CROWCON
Detecting Gas Saving Lives

Crowcon Gasmaster

1 to 4 channel gas detection control panel

Modbus Instructions

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1. Introduction

This document describes the Modbus data interface for Crowcon Gasmaster control panel.

The instrument uses the RTU protocol as described in the Modicon Modbus Protocol Reference Guide except as detailed in this document. Extensions and restrictions to the Modbus protocol that have been used in other Crowcon instruments are used here where these extensions and restrictions are known and appropriate.

1.1. Related Documents

[1] Modicon Modbus Protocol Reference Guide, MODICON Inc.

1.2. Note on Modbus Terminology and Registers

The standard Modbus specification [2] talks of 16 bit (one word) registers and numbers of data bytes. The interpretation of registers and words used in this document (and used by other Crowcon products using Modbus, but perhaps with different terminology) is as follows:

A register will refer to the address of a piece of data within the register map. A register may consist of one or more 16-bit words. Registers are uniquely identified by their address.

The size of a register (sometimes also confusingly referred to as the number of registers) - that is the amount of data at a particular register address - is referred to by the number of words it contains.

Restated, we have uniquely addressed registers referring to one or more words of data.

1.3. Abbreviations

Abbreviation	Meaning
ASCII	A character based transmission protocol which can be easily displayed in human understandable form. A weakness is it uses more bandwidth than RTU
CRC	Cyclic Redundancy Check – a message postfix used to determine if the message packet has been received without corruption.
FTM	Functional Test Mode – some registers to do with hardware and production testing only have the desired effect during FTM.
PLC	Programmable Logic Controller – part of the industrial IT network responsible for data collection and evaluation.
RTU	Remote Terminal Unit – a data format which requires the receiver to decode it to a human understandable form. It is normally binary encoded rather than ASCII.

2. Modbus Specification

The Gasmaster control panel only uses the RTU (remote terminal unit) communications mode, where each 8-bit byte in a message contains two 4-bit hexadecimal numbers, transmitted in binary (rather than as ASCII representations of hexadecimal numbers).

2.1. Data format

Basic data format is fixed to the following:

Data format is: 1 start bit

8 data bits, least significant bit first

no parity bit

2 stop bits/ 1 stop bit (configurable)

Error check: cyclic redundancy check (CRC)

Baud rate: 9600

Some PLCs cannot work with an 11 bit format (1 start, 8 data, 2 stop), so an option is being provided to allow a 10 bit format (1 start, 8 data, 1 stop).

2.2. Data Timing

Standard Modbus defines a silent interval of 3.5 characters times to delimit data packets. However, a silent interval of 5.7mS is used to define the termination of a data packet – this assists PC software in transmitting data packages which conform.

The error condition described in [3] when there is a delay of 1.5 character times, but less than 3.5 character times between data, is not implemented – this can, apparently, cause problems with legacy systems and PC timings.

On receipt of a message requiring a response, the instrument will pause for a guaranteed period of at least 50mS before transmission will commence. Again, there may be timing problems on PC systems if this restriction is not applied.

2.3. Instrument Address

Each instrument on a communications loop requires a unique address in the range 1 – 247. This address may be set via the keys on the instrument front panel or by sending a Modbus message to the instrument requesting a change of address – care should be taken not to have multiple instruments on one communications loop with the same address. Communications with multiple instruments at the same communications address is not defined.

All instruments act on the broadcast (address 0) message. No instruments respond to the broadcast message.

2.4. Implemented Functions

The Gasmaster only implements two of the Modbus commands. These are:

03 - Read Holding registers

16 - Preset multiple registers

Both these commands will support multiple and single register reads and presets.

Where it is appropriate, when data is transmitted to the instrument, the instrument's non-volatile backup storage will be silently and automatically updated.

See [3] for details of message format and calculation of CRCs.

2.5. Data Types and Ranges

The following data types may be used, ranges in this table represent the maximum allowable and a smaller range may be specified in the register map.

UINT8	Single byte, unsigned data (8 bits), null padded in most significant bits to create a word.
	Range = 0 to 255
INT8	Single byte, signed data (8 bits), sign extended in most significant bits to create a word.
	Range = -128 to 127
UINT16	Two bytes, unsigned integer (16 bits), one word long, most significant byte first.
	Range = 0 to 65535
INT16	Two bytes, signed integer (16 bits), one word long.
	Range = -32768 to 32767
UINT32	Four bytes, unsigned integer (32 bits), 2 words, most significant word first.
	Range = 0 to 4,294,967,295
INT32	Four bytes, signed integer (32 bits), 2 words, most significant word first.
	Range = -2,147,483,648 to 2,147,483,647
TEXT nn	Text string, nn characters long, packed 2 characters per word, of length nn/2 words. Ordered with first character in high byte of first word. Null padded in least significant byte of last word if needed.
	Range 1-255. A zero byte can be used, and this will mark the termination of the string.
FLOAT	Floating point number, in IEEE-754 format.
ENUM nn	Data enumeration. A UINT16 where each number (counting from 0) refers to an option from a list of nn possibilities. In the Register map notes below, enumerations are listed in numeric order.
	Range 0 to the number of enumerations listed.
BIT nn	An array of nn bits, null padded as necessary in the most significant word, from the most significant bit to create a whole word. Length is nn/16 words.

2.6. Register Access Permissions

Permissions used in the register map following are:

R/W	Read and write always allowed
R	Read only. The information cannot be modified via Modbus.
R(W)	Read only, unless the security address (see control section below) has been set to the appropriate value, when the location is also write-able.

3. Register Map

3.1. Instrument Identification

Information about the instrument as a whole.

Address	Name	Words	R/W	Data Type	Notes/Example
1	Instrument identification	8	R	TEXT16	“GasmasterIII”
2	Manufacturer	8	R	TEXT16	“Crowcon”
3	Software version	8	R	TEXT16	e.g. “V1 i1.01”
4	Instrument serial number	8	R(W)	TEXT16	A combination of works order number and line item, written as text.
5	System Name	8	R(W)	TEXT16	“free text here”, whatever the customer wants to call their system. Helps in a multi drop scheme

3.2. System Config

Address	Name	Words	R/W	Data Type	Notes/Example
50	Modbus Address	1	R(W)	UINT8	e.g. 34 Range 1 to 247
51	Modbus Stop bit Config	1	R(W)	ENUM2	2 Stop Bits, 1 Stop Bit.
52	Next Service Due	2	R(W)	INT32	Seconds since power-up
53	Language	1	R(W)	ENUM2	UK English, Alternate language
54	System Type	1	R(W)	ENUM3	Standard Enclosure Multiple, Standard Enclosure Single, Flameproof Enclosure. NOTE this is used to determine whether to use channel 2 to 4 of channel display.
55	Menu Display Contrast	1	R(W)	UINT8	0 low contrast to 255 high contrast
56	Channel Display Contrast	1	R(W)	UINT8	0 low contrast to 255 high contrast
57	Common Relay Low Type	1	R(W)	ENUM3	Non latching, Latched, Latching Acceptable.
58	Common Relay Low Energisation	1	R(W)	ENUM2	Normally de-energised, Normally energised

Address	Name	Words	R/W	Data Type	Notes/Example
59	Common Relay High Type	1	R(W)	ENUM3	Non latching, Latched, Latching Acceptable.
60	Common Relay High Energisation	1	R(W)	ENUM2	Normally de-energised, Normally energised
61	Common Relay Fault Type	1	R(W)	ENUM2	Non latching, Latched.
62	Common Relay Fault Energisation	1	R(W)	ENUM2	Normally de-energised, Normally energised
63	Sounder AV Drive type	1	R(W)	ENUM3	Non latching, Latched, Latching Acceptable.
64	Beacon AV Drive type	1	R(W)	ENUM2	Non latching, Latched.
65	Supervisor Password	7	R(W)	TEXT14	Text string for supervisor password. Can be NULL for no password
66	System Clock Adjustment	2	R(W)	INT32	Number of counts to slow (+) or speed up (-) the System Timer (range: -200 to +200 = +-1%)
67	Mains Fail Config	1	R(W)	ENUM2	How mains fail is to be notified to user:- Mains Fail as Warning, Mains Fail as Fault.
68	Pellistor Saver Threshold	2	R(W)	FLOAT	The %LEL value at which a pellistor is switched off to save it from excess exposure. Typically between 90to 95%.

3.3. Channel Config

Channel 1

Address	Name	Words	R/W	Data Type	Notes/Example
100	Ch1.Location	8	R(W)	TEXT16	“Boiler Room” For use by PC or SCADA systems.
101	Ch1.GasName	8	R(W)	TEXT16	“CH4” Note only 4 characters displayed on LCD.
102	Ch1.Type	1	R(W)	ENUM6	Not active, Detector 4to20 Source, Detector 4to20 Sink, Fire 4to20 Source, Fire 4to20 Sink,

Address	Name	Words	R/W	Data Type	Notes/Example
					Conv. Fire, ESU 4to20 Sink Pellistor
103	Ch1.Range	2	R(W)	FLOAT	The full scale range of the channel e.g. 2.36. Should be in range 1.00 to 9999, 3 sig fig only Not used for Fire and ESU.
104	Ch1.Units	1	R(W)	ENUM6	NONE, %LEL, PPM, PPB, %VOL, FIRE
105	Ch1.Alarm Low Level	2	R(W)	FLOAT	The alarm level for dangerous levels of gas. For Fire: not used. For ESU: Fan slow fault level (mA).
106	Ch1.Alarm Low Hysteresis	2	R(W)	FLOAT	
107	Ch1.Alarm Low Sense	1	R(W)	ENUM1	Rising, Falling Not used for a fire channel. Always rising for an ESU channel.
108	Ch1.Relay Low Type	1	R(W)	ENUM3	Non latching, Latched, Latching Acceptable.
109	Ch1.Relay Low Energisation	1	R(W)	ENUM2	Normally de-energised, Normally energised
110	Ch1.Alarm High Level	2	R(W)	FLOAT	The alarm level for injurious levels of gas. For Fire: alarm trigger level. For ESU: Fan stall fault level (mA).
111	Ch1.Alarm High Sense	1	R(W)	ENUM2	Rising, Falling. Always rising for a fire or ESU channel.
112	Ch1.Relay High Type	1	R(W)	ENUM3	Non latching, Latched, Latching Acceptable.
113	Ch1.Relay High Energisation	1	R(W)	ENUM2	Normally de-energised, Normally energised
114	Ch1.Interpret Low	1	R(W)	ENUM3	Interpret as fault, Interpret as warning, Interpret as Inhibit.

Address	Name	Words	R/W	Data Type	Notes/Example
115	Ch1.Apply ZFS	1	R(W)	ENUM2	No ZFS, Apply ZFS.
116	Ch1.Fire Reset Time	1	R(W)	UINT16	The length of time power is removed for a conventional fire loop to reset the sensor. Range 1 to 30 secs; default 5 secs.
117	Ch1.Stabilisation Time	1	R(W)	UINT16	The length of time after power up before valid readings is obtained from a sensor. Range 1 to 120 secs; default 60 secs.
118	Ch1.Alarm 1 Silent	1	R(W)	ENUM2	Alarm 1 Annunciated, Alarm 1 Silent.
119	Ch1.Input zero	2	R(W)	FLOAT	Range 3 to 5 mA for gas detector inputs. For a pellistor it is an ADC count in range 200 to 500
120	Ch1.Input scale	2	R(W)	FLOAT	A scale correction factor in range 0.9 to 1.1 For a pellistor it is a calibration scale factor in the range 0.02 to 0.25
121	Ch1.Output zero	2	R(W)	FLOAT	A float value of output offset in the range –1.0 to +1.0. Note use runtime control registers to set these values during output calibration operations.
122	Ch1.Output scale	2	R(W)	FLOAT	A float value of output offset in the range 0.8 to 1.2. Note use runtime control registers to set these values during output calibration operations.
123	Ch1.Input Scale Limit	2	R(W)	FLOAT	The limit value of gain for pellistors Typical values are:- VQ21/VQ1 – 0.13 VQ25/VQ22 – 0.12 VQ41 – 0.21

Channel 2

Address	Name	Words	R/W	Data Type	Notes/Example
200 to 223	Ch2.* as per ch1.				

Channel 3

Address	Name	Words	R/W	Data Type	Notes/Example
300 to 323	Ch3.* as per ch1.				

Channel 4

Address	Name	Words	R/W	Data Type	Notes/Example
400 to 423	Ch4.* as per ch1.				

3.4. Runtime Data

Address	Name	Words	R/W	Data Type	Notes/Example
500	Time	2	R	UINT32	Seconds since power up.
501	Status	1	R	BIT3	0-System Fault 1-Global Inhibit 2-Warning
502	System Fault 1	2	R	UINT32	Bit packed variable see section 3.4.1
503	System Fault 2	2	R	UINT32	Bit packed variable see section 3.4.1
504	System Warning 1	2	R	UINT32	Bit packed variable see section 3.4.1
505	System Warning 2	2	R	UINT32	Bit packed variable see section 3.4.1
506	Channel 1 Level	2	R	FLOAT	Gas level
507	Channel 1 Status	1	R	BIT6	Bit 0 – Alarm 1 Bit 1 – Alarm 2 Bit 2 – Undefined Bit 3 – Inhibit Bit 4 – Low Interpret Warning Bit 5 – Fault
508	Channel 2 Level	2	R	FLOAT	Gas level

Address	Name	Words	R/W	Data Type	Notes/Example
509	Channel 2 Status	1	R	BIT6	Bit 0 – Alarm 1 Bit 1 – Alarm 2 Bit 2 – Undefined Bit 3 – Inhibit Bit 4 – Low Interpret Warning Bit 5 – Fault
510	Channel 3 Level	2	R	FLOAT	Gas level
511	Channel 3 Status	1	R	BIT6	Bit 0 – Alarm 1 Bit 1 – Alarm 2 Bit 2 – Undefined Bit 3 – Inhibit Bit 4 – Low Interpret Warning Bit 5 – Fault
512	Channel 4 Level	2	R	FLOAT	Gas level
513	Channel 4 Status	1	R	BIT6	Bit 0 – Alarm 1 Bit 1 – Alarm 2 Bit 2 – Undefined Bit 3 – Inhibit Bit 4 – Low Interpret Warning Bit 5 – Fault

3.4.1. Fault and Warning Bit Packed Variable Definitions

The following table defines the mapping of status word bits to faults.

Bit identity	Fault identity	Fault meaning
0 System Fault 1	1	Measurement system failure on ADC zero signal
1 System Fault 1	2	Measurement system failure on ADC span signal
2 System Fault 1	3	Battery Flat – shutting down
3 System Fault 1	4	Battery Low – not much time before shutdown
4 System Fault 1	5	Relay power supply fail – P12V not in expected range
5 System Fault 1	6	Main supply fail – power from main supply is not within expected range
6 System Fault 1	7	NVM hardware fail – there was a problem erasing or writing to on chip flash non volatile storage.
7 System Fault 1	8	No valid data in NVM at power-up - Loaded default parameters
8 System Fault 1	9	Common alarm low relay coil open circuit fault
9 System Fault 1	10	Common alarm high relay coil open circuit fault
10 System Fault 1	11	Common fault relay coil open circuit fault
11 System Fault 1	12	Channel 1 Alarm Low relay coil open circuit fault
12 System Fault 1	13	Channel 1 Alarm Low relay coil open circuit fault
13 System Fault 1	14	Channel 2 Alarm Low relay coil open circuit fault
14 System Fault 1	15	Channel 2 Alarm Low relay coil open circuit fault

Bit identity	Fault identity	Fault meaning
15 System Fault 1	16	Channel 3 Alarm Low relay coil open circuit fault
16 System Fault 1	17	Channel 3 Alarm Low relay coil open circuit fault
17 System Fault 1	18	Channel 4 Alarm Low relay coil open circuit fault
18 System Fault 1	19	Channel 4 Alarm Low relay coil open circuit fault
19 System Fault 1	20	Channel 1 ESU fan stalled
20 System Fault 1	21	Channel 2 ESU fan stalled
21 System Fault 1	22	Channel 3 ESU fan stalled
22 System Fault 1	23	Channel 4 ESU fan stalled
23 System Fault 1	24	Channel 1 ESU fan slow
24 System Fault 1	25	Channel 2 ESU fan slow
25 System Fault 1	26	Channel 3 ESU fan slow
26 System Fault 1	27	Channel 4 ESU fan slow
27 System Fault 1	28	Channel 1 Signal Over range
28 System Fault 1	29	Channel 2 Signal Over range
29 System Fault 1	30	Channel 3 Signal Over range
30 System Fault 1	31	Channel 4 Signal Over range
31 System Fault 1	32	Channel 1 Signal Under range
0 System Fault 2	33	Channel 2 Signal Under range
1 System Fault 2	34	Channel 3 Signal Under range
1 System Fault 2	35	Channel 4 Signal Under range
3 to 31 System Fault 2		Never Set

The following table defines the mapping of status word bits to warnings.

Bit identity	Warning identity	Warning meaning
0 System Warning 1	1	Supervisor mode
1 System Warning 1	2	Global inhibit active
2 System Warning 1	3	Testing audio visual alarm
3 System Warning 1	4	Service / calibration due
4 System Warning 1	5	Common Alarm Low relay forced
5 System Warning 1	6	Common Alarm High relay forced
6 System Warning 1	7	Common Fault relay forced
7 System Warning 1	8	Detector 1 stabilising
8 System Warning 1	9	Detector 1 input low
9 System Warning 1	10	Detector 1 initiated inhibit
10 System Warning 1	11	Channel 1 inhibited
11 System Warning 1	12	Channel 1 input simulated
12 System Warning 1	13	Channel 1 output forced

Bit identity	Warning identity	Warning meaning
13 System Warning 1	14	Channel 1 alarm low relay forced
14 System Warning 1	15	Channel 1 alarm high relay forced
15 System Warning 1	16	Detector 2 stabilising
16 System Warning 1	17	Detector 2 input low
17 System Warning 1	18	Detector 2 initiated inhibit
18 System Warning 1	19	Channel 2 inhibited
19 System Warning 1	20	Channel 2 input simulated
20 System Warning 1	21	Channel 2 output forced
21 System Warning 1	22	Channel 2 alarm low relay forced
22 System Warning 1	23	Channel 2 alarm high relay forced
23 System Warning 1	24	Detector 3 stabilising
24 System Warning 1	25	Detector 3 input low
25 System Warning 1	26	Detector 3 initiated inhibit
26 System Warning 1	27	Channel 3 inhibited
27 System Warning 1	28	Channel 3 input simulated
28 System Warning 1	29	Channel 3 output forced
29 System Warning 1	30	Channel 3 alarm low relay forced
30 System Warning 1	31	Channel 3 alarm high relay forced
31 System Warning 1	32	Detector 4 stabilising
0 System Warning 2	33	Detector 4 input low
1 System Warning 2	34	Detector 4 initiated inhibit
2 System Warning 2	35	Channel 4 inhibited
3 System Warning 2	36	Channel 4 input simulated
4 System Warning 2	37	Channel 4 output forced
5 System Warning 2	38	Channel 4 alarm low relay forced
6 System Warning 2	39	Channel 4 alarm high relay forced
7 System Warning 2	40	Channel 1 Pellistor saver enabled
8 System warning 2	41	Channel 2 Pellistor saver disabled
9 System warning 2	42	Channel 3 Pellistor saver entered
10 System warning 2	43	Channel 4 Pellistor saver exited
11 to 31 System Warning 2		Not yet set

3.5. Channel Control

Channel 1

Address	Name	Words	R/W	Data Type	Notes/Example
540	Channel 1 Inhibit	1	R/W	ENUM2	No inhibit Channel inhibit
541	Channel 1 Action Zero	1	R/W	ENUM3	Idle Perform Zero Zero Fail Set to “Perform Zero” then wait for “Idle” or “Zero Fail”. If “Zero Fail” then write to set it back to “Idle”.
542	Channel 1 Cal Level	2	R/W	FLOAT	The concentration of the cal gas.
543	Channel 1 Cal Action	1	R/W	ENUM4	Idle Perform Cal Cal Fail (Input) Cal Fail (Gain) Set to “Perform Cal” then wait for “Idle” or “Cal Fail”. If “Cal Fail” then write to set it back to “Idle”.
544	Channel 1 OP Cal Control	1	R/W	ENUM4	Normal/Idle Measure Low mA Measure High mA Cal Fail For operation see Note 1 below.
545	Channel 1 OP Cal Level	2	R/W	FLOAT	Measured mA level. For low mA range is 3 to 5. For high mA range is 19 to 21.
546	Channel 1 Pellistor saver disabled	1	R(W)	ENUM2	0 not disabled 1 disabled

Note 1 – Operation of OP Cal Control; Set to “Measure Low mA” system then requires a measured value of mA to be written to 545. A valid low mA value will move OP Cal Control to “Measure High mA” and an invalid value will move OP Cal Control to “Cal Fail”. With the control set to “Measure High mA” the system requires a measured value of mA to be written to 545. A valid high mA value will move OP Cal Control to “Normal/Idle” and will cause the output calibration offset and scale values to evaluated and an invalid value will move OP Cal Control to “Cal Fail”. “Cal Fail” values when read should be overwritten by “Normal/Idle” and the calibration operation started again.

Channel 2

Address	Name	Words	R/W	Data Type	Notes/Example
550	Channel 2 as per channel 1				

Channel 3

Address	Name	Words	R/W	Data Type	Notes/Example
560	Channel 3 as per channel 1				

Channel 4

Address	Name	Words	R/W	Data Type	Notes/Example
570	Channel 4 as per channel 1				

3.6. System Control

Address	Name	Words	R/W	Data Type	Notes/Example
600	Accept Reset	1	R/W	ENUM2	Idle, Cause Accept Reset Automatically reverts to idle when action complete
601	NVM control	1	R/W	ENUM7	Idle, Save Parameter Config, Restore Parameter Config, Clear Parameter Config, Save Text Config, Restore Text Config, Clear Text Config. Automatically reverts to idle when action complete
602	Protection	1	R/W	ENUM2	Protect Off, Protect On
603	Power Up Test	1	R/W	ENUM2	Idle, Do Reset and Power Up Test. Automatically reverts to idle when action complete. Will momentarily halt Modbus activity while power-up self tests are in progress. Not FTM -> Exception

Address	Name	Words	R/W	Data Type	Notes/Example
604	Relay Stimulation Sequence	1	R/W	BIT14	Bit 0 – Common Low Relay Bit 1 – Common High Relay Bit 2 – Common Fault Relay Bit 3 – Ch1 Alarm Low Relay Bit 4 – Ch1 Alarm High Relay Bit 5 – Ch2 Alarm Low Relay Bit 6 – Ch2 Alarm High Relay Bit 7 – Ch3 Alarm Low Relay Bit 8 – Ch3 Alarm High Relay Bit 9 – Ch4 Alarm Low Relay Bit 10 - Ch4 Alarm High Relay Bit 11- AVDrive Beacon Bit 12 – AVDrive Low Sound Bit 13 – AVDrive High Sound Logic 1 energises relay Not FTM -> Exception
605	Relay Monitor	1	R	BIT11	Bit 0 – Common Low Relay Bit 1 – Common High Relay Bit 2 – Common Fault Relay Bit 3 – Ch1 Alarm Low Relay Bit 4 – Ch1 Alarm High Relay Bit 5 – Ch2 Alarm Low Relay Bit 6 – Ch2 Alarm High Relay Bit 7 – Ch3 Alarm Low Relay Bit 8 – Ch3 Alarm High Relay Bit 9 – Ch4 Alarm Low Relay Bit 10 - Ch4 Alarm High Relay Logic 1 relay coil faulty. Not FTM -> Exception
606	Analogue Out1 Stimulation	1	R/W	UINT8	Level in range 0 to 255 corresponds to 0 to 25.5 mA (0 to 6.375 V). Not FTM -> Exception
607	Analogue Out2 Stimulation	1	R/W	UINT8	Level in range 0 to 255 corresponds to 0 to 25.5 mA (0 to 6.375 V). Not FTM -> Exception
608	Analogue Out3 Stimulation	1	R/W	UINT8	Level in range 0 to 255 corresponds to 0 to 25.5 mA (0 to 6.375 V). Not FTM -> Exception
609	Analogue Out4 Stimulation	1	R/W	UINT8	Level in range 0 to 255 corresponds to 0 to 25.5 mA (0 to 6.375 V). Not FTM -> Exception
610	DAC0 Output	1	R/W	UINT8	Level in range 0 to 255 corresponds to 0 to 5V Not FTM -> Exception

Address	Name	Words	R/W	Data Type	Notes/Example
611	DAC1 Output	1	R/W	UINT8	Level in range 0 to 255 corresponds to 0 to 5V Not FTM -> Exception
612	Indicator Stimulation	1	R/W	ENUM6	All Off Alarm LED Fault LED Power LED Warning LED Sounder Not FTM -> Exception
613	Chan LCD Test	1	R/W	ENUM10	Normal display operation All Segments Off All Segments On Sweep horiz segs down chan Sweep vert segs across disp Sweep horiz segs down disp Walk segs around all digits Walk segs around rows then cols Walk seg around disp Walk bit along message Not FTM -> Exception
614	Chan LCD Seq	1	R/W	UINT8	Sequence in test: 0=start, 1…<last seq in test>, 250=enable auto sequencing Not FTM -> Exception
615	Menu LCD Test	1	R/W	ENUM8	Normal display operation All Segments Off All Segments On Sweep vert pixel col across char Sweep horiz pixel rows down line Sweep vert pixel col across disp Sweep horiz pixel row down disp Disp char set incrementing Not FTM -> Exception
616	Menu LCD Seq	1	R/W	UINT8	Sequence in test: 0=start, 1…<last seq in test> Not FTM -> Exception
617	LCD Backlight	1	R/W	ENUM4	Normal operation Backlight Off Backlight Dim Backlight Bright Not FTM -> Exception

Address	Name	Words	R/W	Data Type	Notes/Example
618	MUX control – Ch1	1	R/W	ENUM2	MUX source MUX sink Not FTM -> Exception
619	MUX control – Ch2	1	R/W	ENUM2	MUX source MUX sink Not FTM -> Exception
620	MUX control – Ch3	1	R/W	ENUM2	MUX source MUX sink Not FTM -> Exception
621	MUX control – Ch4	1	R/W	ENUM2	MUX source MUX sink Not FTM -> Exception
622	Raw ADC – Ch1	1	R	UINT16	Input channel 1 Full Scale = 4092 corresponding to 25.5 mA on 4 to 20 input
623	Raw ADC – Ch2	1	R	UINT16	Input channel 2 Full Scale = 4092 corresponding to 25.5 mA on 4 to 20 input
624	Raw ADC – Ch3	1	R	UINT16	Input channel 3 Full Scale = 4092 corresponding to 25.5 mA on 4 to 20 input
625	Raw ADC – Ch4	1	R	UINT16	Input channel 4 Full Scale = 4092 corresponding to 25.5 mA on 4 to 20 input
626	Raw ADC – PSU	1	R	UINT16	Mains or plant DC voltage Full Scale = 4092 corresponding to 39V
627	Raw ADC – Vsys	1	R	UINT16	Voltage after diode OR'ing mains and battery volts Full Scale = 4092 corresponding to 39V
628	Raw ADC – P12V	1	R	UINT16	Positive 12V switcher derived rail voltage. Full Scale = 4092 corresponding to 17.5V
629	Raw ADC – Check Low	1	R	UINT16	0.45 V = 1/11 5V Fullscale = 4092 corresponding to 5V.

Address	Name	Words	R/W	Data Type	Notes/Example
630	Raw ADC – Check High	1	R	UINT16	4.55 V = 10/11 5V Fullscale = 4092 corresponding to 5V.
631	Raw ADC – VLCD0	1	R	UINT16	LCD contrast voltage – dot matrix display 0 corresponds to –5V. Full Scale = 4092 corresponds to +5V.
632	Raw ADC – VLCD1	1	R	UINT16	LCD contrast voltage – segment display 0 corresponds to –5V. Full Scale = 4092 corresponds to +5V.
633	Button	1	R	BIT7	Bit 0-Accept Reset Bit 1-Up Bit 2-Down Bit 3-Enter Bit 4-Back Bit 5-Remote Accept Reset Bit 6-Remote Inhibit Logic 1 = button pressed or signal active
634	Fire Reset	1	R/W	BIT4	Bit 1 – Ch1 Power Bit 2 – Ch2 Power Bit 3 – Ch3 Power Bit 4 – Ch4 Power Logic 1 = power on, logic 0 = power reset. Not FTM -> Exception
635	Battery Switch	1	R/W	ENUM2	Battery disconnected Battery connected Not FTM -> Exception

3.7. Event Log

3.7.1. Event Log Map

This section specifies the Modbus map for events. For a complete explanation of the use of the controls and the format of the event data refer to section 3.7.2. Event data is always read in blocks of 10 events for efficiency of communications.

Address	Name	Words	R/W	Data Type	Notes/Example
700	Read control	1	R/W	ENUM4	Abort read, Reset, Next Block, Clear Log (not imp)
701	Service event time and	2	R(W)	UINT32	Seconds since 1 Jan 1970.

	date				
702	Event 1 time	2	R	UINT32	Time of event
703	Event 1 IDs	1	R	UINT16	Event ID and ID byte
704	Event 1 data word	2	R	UINT32	Event data word
705	Event 2 time	2	R	UINT32	Time of event
706	Event 2 IDs	1	R	UINT16	Event ID and ID byte
707	Event 2 data word	2	R	UINT32	Event data word
708	Event 3 time	2	R	UINT32	Time of event
709	Event 3 IDs	1	R	UINT16	Event ID and ID byte
710	Event 3 data word	2	R	UINT32	Event data word
711	Event 4 time	2	R	UINT32	Time of event
712	Event 4 IDs	1	R	UINT16	Event ID and ID byte
713	Event 4 data word	2	R	UINT32	Event data word
714	Event 5 time	2	R	UINT32	Time of event
715	Event 5 IDs	1	R	UINT16	Event ID and ID byte
716	Event 5 data word	2	R	UINT32	Event data word
717	Event 6 time	2	R	UINT32	Time of event
718	Event 6 IDs	1	R	UINT16	Event ID and ID byte
719	Event 6 data word	2	R	UINT32	Event data word
720	Event 7 time	2	R	UINT32	Time of event
721	Event 7 Ids	1	R	UINT16	Event ID and ID byte
722	Event 7 data word	2	R	UINT32	Event data word
723	Event 8 time	2	R	UINT32	Time of event
724	Event 8 Ids	1	R	UINT16	Event ID and ID byte
725	Event 8 data word	2	R	UINT32	Event data word
726	Event 9 time	2	R	UINT32	Time of event
727	Event 9 Ids	1	R	UINT16	Event ID and ID byte
728	Event 9 data word	2	R	UINT32	Event data word
729	Event 10 time	2	R	UINT32	Time of event
730	Event 10 Ids	1	R	UINT16	Event ID and ID byte
731	Event 10 data word	2	R	UINT32	Event data word

3.7.2. Event Log Register Descriptions

Read Control

Used to set up the log ready for reading.

Reset – resets event log control to start at the beginning of the log. It also loads the first block of 10 event records ready for reading.

Next Block – Loads subsequent blocks of event records ready for reading.

Clear – not implemented yet (may become more relevant if the event log is ever implemented in NVM), at present this value causes an exception.

Typical Modbus sequence for reading events

Register (Operation)	Data	Comment
700 (write)	1	Resets the event log to present the oldest event as event 1.
702 to 731 (read)	**	Reads a block of 10 events
700 (write)	2	Presents the next 10 events.
702 to 731 (read)	**	Reads the next block of 10 events. When these are scanned one of the events indicates end of list.
700 (write)	0	Terminate log read operations

Service event time and date

This data is stored in NVM and used to create the service event. This value should be modified only after the system has been serviced.

Event block – time, identities, data word.

Time is defined as a count of seconds since power-up. The device reading the events will have to convert this to a date and time format for display to the user based on the current system clock reading (register 500).

Event Description	Event ID 1 byte	Event Data 1 byte	Additional Data 4 bytes
Alarm Low Entered	1	Channel ID	0
Alarm Low Exited	2	Channel ID	Peak level while in alarm (or trough level for falling alarms) [FLOAT]
Alarm High Entered	3	Channel ID	0
Alarm High Exited	4	Channel ID	Peak level while in alarm (or trough level for falling alarms) [FLOAT]
Detector comes online	5	Channel ID	0
Accept Reset	6	0	0
Warning Set	7	Channel ID Or 255 for system warning	Warning ID
Warning Cleared	8	Channel ID Or 255 for system warning	Warning ID
Power Status change	9	New power status ID	0
Power Level	10	0	When running on battery Vsys is logged every 60 secs [FLOAT].
Fault State Entered	11	Channel ID Or 255 for system fault	Fault ID

Fault State Exited	12	Channel ID Or 255 for system fault	Fault ID
Config Change	13	2 = Config Block B 3 = Config Block A 4 = Text	CRC16
NVM Repaired (redundant from V1, i1.01)	14	2 = Config Block B 3 = Config Block A 4 = Text	0
Pellistor Off	15	Channel ID	0
Pellistor Re-warm	16	Channel ID	0
Service Event	254	0	Time and Date in seconds since 1st Jan 1970 [UINT32].
End of Event List	255	255	0

Event Data definitions

Data Description	Values
Channel ID	Channel 1 = 1, Channel 2 = 2, Channel 3 = 3, Channel 4 = 4,
Power status ID	Mains OK = 0, Mains fail = 1, Mains fail accepted = 2, Battery Low = 3, Battery Cut Off = 4.
Fault ID	TBD

NOTE that the system will store a maximum of 300 events in RAM, i.e. if power is removed or the system resets the events will be lost.

A Service event is a special case because the event data contains the date of the last service. This data is stored in NVM and the service event is reconstituted whenever a system reset occurs.

Clear log

At present does nothing so therefore not implemented

3.8. Alternate Language Strings

Address	Name	Words	R/W	Data Type	Notes/Example
800	Text string ident	1	R/W	ENUM 210	Select text string
801	Text string length (L)	1	R	UINT16	Max length of selected text (0..32)
802	Primary language text	16	R	STRING 32	Selected text string for primary language
803	Configurable language text	16	R/W	STRING 32	Selected text string for configurable language

4. Exception Responses

Gasmaster will respond to errors as described in [3], with the following exception codes being supported:

1 – Illegal function function code not supported (i.e. not 3 or 16)

2 – Illegal data address invalid/unknown register address, invalid number of registers, invalid number or words for the specified registers, write to read only register

3 – Illegal data value Invalid number or enumeration code or data type

6 – Slave device busy An attempt has been made to write to configuration data which is accessible from the instrument's front panel menu system whilst a user is using the menu system. This error prevents the apparent inconsistencies of data changing whilst an operator is using the instrument.

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