enable Switch (0x0015h)

A read returns HART® module status flag, 0: disable and 1: enable. Writing to the register will set the flag.

1.8.18 Ez-Touch Enable Switch (0x0016h)

A read returns Ez-Touch status flag, 0: disable and 1: enable. Writing to the register will set the Ez-Touch status.

1.8.19 Bluetooth Enable Switch (0x0017h)

A read returns Bluetooth module status flag, ”0”means disable and “1” means enable. Writing to the register will set the flag.

1.8.20 BCM Status Register (0x0018h)

A read returns BCM status: Bit Map:

Bit15: BCM card Installation Indicator, 1: Installed 0: Not installed

Bit14: Working Status, 1: Working 0: Not working

Bit7:0: BCM type

1.8.21 Modbus Com Address (0x0019h)

A read command returns the current address of the Modbus communication. A write command changes the address to the requested value. Valid addresses are 1-247 decimal. **Factory default is 1.**

1.8.22 Com Baud Rate (0x001Ah)

A read command returns the current baud rate for Com1. A write command changes the baud rate to the requested values. Valid settings are shown in the table below. **Factory default is 19,200.**

Table 17 Com Baud Rate

Baud Rate	Value	Val (Hex)	Access
2400	0	0	Read/write
4800	1	1	Read/write
9600	2	2	Read/write
19200	3	3	Read/write
38400	4	4	Read/write
115200	5	5	Read/write

Exception: If the baud rate is not in range, an illegal data value (03) is returned.

US

1.8.23   Com Data Format (0x001Bh)

A read command returns the current data format for Com1. A write command changes the data format to the requested values. Valid settings are shown in the table below. **Default format is 8-N-1.**

Table 18 Com1 Data Format

Data	Parity	Stop	Format	Data (Bits 8-9)	Access
8	None	1	8-N-1	0	Read/write
8	Even	1	8-E-1	1	Read/write
8	Odd	1	8-O-1	2	Read/write
8	None	2	8-N-2	3	Read/write

1.8.24   Total Receive Errors / Reset Errors (0x001Ch)

A read indicates the total Modbus Communication Receive Errors that occurred during receiving in the channel or in the slave device. The maximum count is 65535 and the counter will rollover to zero and begin counting again. The total errors are an accumulation of the individual communication errors listed below.

1.8.25   Function Code Errors (0x001Dh)

A read indicates the number of Function Code Errors that occurred in the slave device. The maximum count is 65535, the counter will rollover to zero and begin counting again.

1.8.26   Starting Address Errors (0x001Eh)

A read indicates the number of Starting Address Errors that occurred in the slave device. The maximum count is 65535, the counter will rollover to zero and begin counting again.

1.8.27   Number of Register Errors (0x001Fh)

A read indicates the Number of Register Errors that occurred in the slave device. The maximum count is 65535, the counter will rollover to zero and begin counting again.

1.8.28   RXD CRC Errors (0x0020h)

A read indicates the number of RXD CRC Errors that occurred in the slave device. The maximum count is 65535, the counter will rollover to zero and begin counting again.

1.8.29   Parity Errors (0x0021h)

A read indicates the number of hardware UART Parity Errors that occurred in the slave device. The maximum count is 65535, the counter will rollover to zero and begin counting again.

1.8.30   Overrun Errors (0x0022h)

A read indicates the number of hardware UART Overrun Errors that occurred in the slave device. The maximum count is 65535, the counter will rollover to zero and begin counting again.

1.8.31   Framing Errors (0x0023h)

A read indicates the number of hardware UART Framing Errors that occurred in the slave device. The maximum count is 65535, the counter will rollover to zero and begin counting again.

1.8.32 RTC (Real Time Clock) (0x0024h)

Updating the RTC clock requires a proper sequence. Registers must be written in order: First: 0x24h (Year and Month), then 0x25h (Day and Hour) and 0x26h must be the last one (Minute and Second).

A read indicates the RTC year and month. The high byte indicates last two digits of the current year (0:99) and Low byte indicates the current month (1:12). Writing to the register will held the data in the system but requires to write the register 0x26h (RTC Minute and Second) to update the RTC.

1.8.33 RTC (Real Time Clock) (0x0025h)

A read indicates the RTC Day and Hour. The high byte indicates current RTC day (1:31) and Low byte indicates the hour (0:23). Writing to the register will held the data in the system but requires to write the register 0x26h (RTC Minute and Second) to update the real time clock.

1.8.34 RTC (Real Time Clock) (0x0026h)

A read indicates the RTC minute and second. The high byte indicates current RTC minute (0:59) and low byte indicates the second (0:59). Writing to the register will update the RTC.

1.8.35 Average Interval (0x0027h)

Writing this register will set the gas measurements average interval to once every 1, 8 or 24 hours.

1.8.36 Average Start Hour (0x0028h)

Writing this register will set the starting point of the Average interval. This is used to determine when the 8 or 24 hour average interval starts.

1.8.37 Sensor Swap Delay Enable (0x0029h)

A read returns Swap Delay Enable status flag, 0: disable and 1: enable. Writing to the register will set the flag.

1.8.38 Alternate Toxic Display Unit (0x002Ah)

A read returns Alternate Toxic display unit in number.

Table 19 Alternate Toxic Unit

Unit	Value
PPM	0x01
MG Per M3	0x02
µmol Per Mol	0x03
Not Applicable	0xFF

1.8.39 Reset Factory Default (0x002Ch)

Writing to the register will set the factory default except Modbus setting.

1.8.40 Reset Instrument (0x002Dh)

Writing to the register will reset the previous faults and errors.

1.8.41   User Short Tag (0x002Eh: 0x0031h)

Unit tags are for customer use. The registers can be read or write. Each register has two bytes and each byte can be able to held one ASCII character.

1.8.42   Reset All Event Counters (0x0032Ah)

Writing to this register resets all event counters to zero.

1.8.43   Event Index (0x0033h)

There are 6 event logs and each event log can hold their 10 most recent events. The user can be able to read each event by setting this event index followed by the desired event log. The event index is a number from 0 to 9. The default value for the event index is 0. After the user set the event index, the system will keep the last event index as long as the power is on. For example, in order to read the oldest warning event in the warn event log, set the event index register to "9" and then read the register 0x0034 h, 0x0035h and 0x0036h for the warn event time (year, month, day, hour, minute and second) and register 0x0037 and 0x0038 for the warn event code. This event index applies for all 6 event logs.

1.8.44   Event, Warn, Alarm, Fault, Maintenance Calibration and Restart Log

Event logs time stamp and event code registers.

Table 20 Event Log Time Stamps and Registers

Event	Yr: Month	Day: Hour	Min: Sec	Code Hi	Code Lo
Warn	0x0034h	0x0035h	0x0036h	0x0037h	0x0038h
Alarm	0x003Ah	0x003Bh	0x003Ch	0x003Dh	0x003Eh
Fault	0x0040h	0x0041h	0x0042h	0x0043h	0x0044h
Maintenance	0x0046h	0x0047h	0x0048h	0x0049h	0x004Ah
Calibration	0x004Ch	0x004Dh	0x004Eh	0x004Fh	0x0050h
Restart	0x0052h	0x0053h	0x0054h	0x0055h	0x0056h

1.8.45   Warn Event Counter (0x0039h)

A read indicates total number of warning events have been stored in the warn event log. The maximum counter value is 65535.

1.8.46   Alarm Event Counter (0x003Fh)

A read indicates total number of Alarm events have been stored in the alarm event log. The maximum counter value is 65535.

1.8.47   Fault Event Counter (0x0045h)

A read indicates total number of Fault events have been stored in the fault event log. The maximum counter value is 65535.

1.8.48   Maintenance Event Counter (0x004Bh)

A read indicates total number of Maintenance events have been stored in the maintenance event log. The maximum counter value is 65535.

US

1.8.49 Calibration Event Counter (0x0051h)

A read indicates total number of Calibration events have been stored in the calibration event log. The maximum counter value is 65535.

1.8.50 Restart Event Counter (0x0057h)

A read indicates total number of Restart events have been stored in the restart event log. The maximum counter value is 65535.

Sensors Section: In this section, most registers will focus on sensor-related configurations and setup. There are two channels in the transmitter and each channel section can be selected by setting the channel index register (0x0064h).

1.8.51 Channel Index (0x0064h)

A read returns a value of current channel index and a write will set the other channel. The default value for the channel index is 1. After the user set the channel index, the system will keep the current channel index as long as the power is on. Recycling the power will reset the channel index to default value.

1.8.52 Analog Output (0x0065h)

A read returns a value of current output in micro amp (µA).

1.8.53 Sensor Mode (0x0066h)

A read returns a value of current sensor mode. The value is a number from 0 to 19.

Table 21 Sensor Mode

Decimal Number	Current Mode
0	Startup mode
1	Operate mode
2	Calibration initializing
3	Reset sensor life
4	Wait for zero gas
5	Soak zero gas
6	Zero in Progress
7	Zero pass
8	Waiting span gas
9	Soak span gas
10	Span in Progress
11	Remove span gas
12	Span pass
13	Calibration abort
14	Calibration fail
15	Wait for cal check gas
16	Gas Check in Progress

US

Decimal Number	Current Mode
17	Gas check pass
18	Gas check abort
19	Gas check fail

1.8.54   Sensor Status (0x0067h)

A read returns a value of current sensor status for Digital sensors.

1.8.55   Sensor Fault/Errors (0x0068h and 0x0069h)

A read returns a value of current sensor fault bitmap. Bitmap value other than "0" represents related fault bits below. The fault/error can be more than one.

Table 22 Sensor Faults

Register 68h:

Bit	Fault Name
0	Sensor Missing
1	Sensor Supply Voltage Fault
2	Temperature Out of Range
3	Sensor Element Error
4	Sensor Heater Fault
5	Other Sensor Internal Faults
6	TEDS CRC-16 Error
7	Sensor EOL Fault
8	Sensor Blockage Fault
9	Negative Drift
10	CAL Line Shortage Fault
11	Zero Calibration Fault
12	Span Calibration Fault
13	Gas Check Timeout
14	Reserved
15	Reserved

US

Register 69h:

Bit	Fault Name
0	Reserved
1	Reserved
2	Reserved
3	Reserved
4	Reserved
5	Reserved
6	Reserved
7	Reserved
8	Reserved
9	Reserved
10	Reserved
11	Reserved
12	Reserved
13	Reserved
14	Reserved
15	Reserved

1.8.56 Sensor Type (0x006Ah)

A read returns a value of current sensor type. 2 bytes data and the most significant byte represent the sensor type.

Table 23 Sensor Type

Sensor Type	MSB and xx: neglect
Passive Cat-Bead	01 xx
Passive MOS	02 xx
IR 400	03 xx
IR 700	04 xx
Passive NSS	05 xx
XIR	06 xx
X-cell	07 xx
Digital Legacy	08 xx
Test/Null	0xFF

US

1.8.57   Gas Reading (0x6B and 0x6Ch)

A read returns a gas reading and the gas reading is in IEEE-745 Single-precision floating point format. Therefore it requires two registers (32 bits).
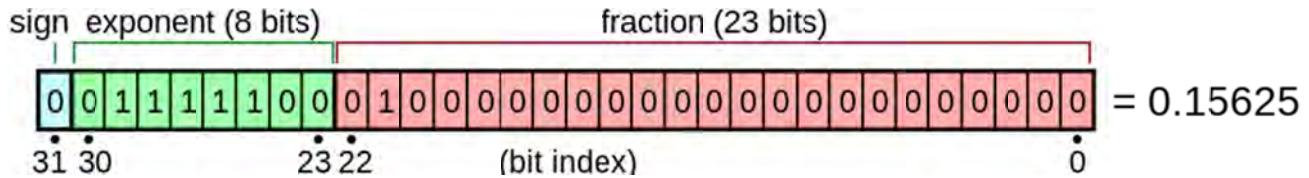
1.8.58   Gas Unit (0x6Dh)

A read returns a gas unit number.

Table 24 Gas Unit

Gas Unit Code (0x69)	Number
None	0
Percentage LEL	1
Percent	2
PPM	3
MRM/H	4
Milligram Per Cubic Meter	5
CH4 (%)	6
% LEL Meter	7
PPM Meter	8
µMOL Per MOL	9
µMOL Per MOL	10

1.8.59   Customer Select Full Scale (0x6E and 0x6Fh)

A read returns a value of customer selected full scale in IEEE-745 single-precision float point format. A write command is used to set a desired full scale. The new selected full scale must be larger than cal span value, warn set point and alarm set point.

1.8.60   Cal Span Gas Level (0x70 and 0x71h)

A read returns a value of calibration span gas level in IEEE-745 single-precision float point format. A write command is used to set the desired cal span gas level. The new selected cal span gas level must be smaller than the customized selected full scale.

US

1.8.61 Percentage of Actual Full Scale (0x72h)

A read returns a percentage of actual full scale.

1.8.62 Calibration Command (0x74h)

A read returns the current calibration command. A write command is used to set the desired Calibration command.

1.8.63 Latch Setting (0x75h)

A read returns the current Relay setting. A write command is used to set the desired Relay setting.

Relay setting: Bit1: Alarm, Bit0: Warn. The rest of the bits (2 to 15) are reserved.

1.8.64 Alarm Set Point (0x76h)

A read returns the current Alarm set point in integer format. A write command is use to set the desired alarm set point.

1.8.65 Warn Set Point (0x77h)

A read returns the current Warn set point in integer format. A write command is use to set the desired alarm set point.

1.8.66 Warn Direction (0x78h)

A read returns the current Warn direction. A write command is use to set the desired Warn direction.
0: downward and 1: upward. A write command is only applied for Oxygen sensor.

1.8.67 Sensor Interior Temperature (0x79h)

A read returns the current sensor temperature.

1.8.68 Extended Sensor Fault (0x7A and 0x7Bh)

A read returns the current extended sensor faults.

Table 25 Extended Sensor Faults 7A

Bit	Fault Name	Fault Description
0	General Sensor Internal Fault	General sensor fault. Specific fault cause is not covered by items listed below.
1	Sensor Negative Supply Fault	Negative supply in sensor module has failed.
2	Sensor FLASH Error	Sensor module FLASH test has failed.
3	Sensor RAM Error	Sensor module RAM test has failed.
4	External Memory Access Error	External memory in sensor module cannot be accessed.
5	External Memory Checksum Error	External memory in sensor module has invalid checksum.
6	Parameter Out of Range Fault	Indicates that a parameter is out of range for sensor module that can calculate gas reading directly.
7	High IR Fault	IR reading is too high.
8	Lamp Fault	Lamp has failed.
9	Reference Failure	Reference channel in IR sensor has failed.

Bit	Fault Name	Fault Description
10	Analytical Failure	Analytical channel in IR sensor has failed.
11	Low Signal Failure	Input signal in IR sensor is too low.
12	Excess Negative Reading Fault	Excess negative gas reading has been detected.
13	Clipping Fault	IR signal clipping has been detected.
14	Reserved	
15	Reserved	

Register 7B is bit 16 to 32 and currently all bits are reserved.

1.8.69 Sensor Firmware Revision (0x7Ch)

A read returns the current sensor firmware revision. High byte: Major, Low Byte: Minor

Table 26 Calibration Command

Calibration Command	Number
Request Non	0
Zero Calibration	1
Auto Calibration	2
Gas Check	3

1.8.70 Sensor Drift Count (0x7Dh)

A read returns the current sensor drift count.

1.8.71 Minimal Interval (0x7E and 0x7Fh)

A read returns the minimum gas measurement in IEEE-745 Single-precision float point format over the selected average interval.

1.8.72 Maximum Interval (0x80 and 0x81h)

A read returns the maximum gas measurement in IEEE-745 Single-precision float point format over the selected average interval.

1.8.73 Average Interval (0x82 and 0x83h)

A read returns the average gas measurement in IEEE-745 Single-precision float point format over the selected average interval.

1.8.74 Gas Table Select (0x84h)

A read returns the current Gas table. A write command is use to set the desired Gas table. The gas table selections are for digital sensors.

1.8.75 Sensor Data Sheet Reset (0x85h)

Writing "1" to the register will reset the sensor data sheet.

1.8.76 Sensor Disable (0x86h)

A read returns the current sensor status (enable or disable). Writing "1" to the register will disable the channel. Sensor disable is only allowed in digital sensor and sensor must be disconnected from the unit.

1.8.77 Gas ID Type (0x87h)

A read returns the gas ID type.

Table 27 Gas ID Type

Sensor Type	MSB	LSB	Sensor Type Description
Portable Instruments	0x00	0x00-0xFF	Legacy portable sensors
Passive Cat-Bead	0x01	0x00	COMB GM 29%LEL
Passive Cat-Bead	0x01	0x01	COMB GM 40%LEL
Passive Cat-Bead	0x01	0x02	COMB GM 55%LEL
Passive Cat-Bead	0x01	0x03	COMB GM 31%LEL
Passive Cat-Bead	0x01	0x04	COMB GM 49%LEL
Passive Cat-Bead	0x01	0x05	COMB GM 68%LEL
Passive MOS	0x02	0x00	H2S MOS
IR400	0x03	0x00	GM Infrared
IR700	0x04	0x00	GM Infrared
Passive NSS	0x05	0x00	H2S NSS MOS
XIR	0x06	0x00	COMB MSA 29%LEL
XIR	0x06	0x01	COMB MSA 40%LEL
XIR	0x06	0x02	COMB MSA 55%LEL
XIR	0x06	0x03	COMB MSA 31%LEL
XIR	0x06	0x04	COMB MSA 49%LEL
XIR	0x06	0x05	COMB MSA 68%LEL
Xcell	0x07	0x00	Oxygen
Xcell	0x07	0x01	H2S E-Chem 0-100.0
Xcell	0x07	0x02	H2S E-Chem 0-50.0
Xcell	0x07	0x03	H2S E-Chem 0-10.0
Xcell	0x07	0x04	CO E-Chem 0-100
Xcell	0x07	0x05	CO E-Chem 0-500
Xcell	0x07	0x06	CO E-Chem 0-1000
Xcell	0x07	0x07	NH3
Xcell	0x07	0x08	Cl2
Xcell	0x07	0x09	ClO2
Xcell	0x07	0x0A	SO2
Xcell	0x07	0x0B	CO/H2S

Sensor Type	MSB	LSB	Sensor Type Description
Xcell	0x07	0x0C	NO
Xcell	0x07	0x0D	NO2
Xcell	0x07	0x0E	NOx
Digital Legacy	0x08	0x00	Low %Oxygen
Digital Legacy	0x08	0x01	H2S E-Chem 0-500
Digital Legacy	0x08	0x02	NH3
Digital Legacy	0x08	0x03	Cl2
Digital Legacy	0x08	0x04	ClO2
Digital Legacy	0x08	0x05	SO2
Digital Legacy	0x08	0x06	NO
Digital Legacy	0x08	0x07	NO2
Digital Legacy	0x08	0x08	NOx
Digital Legacy	0x08	0x09	H2 E-Chem
Digital Legacy	0x08	0x0A	HCN
Digital Legacy	0x08	0x0B	HCL
Digital Legacy	0x08	0x0C	GM Comb 29% Propane
Digital Legacy	0x08	0x0D	GM Comb 50% Propane

1.8.78   Remaining Sensor Life (0x88h)

A read returns the remaining sensor life in percentage.

1.8.79   Alarm Direction Select (0x89h)

A read returns the current Alarm direction. A write command is use to set the desired Alarm direction.
0: downward and 1: upward. A write command is only applied for Oxygen sensor.

1.8.80   Alarm Enable/Disable (0x8Ah)

A read returns the current Alarm Enable Flag. Disabling the alarm is prohibited in S5000. 0: Disable and
1: Enable

1.8.81   Warn Enable/Disable (0x8Bh)

A read returns the current Warn Enable Flag. Disabling the alarm is prohibited in S5000. 0: Disable and
1: Enable

1.8.82   TruCal Enable (0x8Ch)

A write will enable or disable the True Calibration feature on applicable sensors.

1.8.83   Blockage Enable/Disable (0x8Dh)

A write will enable or disable the blockage feature on applicable sensors.

US

1.8.84   Sensor Alarm State (0x8Eh)

A read returns the current gas alarm state. Alarm conditions are as:

Table 28 Sensor Alarm State

Number	Alarm State
0	No Alarm and Warn
1	Warn
2	Alarm
3	Alarm and Warn

1.8.85   Displayable as Found (0x8Fh and 0x90h)

A read returns the gas measurement of the sensor before the calibration adjustment was completed. This value is not maintained on a reset condition and is only available after a calibration.

1.8.86   Percentage of Span Change (0x91h)

A read will return a percentage of the difference between the gas measurements before the sensor was calibrated to the gas measurements after the sensor was calibrated. This is updated upon each successful calibration. A value of 0 indicates the data is not available.

1.9.   Restoring Serial Bus Defaults

To restore serial bus defaults:

- Use the User Interface to reset the Modbus communication.

- Address factory default is 1.

- Baud rate factory default is 19,200.

- Format factory default is 8-N-1.

US

S5000 Modbus Specification

Notes

US

Notes

S5000 Modbus Specification

Notes

US