

FL500 HART[®] Communication Operating Manual



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1. Introduction

The FL500 UV/IR flame detector (hereafter referred to as the "FL500" or "device") is compliant with HART protocol Revision 7.0. This manual gives information about device-specific features related to the implementation of the HART protocol. This manual is made to be used as a technical reference for HART-capable host application developers, system integrators, and knowledgeable end users.

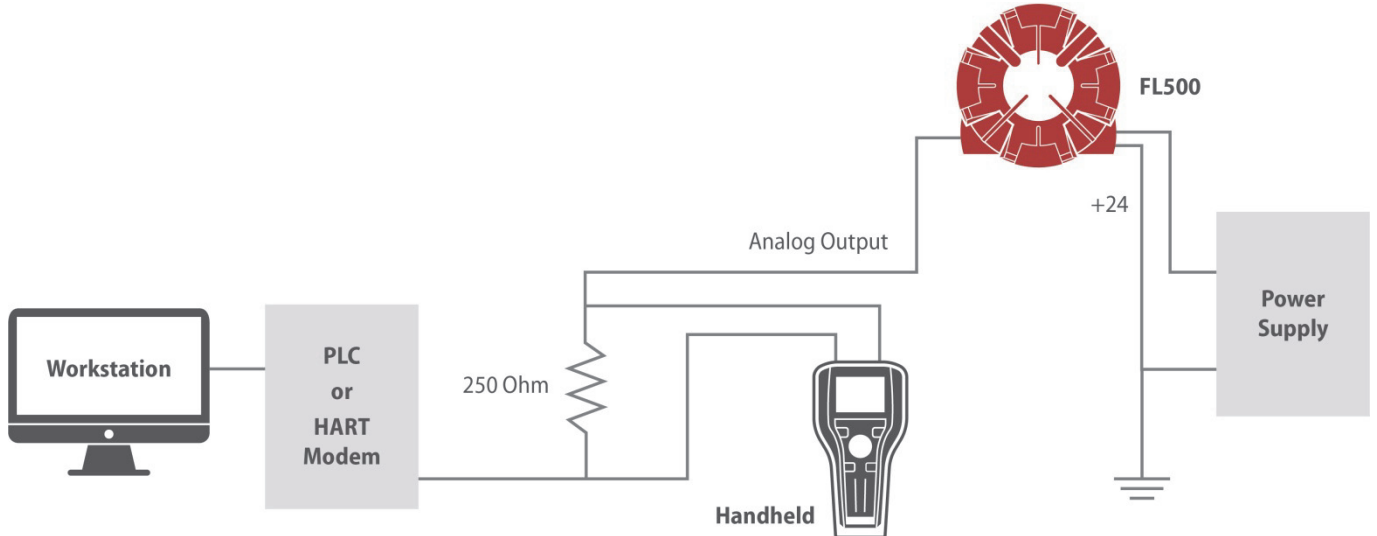
Refer to the FL500 UV/IR Flame Detector Operating Manual (PN 10193213) for information about the FL500.

2. Device Identification

Manufacturer Name	General Monitors, Inc.
Model Name	FL500
Device Type Code	144 (93 hex)
Device Revision	1
HART ID Code	223 (DF hex)
HART Protocol Revision	7.0
Number of Device Variables	0
Physical Layers Supported	1
Physical Device Category	FSK

3. Getting Started

HART communication with the FL500 can be enabled through HART handheld communicators and PC-based systems. The following shows a typical setup.



After the device is installed and connected to a PC, host application, or handheld communicator, the master typically starts communication to the device by sending HART Command 0. The device responds only if its tag matches. The data in the reply to Command 11 is identical to that of Command 0, so the master can make the Unique Identifier to be used with more commands.

NOTE: Use the handheld communicator to retrieve diagnostic information and change device settings as necessary. Do NOT use the handheld communicator as a permanent part of a safety system.

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4. Connections

The HART protocol uses the 4 – 20 mA current loop.

Normal Current	Special Current	Description
3.5 mA	1.5 mA	Fault
3.5 mA	2.0 mA	COPM error
4.0 mA	4.0 mA	Normal (Ready)
8.0 mA	8.0 mA	IR-only fire detected
12.0 mA	12.0 mA	UV-only fire detected
16.0 mA	16.0 mA	Both UV/IR (Alarm Low)
20.0 mA	20.0 mA	Fire after time delay (Alarm High)

For information about terminal connections, refer to the FL500 UV/IR Flame Detector Operating Manual (PN 10193213).

5. Dynamic Variables

The only dynamic variable for the HART protocol is the primary variable. The output of the primary variable is the FL500 Operating Mode. The primary variable is equivalent to Modbus register 0x00.

Refer to the following section for the decimal values related to the FL500 Operating Modes.

5.1. FL500 Operating Mode Decimal Values

Mode	Decimal Value
Initialization	0
Start-up	1
Normal (standby)	2
Fault	3
COPM check	4
IR-only fire	5
UV-only fire	6
Alarm Test	7
Alarm Low latching only	8
Alarm High latching only	9
Alarm Low non-latching only	10
Alarm High non-latching only	11
ATE test	12
ATEX test	13
Alarm Low and Alarm High latching	14

6. Error Status

Common-practice command 48 sends the Error status. The Error status is equivalent to Modbus register 0x02.

Byte	Bit	Hex	Description	Class	Device Status Bits Set
1 (upper)	0	0x0100	Alarm High relay	Error	4,7
	1	0x0200	Alarm Low relay	Error	4,7
	2	0x0400	Fault relay	Error	4,7
	3	0x0800	Output current	Error	4,7
	4	0x1000	Alarm Test input/output	Error	4,7
	5	0x2000	Not used	Error	4,7
	6	0x4000	UV 10 minutes	Error	4,7
	7	0x8000	Alarm Reset switch shorted	Error	4,7
0 (lower)	0	0x0001	Internal voltage	Error	4,7
	1	0x0002	Not used	Error	4,7
	2	0x0004	IR COPM	Error	4,7
	3	0x0008	UV COPM	Error	4,7
	4	0x0010	Low supply voltage	Error	4,7
	5	0x0020	Noncritical EEPROM	Error	4,7
	6	0x0040	EEPROM checksum	Error	4,7
	7	0x0080	Flash checksum	Error	4,7

These bits can be set at device start-up to indicate an instrument failure. These bits can also be set by a failure detected during continuous background diagnostic testing.

7. Universal Commands

Command 3 sends the current loop variable and the primary variable for a total of 9 bytes. Command 9 sends the primary variable only.



8. Common-practice Commands

Command Number	Byte	Command
38	N/A	Reset Configuration Changed flag
48	0	Priority Fault, Low Byte
48	1	Priority Fault, High Byte
48	2	Error status, Low Byte*
48	3	Error status, High Byte*
48	4	Power Cycled flag
48	5	Event Happened flag
48	6	0x01 = Maintenance necessary 0x02 = Alarm High or Alarm Low
48	7	0

* Equivalent to Modbus register x02

The FL500 does not use Burst mode or the Catch Device variable.

9. Device-specific Commands

The following device-specific commands are used only for the FL500.

Command Number	Command	Description
131	Abort Alarm Test	Puts the device in Normal operating mode
132	Start or Stop Alarm Test	Starts or stops Alarm Test mode
139	Reset Alarm High	Resets the latching Alarm Low and Alarm High relays
141	Set Alarm High Relay Configuration	Sets the configuration of the relay settings
142	Reset Event Happened Flag	
143	Read Event Logging Counters	Reads all five event logging counters
144	Clear Event Logging Counters	Resets all five event logging counters to 0
145	Read Alarm Low Event Log	Reads the Alarm Low event log*
146	Read Alarm High Event Log	Reads the Alarm High event log*
147	Read Fault Event Log	Reads the Fault event log*
148	Read Maintenance Event Log	Reads the Maintenance event log*
149	Set Clock	Sets the internal real-time clock
150	Read Clock	Reads the internal real-time clock setting
151	Set Run-time Meter	Sets the internal run-time meter
152	Read Run-time Meter	Reads the internal run-time meter
154	Set Event Index	Sets the index of logged events to read from 0 to the latest event
155	Read Event Index	Reads the index of logged events
163	Get Fast-changing Information	Refer to Section 9.18 "Command 163: Get Fast-changing Information" for more information
164	Get Slow-changing Information	Refer to Section 9.19 "Command 164: Get Slow-Changing Information" for more information
165	Get Set-up Information	Refer to Section 9.20 "Command 165: Get Set-up Information" for more information
166	Get Device Constants	Refer to Section 9.21 "Command 166: Get Device Constants" for more information
170	Set Current Range	Refer to Section 9.22 "Command 170: Set Current Range" for more information
200	Set Sensitivity	Sets the sensitivity parameter on flame detectors to increase the field of view

Command Number	Command	Description
201	Set Alarm High Delay	Sets the delay in seconds for the time between when an Alarm Low event occurs until an alarm is activated
203	Set DIP Switch Override	Refer to Section 9.25 "Command 203: Set DIP Switch Override" for more information
204	Reset COPM Fault	Resets a COPM Fault condition
205	Get Flame Device Info	Refer to Section 9.27 "Command 205: Get Flame Device Info" for more information

* For event logs, Event 0 is the most recent event. Event 1 is the event just before that, and so forth.

9.1. Command 131: Abort Alarm Test

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	N/A	N/A

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-15		Undefined
16	Error	Access restricted
17-127		Undefined

9.2. Command 132: Start or Stop Alarm Test

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	0 = Off, 1 = On

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	0 = Off, 1 = On

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-15		Undefined
16	Error	Access restricted
17-127		Undefined

9.3. Command 139: Reset Alarm High

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
None	N/A	N/A

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-15		Undefined
16	Error	Access restricted
17-127		Undefined

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9.4. Command 141: Set Alarm High Relay Configuration**Request Data Bytes**

Byte	Format	Description
0	Unsigned-8	Alarm High relay La/nL: 0 = nL, 1 = LA
1	Unsigned-8	Alarm High relay En/dE: 0 = dE, 1 = En
2	Unsigned-8	Alarm Low relay La/nL: 0 = nL, 1 = LA
3	Unsigned-8	Alarm Low relay En/dE: 0 = dE, 1 = En
4	Unsigned-8	Not used
5	Unsigned-8	Not used

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Alarm High relay La/nL: 0 = nL, 1 = LA
1	Unsigned-8	Alarm High relay En/dE: 0 = dE, 1 = En
2	Unsigned-8	Alarm Low relay La/nL: 0 = nL, 1 = LA
3	Unsigned-8	Alarm Low relay En/dE: 0 = dE, 1 = En
4	Unsigned-8	Zero
5	Unsigned-8	Zero

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-2		Undefined
3	Error	Passed parameter too large
4		Undefined
5	Error	Too few data bytes received
16	Error	Access restricted
17-27		Undefined

9.5. Command 142: Reset Event Happened Flag

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
None	N/A	N/A

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-15		Undefined
16	Error	Access restricted
17-127		Undefined

9.6. Command 143: Read Event Logging Counters

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-1	Unsigned-16	Alarm Low event counter
2-3	Unsigned-16	Alarm High event counter
4-5	Unsigned-16	Fault event counter
6-7	Unsigned-16	Maintenance event counter
8-9	Unsigned-16	Calibrate event counter

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-127		Undefined

9.7. Command 144: Clear Event Logging Counters**Request Data Bytes**

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
None	N/A	N/A

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-127		Undefined

9.8. Command 145: Read Alarm Low Event Log**Request Data Bytes**

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-3	Unsigned-32	Event running time in seconds
4-6	Date	Event date: Day, Month, Year
7	Unsigned-8	Event hour
8	Unsigned-8	Event minute
9	Unsigned-8	Event second
10-13	Unsigned-8	Reserved = 0

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-127		Undefined

9.9. Command 146: Read Alarm High Event Log

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-3	Unsigned-32	Event running time in seconds
4-6	Date	Event date: Day, Month, Year
7	Unsigned-8	Event hour
8	Unsigned-8	Event minute
9	Unsigned-8	Event second
10-13	Unsigned-8	Reserved = 0

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-127		Undefined

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9.10. Command 147: Read Fault Event Log

This command reads the sensor life for the specified sensor.

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-3	Unsigned-32	Event running time in seconds
4-6	Date	Event date: Day, Month, Year
7	Unsigned-8	Event hour
8	Unsigned-8	Event minute
9	Unsigned-8	Event second
10-11	Unsigned-16	Event cause Refer to Section 10 "Fault Event Log – Cause Description" for more information

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-127		Undefined

9.11. Command 148: Read Maintenance Event Log

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-3	Unsigned-32	Event running time in seconds
4-6	Date	Event date: Day, Month, Year
7	Unsigned-8	Event hour
8	Unsigned-8	Event minute
9	Unsigned-8	Event second
10-11	Unsigned-8	Reserved = 0

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-127		Undefined

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9.12. Command 149: Set Clock

This command sets the internal real-time clock.

Request Data Bytes

Byte	Format	Description
0-2	Date	Date: Day, Month, Year
3	Unsigned-8	Hours
4	Unsigned-8	Minutes
5	Unsigned-8	Seconds

Response Data Bytes

Byte	Format	Description
0-2	Date	Date: Day, Month, Year
3	Unsigned-8	Hours
4	Unsigned-8	Minutes
5	Unsigned-8	Seconds

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-4		Undefined
5	Error	Too few data bytes received
6-127		Undefined

9.13. Command 150: Read Clock

Request Data Bytes

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-2	Date	Date: Day, Month, Year
3	Unsigned-8	Hours
4	Unsigned-8	Minutes
5	Unsigned-8	Seconds

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-127		Undefined

9.14. Command 151: Set Run-time Meter

Request Data Bytes

Byte	Format	Description
0-3	Unsigned-32	Run-time meter value

Response Data Bytes

Byte	Format	Description
0-3	Unsigned-32	Run-time meter value

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-4		Undefined
5	Error	Too few data bytes received
6-127		Undefined

9.15. Command 152: Read Run-time Meter**Request Data Bytes**

Byte	Format	Description
0	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-3	Unsigned-32	Run-time meter value

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
17-127		Undefined

9.16. Command 154: Set Event Index**Request Data Bytes**

Byte	Format	Description
0	Unsigned-8	Sets the index event before reading the event log Range: 0 – 9

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Event index

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-2		Undefined
3	Error	Passed parameter too large
4		Undefined
5	Error	Too few data bytes received
6-127		Undefined

9.17. Command 155: Read Event Index

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Event index

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-127		Undefined

US

9.18. Command 163: Get Fast-changing Information

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-1	Unsigned-16	Mode Refer to Section 5.1 "FL500 Operating Mode Decimal Values" for information
2-3	Unsigned-16	Submode
4-7	Float	Analog output
8-9	Unsigned-16	Priority fault
10-11	Bit map	Error status
12	Unsigned-8	Alarm High status: 0 = Off, 1 = On, 2 = Accepted
13	Unsigned-8	Alarm Low status: 0 = Off, 1 = On, 2 = Accepted
14	Unsigned-8	Alarm Mid status: 0 = Off, 1 = On, 2 = Accepted
15	Unsigned-8	Power Cycled flag
16	Unsigned-8	Event Happened flag
17	Integer-8	0
18-21	Integer-32	0

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-127		Undefined

9.19. Command 164: Get Slow-Changing Information

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-1	Signed-16	Temperature
2-5	Float	Supply voltage
6-7	Signed-16	0

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-127		Undefined

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9.20. Command 165: Get Set-up Information

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	FL500 type: 01 = UV/IR, 02 = UV only, 03 = Hydrogen
1	Enumerated	Measured units
2-5	Unsigned-32	0
6	Unsigned-8	0
7	Unsigned-8	Alarm High relay La/nL: 0 = nL, 1 = LA
8	Unsigned-8	Alarm High relay En/dE: 0 = dE, 1 = En
9	Unsigned-8	0
10	Unsigned-8	Alarm Low relay La/nL: 0 = nL, 1 = LA (Alarm Low)
11	Unsigned-8	Alarm Low relay En/dE: 0 = dE, 1 = En (Alarm Low)
12	Unsigned-8	0
13	Unsigned-8	0
14	Unsigned-8	0
15	Unsigned-8	Alarm High delay: 3 = 10 sec, 1 = 8 sec, 0 = 4 sec, 2 = 2 sec
16	Unsigned-8	Sensitivity: 0 = 100%, 1 = 75%, 2 = 50%
17	Unsigned-8	0
18	Unsigned-8	0
19	Unsigned-8	0
20	Unsigned-8	DIP switch override: 0 = Setting from switch, 1 = Override switch
21	Unsigned-8	0
22	Unsigned-8	0
23	Unsigned-8	0
24	Unsigned-8	Current range: 0 = 3.5 – 20 mA, 1 = 1.25 – 20 mA

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-127		Undefined

9.21. Command 166: Get Device Constants

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	System firmware revision, ASCII code

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-127		Undefined

9.22. Command 170: Set Current Range

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	0 = 3.5 – 20 mA, 1 = 1.25 – 20 mA

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	0 = 3.5 – 20 mA, 1 = 1.25 – 20 mA

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-2		Undefined
3	Error	Passed parameter too large
4		Undefined
5	Error	Too few data bytes received
6-127		Undefined

9.23. Command 200: Set Sensitivity**Request Data Bytes**

Byte	Format	Description
0	Unsigned-8	Sensitivity: 0 = 100% High, 1 = 75% Mid, 2 = 50% Low

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Sensitivity: High, Mid, Low

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-2		Undefined
3	Error	Passed parameter too large
4		Undefined
5	Error	Too few data bytes received
6-127		Undefined

9.24. Command 201: Set Alarm High Delay

Request Data Bytes

Byte	Format	Description
0	Unsigned-8	Alarm High delay: 2 = 2 sec, 0 = 4 sec, 1 = 8 sec, 3 = 10 sec

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	Alarm High delay

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-2		Undefined
3	Error	Passed parameter too large
4		Undefined
5	Error	Too few data bytes received
6-127		Undefined

US

9.25. Command 203: Set DIP Switch Override**Request Data Bytes**

Byte	Format	Description
0	Unsigned-8	0 = Setting from DIP switch 1 = Override DIP switch

Response Data Bytes

Byte	Format	Description
0	Unsigned-8	0 = Setting from DIP switch 1 = Override DIP switch

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-2		Undefined
3	Error	Passed parameter too large
4		Undefined
5	Error	Too few data bytes received
6-127		Undefined

9.26. Command 204: Reset COPM Fault**Request Data Bytes**

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
None	N/A	N/A

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-15		Undefined
16	Error	Access restricted
17-127		Undefined

9.27. Command 205: Get Flame Device Info

Request Data Bytes

Byte	Format	Description
None	N/A	N/A

Response Data Bytes

Byte	Format	Description
0-1	Unsigned-16	UV signal counts
2-3	Unsigned-16	UV COPM Fault count
4-5	Unsigned-16	IR1 signal count
6-7	Unsigned-16	IR1 COPM Fault count
8-9	Unsigned-16	IR amplitude in millivolts (mV)
10-11	Unsigned-16	IR maximum in mV
12-13	Unsigned-16	IR minimum in mV
14-15	Unsigned-16	Reserved
16-17	Unsigned-16	Reserved
18-19	Unsigned-16	Reserved
20-21	Unsigned-16	Reserved
22-23	Unsigned-16	Reserved

Command-specific Response Codes

Code	Class	Description
0	Success	No command-specific errors
1-127		Undefined

10. Fault Event Log – Cause Description

The Fault Event log shows the cause of the error or fault as it was reported by the Read Event Log commands.

Byte	Bit	Hex	Description
1 (upper)	0	0x0100	Alarm High relay
	1	0x0200	Alarm Low relay
	2	0x0400	Fault relay
	3	0x0800	Output current
	4	0x1000	Alarm Test input/output
	5	0x2000	Not used
	6	0x4000	UV 10 minutes
	7	0x8000	Alarm Reset switch shorted
0 (lower)	0	0x0001	Internal voltage
	1	0x0002	Not used
	2	0x0004	IR COPM
	3	0x0008	UV COPM
	4	0x0010	Low supply voltage
	5	0x0020	Noncritical EEPROM
	6	0x0040	EEPROM checksum
	7	0x0080	Flash checksum

11. Performance

11.1. Sampling Rates

The FL500 responds to interrupts from the sensors. Other items are sampled at 35 ms or a multiple of 35 ms.

11.2. Device Reset

The FL500 cannot be reset by any command. A power cycle is necessary to reset the device.

11.3. Self-Test

The FL500 does a self-test after a power cycle. If any part of the self-test fails, the device immediately sends Fault output.

11.4. Command Response Delay

The FL500 has the following response times:

Response Type	Response Time
Minimum	20 ms
Typical	50 ms
Maximum	100 ms

11.5. Busy and Delayed Response

The FL500 does not use delayed response times.

11.6. Long Messages

The largest data field used by the FL500 is 34 bytes, including the 2 status bytes, sent in response to Commands 20 (Read/Write) and 22 (Long Tag).

11.7. Nonvolatile Memory

The FL500 uses EEPROM to keep configuration parameters for the device. New data is written to EEPROM immediately with a Write command.

11.8. Operating Modes

The FL500 sends No Fire output in Normal operating mode. Different operating modes are used to identify UV and/or IR radiation. Different operating modes are used to identify special conditions.

11.9. Write Protection

The FL500 does not support any write-protection mode.

11.10. Reset Polling Address

To reset the polling address to 0, short the Alarm Reset switch to ground for 10 to 20 seconds during a power cycle reset.

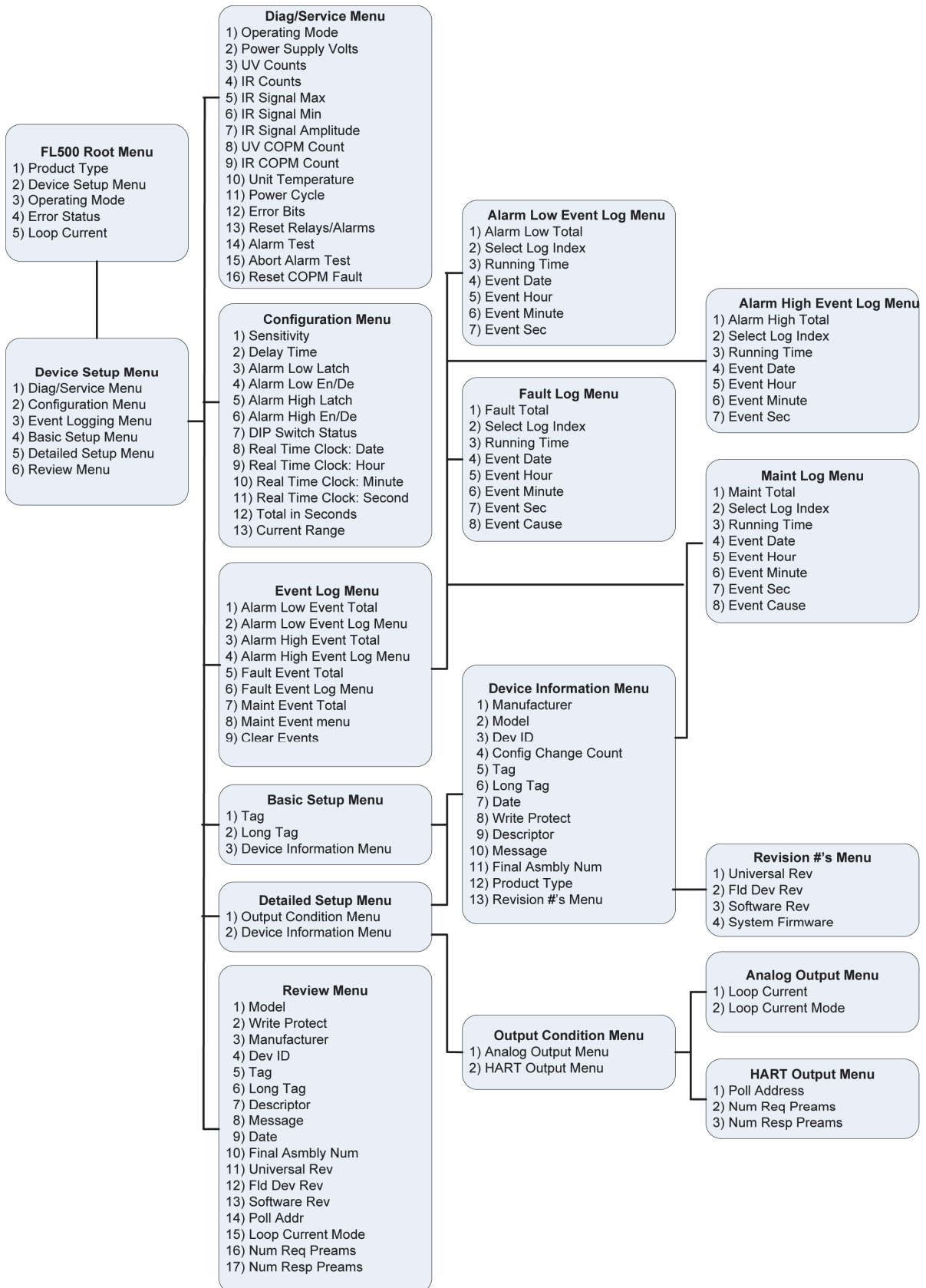
12. Capability Checklist

Manufacturer, model, and revision	General Monitors, Inc., FL500, Revision 1
Device type	FL500 UV/IR Flame Detector
HART revision	7.0
Device description available	Yes
Number and type of sensors	1 UV sensor, 1 IR sensor
Number and type of actuators	0
Number and type of host side signals	1: 4 – 20 mA analog (Can be configured to source or sink)
Number of device variables	0
Number of dynamic variables	1
Mappable dynamic variables	No
Number of common-practice commands	2
Number of device-specific commands	27
Bits of additional device status	8
Alternative operating modes	No
Burst mode	No
Write-protection	Mfg Only

US

13. Default Configuration

Parameter	Default value
Lower range value	0
Upper range value	65535
PV Units	FL500 Operating Mode
Sensor type	UV/IR
Number of wires	3
Damping time constant	N/A
Fault-indication jumper	N/A
Write-protect jumper	N/A
Number of response preambles	5



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