FLAME-MONITOR MODBUS COMMUNICATIONS

The protocol to be used is Modbus RTU. This is implemented by the master (PC, PLC, etc.) issuing a poll to the slave (Flame-Monitor) and the slave responding with the appropriate message.

A typical format of a poll request is as follows:

DST	FNC	ADR HI	ADR LO	DAT HI	DAT LO	CRC LO	CRC HI

DST refers to the logical address of the slave.
FNC is the function being requested. FNC 03 is a read request.
ADR is the message number or register number of the data being requested.
For the Flame-Monitor all registers are mapped as HOLDING REGISTERS, FNC 03. Register addresses begin at 40001 but is interpreted as address 00.
DAT is the number of words being requested. A word is an integer consisting of 2 bytes.

The normal response from a slave is as follows:

DST	FNC	DBC	DATA….. Hi/Lo	CRC LO	CRC HI

DBC is the data byte count being returned. It must be two times the DAT number from the poll request.

DATA is the data returned and is always a series of 2 byte integers. If 4 words were requested then DBC would be 8 and there would be 8 data bytes or 4 data words containing the requested data.

The format of the data is 4800,N,8,1 meaning 4800 baud, no parity, and 1 stop bit.

Below is a table of currently available messages provided by the Flame-Monitor programmers, followed by a description where necessary.

HOLDING REGISTER	MESSAGE ADDRESS	WORD REQUESTED	RESPONSE	VALUE
40001	00	1-6	STATUS	83 (053H) = RUN; 202 (0CAH) = LOCKOUT
40002	01	1	MSGN	Current message being displayed (see Table 1)
40003	02	1	GSTAT	Defines Timer Type
40004	03	1	TIMER	Time, Flame, Address
40005	04	1	FLAME	Flame Signal
40006	05	1-3	LOGSTAT	Current logic module, PURGE, PTFI, AUTO (See Table 2)
40007	06	1	INPUTS	Input limits state
40008	07	1	OUTPUTS	Output relays state
40009	08	2	SYSMINS	System on minutes
40011	10	2	BNRMINS	Burner on minutes
40013	12	2	CYCLES	Completed Burner Cycles
40015	14	1	LOCKOUT	Stored Lockout Count

HOLDING REGISTER	MESSAGE ADDRESS	WORD REQUESTED	RESPONSE	VALUE
			COUNT	
40016	15	1-6	LOCKOUT HISTORY	Last 6 Lockouts, first word is most current lockout
40022	21	1-2	DEVTYP	Programmer device type, 5=EP, 6=EPD, 7=MicroM
40023	22	1	AMPTYP	Amplifier Type; EUVS4=0C0H; EIR1=0A0H; ERT1, EUV1=090H;
40024	23	**N/A**		**Not Used**
40025	24	2	FLAME SIGNAL AVERAGES	PTFI and Auto Flame Signal Averages
40027-40035	26-34	**N/A**		**Not Used**
40036	35	6	Most Recent Lockout Data	Returns complete lockout description of stored lockout history. Includes lockout message, lockout module, @ burner hours, and @ burner cycles
40042	41	6	2nd Most Recent Lockout Data	
40048	47	6	3rd Most Recent Lockout Data	
40054	53	6	4th Most Recent Lockout Data	
40060	59	6	5th Most Recent Lockout Data	
40066	65	6	6th Most Recent Lockout Data	
40072	71	1-3	Input limits and Expansion Module registers	Returns input limits state and lower and upper expansion module (E300) registers. See Table 3
40073	72	1-2	Expansion Module (E300) registers	Returns lower and upper Expansion module registers
40074	73	1		Return only upper Expansion module register

It is suggested that polling intervals not be less than 200 mSec per request. Requesting data such as burner minutes, system minutes and burner cycles should be kept at a minimum due to the amount of processing time required to gather that data.

Messages 00, 05, 08, 10, 15, 21 and 26 are unique in that a limited number of successive registers can be combined with these requests. For example, a request to message 00 can contain up to 6 data words. The response to this would contain STATUS, MSGN, GSTAT, TIMER, FLAME and LOGSTAT. If the requested data word count (DAT) were to be 2 then the response would contain STATUS and MSGN only. Message 15, last 6 lockouts, can return data ranging from 1 to 6, with 1 referring to the most recent lockout.

The MSGN being transmitted is a numerical value and must be interpreted by the communicating device, which actually is an advantage since this can be made to be whatever message text the end user wants. In

other words, it allows for programming custom messages without actually changing the message in the programmer. Refer to Table 1 for message information.

Message 26 returns the current operating status as well as stored burner hours and burner cycles as a snapshot of the entire Flame-Monitor system. When all 9 words are requested, the data returned consists of STATUS, MSGN, FLAME, INPUTS, OUTPUTS, BNRMINS, and BNRCYCS

The Flame-Monitor stores its burner on time and system on time (L1 powered) in minutes. For display purposes, the programmer converts this to hours. The information being supplied by Modbus will be the actual time in minutes and it is up to the communicating device to do the conversion. Since the maximum value stored in the Flame-Monitor is 9,999,999 minutes, the maximum value in hex therefore is 98967FH and comprises two data words. The maximum cycle count is 999,999 decimal or F423FH, still two data words.

To convert, multiply the high word by 10000H (65536), add to this the high byte of low word multiplied by 100H (256) and add to this the low byte of the low word. Example: (98H*10000H) + (96H*100H) + 7FH = 98967FH = 9,999,999 minutes.

As an example, the System on Minutes data is transmitted from the Flame-Monitor to the interface as high word / low word as shown below:

Address 8		Address 9	
High Word		Low Word	
High Byte	Low Byte	High Byte	Low Byte
0	98H	96H	7FH

Note: Data from address 9 cannot be accessed directly.

All values are represented in a HEX or base 16 format.

GSTAT determines the type of value TIMER represents. TIMER can be a running timer such as is used in purge, a flame signal or meaningless. Only the lower nibble of GSTAT has any value. If this value is 0 then the TIMER value has no meaning. The value in TIMER is a background minute timer in the Flame-Monitor and should be ignored. If GSTAT is between 4 and 7, the TIMER represents the current value flame signal. If GSTAT is a 1, 2, or 3 then TIMER represents a running timer value.

The baud rate of the Flame-Monitor is fixed at 4800 bits per second. The format of the data is 8 data bits, no parity and 1 stop bit. Due to the RS485 format, the communication format is considered half-duplex. That is, only one user is permitted on the communication lines at a time.

The information contained in INPUTS and OUTPUTS represents the status of the interlocks and relays respectively. For the INPUTS, a 1 in the interlock position defines the interlock as being on or active where a 1 in any bit position in the OUTPUT register signifies the relay as being energized.

INPUTS

Bit 7							Bit 0
Term P	Term 5/6	Term D		Term 8	Term 7	Term 3	Term 13
Air Flow	Ignition	Low Fire	Ref	High Fire	Main Fuel	FVES or POC	Op Ctrl or AUX#3 if E300

A ‘1’ in the opto-coupler position indicates the opto-coupler is on or interlock closed.

Expansion Module (E300) Lower – refer to bulletin E-3001

Term 35	Term 34	Term 33	Term 32	Term 23	Term 22	Term 21	Term 20
Aux #6	Aux #5	Aux #4	High Temp	High Water	AUX #2	AUX #1	Op Ctrl

Expansion Module (E300) Upper - refer to bulletin E-3001

Term 31	Term 30	Term 29	Term 28	Term 27	Term 26	Term 25	Term 24
High Pressure	Low Gas Pressure or Low Atomizing Media	Low Oil Temp.	Low Oil Pressure	Hi Gas Pressure	Oil Selected	Gas Selected	Low Water

OUTPUTS

Term 11	Term M	Term 6		Term 5	Term 7	Term A	Term X
Auto (RA1)	Blower (RB)	Ignition (RA2)	FVES (RV)	Pilot (RP)	Main Fuel (RF)	Alarm (RL)	High Fire (RH)

Table 3 - Refer to Fireye bulletin E-1101 for terminal designations.

LOGSTAT is an indication of what logic module the control is currently operating in during its cycle and is used for diagnostic purposes only. If a lockout occurs the current value of LOGSTAT is stored as part of the lockout information. The message displayed corresponds to the current logic module.

EXPLANATION OF LOGSTAT

LOGIC DISPATCHER			
VALUE		Module	FUNCTION
DEC	HEX		
69	45H	MPOSTIDLE	
70	46H	MPREPURGE1	Wait for air flow and/or high fire switch to close
71	47H	MPURGE	Open Damper Purge
72	48H	MPOSTPURGE	Low Fire Start
72	49H	MTFI	Pilot Trial
74	4AH	MTFMF	Main Trial
75	4BH	MAUTO	AUTO
76	4CH	MSHTDWN1	Post Purge
77	4DH	MSHTDWN2	Post Purge
78	4EH	MIDLE	Standby

Table 2 Logic Dispatch

Logstat represents the current software module the Flame-Monitor is currently executing. They are named as close to the logic module the actual burner sequence is in. For instance, in the Flame-Monitor, MPURGE represents High Fire Purge where MPOSTPURGE represents the low fire start period where the mod motor is sent to the low fire position in preparation for pilot light-off. MSHUTDWN1 represents the post purge period after a complete cycle or the cool down period after a lockout.

MIDLE or STANDBY is the period of time where the operating control is open or the control is in lockout waiting for reset. On instances of false flame during the purge period, the control algorithm forces the control back to STANDBY until false flame ceases or lockout occurs.

MPREPURGE1 is the period of time prior to PURGE where the control checks the status of the air flow interlocks or the high fire proving switch (D-8). If either switch is found open, the control will remain in this state until the respective switch closes or lockout occurs.

MTFI represents the pilot trial for ignition stage of a burner sequence. MTFMF represents the main trial for main flame period where main fuel is introduced along with pilot and igniter.

MAUTO is the run period of the burner sequence.

MPOSTIDLE and MSHTDWN2 are small periods of time where certain internal tests are conducted and general cleanup before and after a cycle is performed.

The Flame-Monitor outputs the current displayed message as well as the historical lockout messages as numbers. The table below correlates the message number with the actual displayed test message.

Table 1 Message Table

DEC	HEX		E110 FLAME-MONITOR MESSAGES
1	1	R	L1-13 OPEN
2	2	H	HOLD FALSE FLAME – STANDBY
3	3	R	LOW FIRE PURGE
4	4	H	HOLD D-8 LIMIT OPEN – PURGE
5	5	H	HOLD 3-P AIR FLOW OPEN
6	6	L	LOCKOUT LINE FREQUENCY NOISE DETECTED
7	7	L	LOCKOUT FLAME FAIL – PTFI
8	8	C	CHECK UNIT ADDRESS
9	9	H	HOLD M-D LIMIT OPEN
10	A	R	IGNITION TIMING – PTFI
11	B		
12	C	R	FLAME SIGNAL – AUTO
13	D	R	CYCLE COMPLETE – POST PURGE
14	E	R	L1-13 OPEN (AFTER 2 MINUTES)
15	F	L	LOCKOUT AC POWER FAIL (COEN)
16	10	L	LOCKOUT SHORT CIRCUIT TERMINAL 5,6 or 7
17	11	L	LOCKOUT D-8 LIMIT OPEN
18	12	L	LOCKOUT M-D LIMIT OPEN
19	13	L	LOCKOUT FLAME FAIL – MTFI
20	14	L	LOCKOUT FALSE FLAME
21	15	L	LOCKOUT 3-P INTLK OPEN – PURGE
22	16	L	LOCKOUT 3-P INTLK CLOSED
23	17	H	HOLD 3-P INTLK CLOSED – STANDBY
24	18	H	HIGH FIRE PURGE

DEC	HEX		E110 FLAME-MONITOR MESSAGES
25	19	R	PLEASE WAIT (INITIALIZING)
26	1A	L	LOCKOUT 3-P INTLK OPEN – AUTO
27	1B	L	LOCKOUT 3-P INTLK OPEN – MTFI
28	1C	L	LOCKOUT 3-P INTLK OPEN – PTFI
29	1D	L	LOCKOUT 13-3 FVES OPEN
30	1E		
31	1F	C	CHECK FLAME SIGNAL - PTFI
32	20	C	CHECK D-8 HI LIMIT
33	21	C	CHECK M-D LOW LIMIT
34	22	R	FLAME SIGNAL - PTFI
35	23	C	CHECK LOW FIRE SIGNAL - AUTO
36	24	R	FLAME SIGNAL - MTFI
37	25	L	LOCKOUT FLAME FAIL (AUTO)
38	26	H	HOLD 3-P INTLK OPEN - PURGE
39	27	L	LOCKOUT FUEL VALVE STATE CHANGE
E300 EXPANSION MODULE LOCKOUT MESSAGES			
40	28	L	3-P AIR FLOW OPEN
41	29	L	3-P HIGH WATER
42	2A	L	3-P LOW WATER
43	2B	L	3-P HIGH GAS PRESSURE
44	2C	L	3-P LOW GAS PRESSURE
45	2D	L	3-P LOW OIL PRESSURE
46	2E	L	3-P LOW OIL TEMPERATURE
47	2F	L	3-P LOW ATOMIZING MEDIA
48	30	L	3-P HIGH STEAM PRESSURE
49	31	L	3-P HIGH TEMPERATURE
50	32	L	3-P AUX #4 OPEN
51	33	L	3-P AUX #5 OPEN
52	34	L	3-P AUX #6 OPEN
53	35	L	3-P FUEL SELECT
SYSTEM DIAGNOSTIC MESSAGES			
54	36	L	LOCKOUT CHECK CHASSIS
55	37	L	LOCKOUT CHECK PROGRAMMER
56	38	L	LOCKOUT CHECK AMPLIFIER
57	39	L	LOCKOUT CHECK EXPANSION MODULE
58	3A	L	LOCKOUT AMPLIFIER AUTO CHECK FAIL
59	3B	L	LOCKOUT SCANNER NOISE
76	4C	L	LOCKOUT CHECK SCANNER
E300 EXPANSION MODULE HOLD MESSAGES			
60	3C	H	L1-13 AUX #1 OPEN (TERMINAL 20
61	3D	H	L1-13 AUX #2 OPEN (TERMINAL 21
62	3E	H	L1-13 AUX #3 OPEN (TERMINAL 22

DEC	HEX		E110 FLAME-MONITOR MESSAGES
63	3F	H	3-P HIGH WATER (TERMINAL 23)
64	40	H	3-P LOW WATER (TERMINAL 24)
65	41	H	3-P HIGH GAS PRESSURE
66	42	H	3-P LOW GAS PRESSURE
67	43	H	3-P LOW OIL PRESSURE
68	44	H	3-P LOW OIL TEMPERATURE
69	45	H	3-P LOW ATOMIZING MEDIA
70	46	H	3-P HIGH PRESSURE (TERMINAL 31)
71	47	H	3-P HIGH TEMPERATURE (TERMINAL 32)
72	48	H	3-P AUX #4 OPEN (TERMINAL 33)
73	49	H	3-P AUX #5 OPEN (TERMINAL 34)
74	4A	H	3-P AUX #6 OPEN (TERMINAL 35)
75	4B	H	3-P FUEL SELECT
PURGE INTERLOCK RELATED MESSAGES			
76	4C	L	LOCKOUT CHECK SCANNER
77	4D	H	HOLD D-8 LIMIT CLOSED
78	4E	L	LOCKOUT D-8 LIMIT CLOSED
79	4F	H	HOLD M-D LIMIT CLOSED
80	50	L	LOCKOUT M-D LIMIT CLOSED
81	51	L	LOCKOUT 13-3 POC CLOSED (CB ONLY)
82	52	R	DYNAMIC CHECK (CB ONLY)

R=RUN L=LOCKOUT H=HOLD C=CHECK