

This document defines the protocol used by the AN110 and Onboard SHM Datastream Aggregator Module (OSDAM)

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## Revision History

### Version 1.19 to 1.20

1. Added debug information for AN110 realtime command when transmitting LPR data.

### Version 1.18 to 1.19

1. Extended the 'md' offset datetime response in Section 4.2.3 on page 24 to allow the initial offsets to be declared (in seconds) for each sensor group.
2. Added a description for the new parameter <sgdelay> in Table 5 on page 9.
3. Corrected an inconsistency for the 'md' and 'mr' formats that incorrectly placed a <\$00> sequence after the parameter <numgrps>.

### Version 1.17 to 1.18

1. Added a case to the 'md' response which now includes sending a command to indicate subsequent data packets will be offset in time, as detailed in Section 4.2.3 on page 24.
2. Updated the 'md' timeout procedure in Section 4.2.2 on page 24 to include all 'md' responses (including the 'md' response to indicate an offset in the datetime).
3. Updated 'MD' confirmation response in Section 3.2.3 on page 16 to also include the confirmation of a data packet to offset datetime.

### Version 1.16 to 1.17

1. Added a section discussing the timeout criteria for the 'mr' response in Section 4.7.4 and the 'md' response in Section 4.2.2 on page 24.
2. Added a section discussing the termination criteria to exit the 'RLTM' mode in Section 4.7.3 on page 29 and the 'DNLD/LGNG' Section 4.2.1 on page 24.
3. Corrected an error in the the format for the 'mr' and 'md' commands by removing the <\$00> character after the occurrence of the parameter <numgrps>. (See Section 4.7 on page 28 and 4.2 on page 23 for the respective changes).
4. Fixed format for the 'MR' and 'MD' commands in Sections 3.7 and 3.2 respectively, where <txcntr> was incorrectly referenced as <chksum>.

### Version 1.15 to 1.16

1. Introduced an additional parameter <sgdesc> passed with the 'mi' response to describe each sensor group. In practice this will allow <sgname> to be an abbreviated null terminated string to reduce packet overhead when sending 'mr' and 'md' responses. A description of <sgdesc> is provided in Table 5 on page 9 and its use in the 'mi' response is described in Section 4.5 on page 26.
2. Added description for unsupported SHM system and OSDAM responses in Sections 4.12 and 7.16, respectively.

## **Version 1.14 to 1.15**

1. Figure in Section 3.2 is now correct. (Before the figure was the same as the figure in Section 3.7).
2. Descriptions in Sections 3.2 and 3.7 were corrected.

## **Version 1.13 to 1.14**

1. Added a flowchart for the 'MD' command in Section 3.2.
2. Added a flowchart for the 'MR' command in Section 3.7.
3. Updated Section 3.6 to indicate a sensing group is omitted from data logging if (i) the corresponding sensing group line (<sgname#> <\$00> <sgper#>) is not sent or (ii) <sgper> is set to 0.

## **Version 1.12 to 1.13**

1. Corrected reference to 'DNLD' command in Section 4.2 from 'DWND' to 'DNLD'.
2. Corrected hex code for monitor set / get commands and responses.

## 1 Overview

An SHM system can connect to a host PC either directly or indirectly through an Onboard SHM Datastream Aggregator Module (OSDAM), shown in Figure 1. The OSDAM connects the host to multiple SHM systems (up to 16 in total). To achieve this, a set of commands and responses are sent between the host and OSDAM and relayed through a set of commands sent between the OSDAM and SHM system as shown in Figure 2. A majority of the OSDAM commands are identical to the SHM system commands. Additionally, a majority of the SHM system responses are identical to the OSDAM responses. As a result, the protocol described in this document is applicable for interfacing the host to the SHM system either indirectly through the OSDAM or directly through a direct connection with the SHM system.



Figure 1: Photo of the Onboard SHM Datastream Aggregator Module (OSDAM)

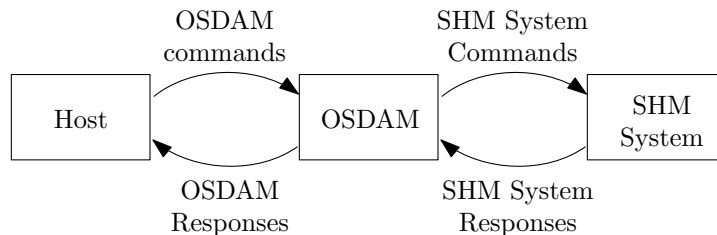


Figure 2: Block diagram illustrating command / responses between the host, OSDAM and SHM system.

The remainder of this document is organized as follows: Section 2 presents the general command structure, commands, responses and parameters used in the application programmable interface (API); Section 3 provides a description, format and example for each of the SHM system commands; Section 4 provides similar details for the SHM system responses; Section 6 provides a description, format and example for the OSDAM commands that differ from the SHM commands; Finally, Section 7 provides similar details for the OSDAM responses.

## 2 API Format

This section provides a general description of the API format which includes: the format of the command structure a list of the SHM system command variable types used along with their corresponding SHM system responses, a list of all the valid parameter types, commonly used parameters and corresponding parameter values, and a description of the valid operating modes.

### 2.1 Command Structure

All OSDAM and SHM system commands and responses follow the same command structure containing six unique fields each of which are summarized in Table 1.

Table 1: Description of general command structure.

Order	Symbol	Size & Type	Description
1	<start>	1-byte char	Start character constant ('/' or 0x2F).
2	<id>	2-byte char	ASCII uppercase/lowercase 2-char ID field to identify the command/response. Commands sent to OSDAM to the end-device are in uppercase. Responses from the end-device to OSDAM are passed in lowercase.
3	<len>	2-byte unsigned short	The number of N-bytes in the parameter(s) field.
4	< $\overline{\text{len}}$ >	2-byte unsigned short	Ones' complement of the parameter length to verify the correct number of N-bytes in the parameter(s) field.
5	<params>	N-bytes	The specific parameters field(s) consisting of N-bytes.
6	<chksum>	1-byte	Checksum such that the sum of all bytes of the command/response excluding the start character <'/'> results in the constant 0x2F when truncated to 8 bits.

- Note:**
- All numerical values in binary form are sent *little-endian*.
  - Responses with parameters <params> field length cannot exceed 4096 bytes.

### 2.2 List of Commands

A list of all OSDAM and SHM system commands are summarized in Table 2. All commands intended for the SHM system are also used by the OSDAM to relay the commands between the host and SHM system. In addition, there are three additional OSDAM specific commands.

Table 2: List of OSDAM / SHM system commands.

ID	Hex	Description	Used by SHM System	Used by OSDAM	Supported by Current Protocol?
LM	\$4C \$4D	List all connected SHM systems	✓	✓	✓
MD	\$4D \$44	Download sensor data	✓	✓	✓
ME	\$4D \$45	End monitoring operation/mode	✓	✓	✓
MG	\$4D \$47	Get SHM system parameter	✓	✓	✓
MI	\$4D \$49	Return SHM system information	✓	✓	✓
ML	\$4D \$4C	Start logging data	✓	✓	✓
MR	\$4D \$52	Start real-time data collection	✓	✓	✓
MS	\$4D \$53	Set SHM system parameter	✓	✓	✓
MT*	\$4D \$54	Test SHM system	✓	✓	
MU*	\$4D \$55	Update SHM system firmware	✓	✓	

ID	Hex	Description	Used by SHM System	Used by OSDAM	Supported by Current Protocol?
OE	\$4F \$45	End OSDAM operation/mode	✓	✓	✓
OI	\$4F \$49	Return OSDAM information		✓	✓
OT*	\$4F \$54	Test OSDAM		✓	
OU*	\$4F \$55	Update OSDAM firmware		✓	
W	\$57	Wake the OSDAM/SHM system	✓	✓	✓

\* Command reserved for future support.

**Note:** All command <id> fields are two uppercase characters. Each command has a corresponding response which uses a lowercase equivalent for its 2-char <id>.

## 2.3 List of Responses

A list of all OSDAM and SHM system responses are summarized in Table 3. All SHM system responses are also used by the OSDAM to relay responses between the SHM system and host. In addition, there are three additional OSDAM specific responses.

Table 3: List of OSDAM / SHM system responses.

ID	Hex	Description	Used by SHM System	Used by OSDAM	Supported by Current Protocol?
lm	\$6C \$6D	List all connected SHM systems	✓	✓	✓
md	\$6D \$64	Download sensor data	✓	✓	✓
me	\$6D \$65	End monitoring operation/mode	✓	✓	✓
mg	\$6D \$67	Get SHM system parameter	✓	✓	✓
mi	\$6D \$69	Return SHM system information	✓	✓	✓
ml	\$6D \$6C	Start logging data	✓	✓	✓
mr	\$6D \$72	Start real-time data collection	✓	✓	✓
ms	\$6D \$73	Set SHM system parameter	✓	✓	✓
mt*	\$6D \$74	Test SHM system	✓	✓	
mu*	\$6D \$75	Update SHM system firmware	✓	✓	
oe	\$6F \$65	End OSDAM operation/mode	✓	✓	
oi	\$6F \$69	Return OSDAM information		✓	✓
ot*	\$6F \$74	Test OSDAM		✓	
ou*	\$6F \$75	Update the OSDAM firmware		✓	
W	\$57	Wake the OSDAM/SHM system	✓	✓	✓

\* Response reserved for future support.

**Note:** The host can use a received response as acknowledgment that its command was successful; otherwise, the command should be resent. After receiving the command/response's first byte, the device (host, OSDAM or SHM system) should allow a 5-second timeout before aborting communication.

**Note:** To indicate to the host an API command is not supported, the SHM system terminates the response by placing the checksum byte immediately after the (NUL terminated) serial number string; thus, truncating the response's normal length.



## 2.4 Parameter Types

The parameter type identifier <ptype>, is an 8-bit quantity where if bit7 is 0, the specific type and size of the parameter is determined by the 7-bit value as listed in Table 4. If bit7 is 1, the parameter is considered a general type with the value of bits 6-0 specifying its length in bytes.

Table 4: List of parameter types.

Ptype ID	Param Type	Bytes	Ptype ID	Param Type	Bytes
0	Boolean	1	9	Half (precision) float	2
1	Unsigned byte	1	10	Single (precision) float	4
2	Signed byte	1	11	Double (precision) float	8
3	Unsigned short	2	12	Long double	10
4	Signed short	2	13	Long double	12
5	Unsigned long	4	14	String (zero terminated)	variable <sup>1</sup>
6	Signed long	4	127	SPLOAT (See Section 2.4.1)	2
7	Unsigned long long	8	≥128	General type	variable <sup>2</sup>
8	Signed long long	8			

<sup>1</sup> String parameter types are auto terminated by NUL characters 0x00.

<sup>2</sup> Size of general types is determined from the <ptype> parameter as: (value of bits 6-0 of <ptype>) + 1

### 2.4.1 Short Positive Float (SPLOAT)

The SPLOAT is a format used to compress unsigned floating point precision numbers greater than a value of 1 to two bytes. The first five bits of the SPLOAT are reserved for the exponent ( $e$ ) and the remaining 11 bits are used by the mantissa ( $f$ ). The equivalent numerical value is computed by,

$$\text{SPLOAT} = 1.f \times 2^e \quad (1)$$

☞ Example: SPLOAT = 322.25, uint16 = 16914, binary = 0100001000010010<sub>2</sub>

## 2.5 Commonly Used Parameters

Table 5: List of commonly used parameters and associated types.

Parameter	Description	Type	Ptype	Usage
<cspd>	Comm. speed	unsigned byte	1	Effective communication speed between the SHM system and host measured in kBytes/sec.
<datetime>	Start time	string	14	Start time for a current logging mode or the previous logging mode.
<freemem>	Free memory	unsigned long	5	Free memory for data storage in kBytes.
<mapID>	Map ID	unsigned byte	1	Identification number used to reference a unique SHM system. The connection map ID is assigned by the host and is set using the monitor set 'MS' command.
<man>	Manufacturer	string	14	OSDAM or SHM system manufacturer.
<mod>	Model name	string	14	OSDAM or SHM system model name.
<numgrps>	Number of sensing groups	unsigned byte	1	Number of sensor groups.
<opmode>	Operation mode	string	14	SHM system operating mode. Valid parameters are

Parameter	Description	Type	Ptype	Usage
<pname>	Parameter name	string	14	SHM system parameter name.
<port>	Comm. port	string	14	Communication port used by a SHM system.
<ptype>	Parameter type	unsigned byte	1	Parameter types for setting variables and defining data structures.
<pvalue>	Parameter value	See Section 2.7.1	–	SHM system parameter value.
<ser>	Serial number	string	14	OSDAM or SHM system serial number.
<sgcount>	Number of total samples	unsigned long	5	Total number of samples logged for a given sensing group.
<sgdata>	Sensing group data block	See Section 2.7.2	–	Data block of sensor data samples for a given sensing group.
<sgdelay>	Sensing group time offset / delay.	unsigned long	5	The number of seconds to initially delay each respective sensing group from the start time declared by <datetime>.
<sgdesc>	Sensing group description	string	14	Description used to identify the sensing group
<sgname>	Sensing group name	string	14	Unique identifier assigned by the SHM system for a group of sensors of the same type.
<sgnsamp>	Number of samples	unsigned byte	1	Total number of sample sets in a data block <sgdata> for a given sensing group.
<sgnsen>	Number of sensors	unsigned byte	1	Total number of sensors in a given sensing group.
<sgptype>	Sensing group ptype	unsigned byte	1	Sensing group parameter type
<sgper>	Sensing group sample period	unsigned long	5	Sensing group_requested/actual sampling period in seconds.
<sgunit>	Sensing group units	string	14	Sensing group units.
<txcntr>	Transmit counter	unsigned byte	1	Data transmission counter.
<ver>	Firmware version	string	14	OSDAM or SHM system firmware version.

## 2.6 Parameter Values

Unless otherwise specified in Table 6, the parameter values for each parameter listed in Table 5 can take any value within the range of the assigned variable type.

Table 6: List of valid values for specific parameter types.

Parameter	Valid String Values / Numerical Range
<datetime>	See Section 2.7.1.
<mapID>	Valid IDs range from 1–16 and a value of 0 corresponds to no assignment.
<opmode>	“IDLE”, “SELFTTEST”, “REALTIME”, “LOGGING”, “LOG&DL”, “DOWNLOAD”, or “UPDATE”.
<port>	“RS-232”, “RS-485”, “ZigBeeC”, or “ZigBeeR”
<sgper>	Valid IDs range from $1-(2^{32}-1)$ and a value of 0 corresponds no data logging for the corresponding sensing group.
<txcntr>	Valid transmission counter values range from 1–255. The value of 0 is reserved for use by the setup parameter headers command and response only.

## 2.7 Parameter Formats

This section presents the formats for the <datetime> and <sgdata> parameters.

## 2.7.1 Start Time <datetime>


The <datetime> parameter is reported in Universal Coordinated Time (UTC) using the 20-byte string format given in Table 7. This format is used as the strings are easily sortable by date and time. The format consists of the full year (“YYYY”), month (“MM”) day (“DD”), hour (“hh”), minute (“mm”) and second (“ss”). The year, month and day are separated by a dash character “-”, the day and time are separated by a space, the hour, minute and second are separated by a colon character “:”, and the date string is terminated with the character “Z”. Presented are two examples. Example 1 shows the character break-down of the string “2013-04-10 18:06:28Z” as representing the date April 10th 2013 at 11:06:28 AM. Example 2 shows the character break-down of the string “2013-12-05 05:24:00Z” as December 12th, 2013 at 03:24:00 PM.


Table 7: Datetime string format

Position	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Format	Y	Y	Y	Y	-	M	M	-	D	D	<space>	h	h	:	m	m	:	s	s	Z
Eg. 1	2	0	1	3	-	0	4	-	1	0		1	1	:	0	6	:	2	8	Z
Eg. 2	2	0	1	3	-	1	2	-	0	5		1	5	:	2	4	:	0	0	Z

## 2.7.2 Sensing Group Data Block <sgdata>

Data block of sensor data samples for a given sensing group. The format for each data block is a two dimensional array in row major order where each row corresponds to a unique sample set and each column corresponds to a unique sensor.

 Format(s): `sgdata[<sgnsamp>][<sgnsen>]` array of <sgptype>

 Example: `<sgnsamp> = 2, <sgnsen> = 3, <sgptype> = 3,`  
`sgdata[1][1] = 111`  
`sgdata[1][2] = 222`  
`sgdata[1][3] = 333`  
`sgdata[2][1] = 444`  
`sgdata[2][2] = 555`  
`sgdata[2][3] = 666`  
`$6F $00 $DE $00 $4D $01 $BC $01 $2B $02 $9A $02`

## 2.8 Operating Modes

### 2.8.1 SHM Systems

The SHM system has seven modes of operation summarized in Table 8. Transitions between operating modes are triggered by issuing a SHM system command or by completing a task and returning to the prior state. A state diagram showing the operating modes along with the triggering commands and returning responses is given in Figure. 3.

Table 8: List of SHM system operating modes.

Mode	Description	During this mode...	Starts by...	Ends by...
DNLD	Download	SHM system is transmitting data to either the OSDAM or host.	Issuing a 'MD' command during the IDLE mode.	Issuing a 'ME' command. <sup>1</sup>

Mode	Description	During this mode...	Starts by...	Ends by...
IDLE	Idle	No activity occurs.	The <u>default</u> state at startup. Occurs when ending any mode except LOG&DL.	Issuing a 'MD', 'ML', 'MR', 'MT', or 'MU' command.
LGDL	Log & download	SHM system is simultaneously logging and transmitting data to either the OSDAM or host.	Issuing a 'MD' command during the LOGGING mode.	Issuing a 'ME' command.
LGNG	Logging	SHM system is logging data.	Issuing a 'ML' command during the IDLE mode or when ending the LOG&DL mode.	Issuing a 'ME' command. <sup>1</sup>
RLTM	Realtime	SHM system is transmitting data to either the OSDAM or host in realtime.	Issuing a 'MR' command during the IDLE mode.	Issuing a 'ME' command.
TEST*	Self-test	SHM system is conducting a self-diagnostic.	Issuing a 'MT' command during the IDLE mode.	Issuing a 'ME' command.
UPDT*	Update	SHM system is receiving a firmware update from either the OSDAM or host.	Issuing a 'MU' command during the IDLE mode.	Issuing a 'ME' command.

\* Operating modes are reserved for future support.

<sup>1</sup> This generally occurs after the last monitor download 'md' response is received by the host but can also be issued during data transmission to terminate the download.

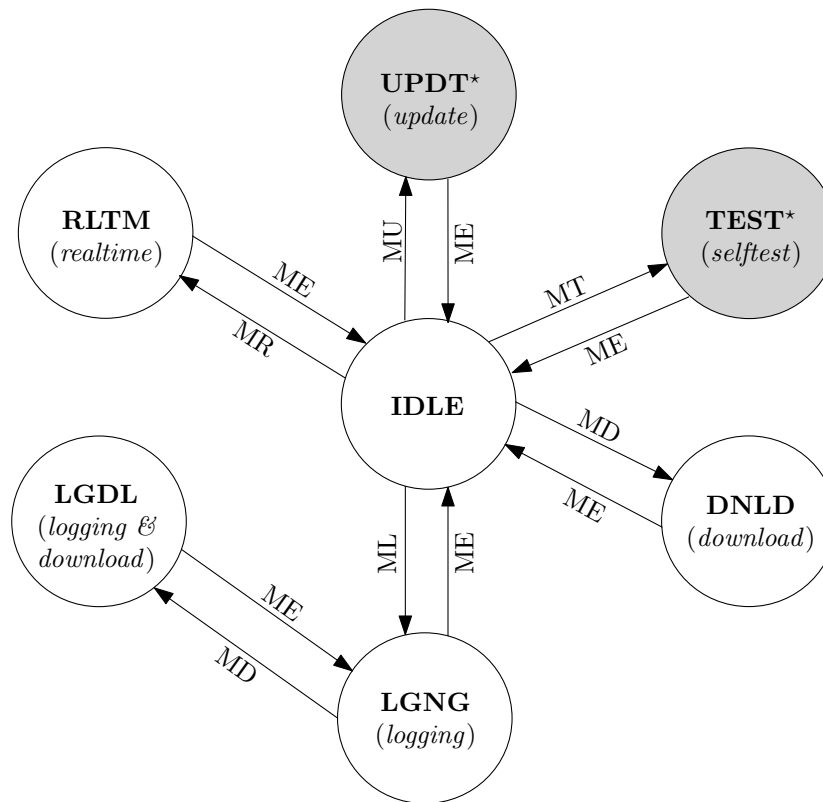


Figure 3: State diagram of the SHM system operating modes.

\* Operating modes shown in light gray are reserved for future support.

## 2.8.2 OSDAM

The OSDAM has three modes of operation summarized in Table 9. Transitions between operating modes are triggered by issuing an OSDAM command or by completing a task and returning to the prior state. A state diagram showing the operating modes along with the triggering commands and returning responses is given in Figure. 4.

Table 9: List of OSDAM operating modes.

Mode	Description	During this mode...	Starts by...	Ends by...
REDY	Ready mode	OSDAM is listening for and executing host commands and SHM system responses.	The <u>default</u> state. Occurs when ending any mode.	Issuing an 'LM', 'OT' or 'OU' command.
LSMN	List monitors	OSDAM is returning list monitor 'lm' commands to the host.	Issuing a 'LM' command during the IDLE mode.	Issuing an 'OE' command.
TEST*	Self-test	OSDAM is conducting a self-diagnostic.	Issuing a 'OT' command during the IDLE mode.	Issuing an 'OE' command.
UPDT*	Update	OSDAM is receiving a firmware update from either the host.	Issuing a 'OU' command during the IDLE mode.	Issuing an 'OE' command.

\* Operating modes are reserved for future support.

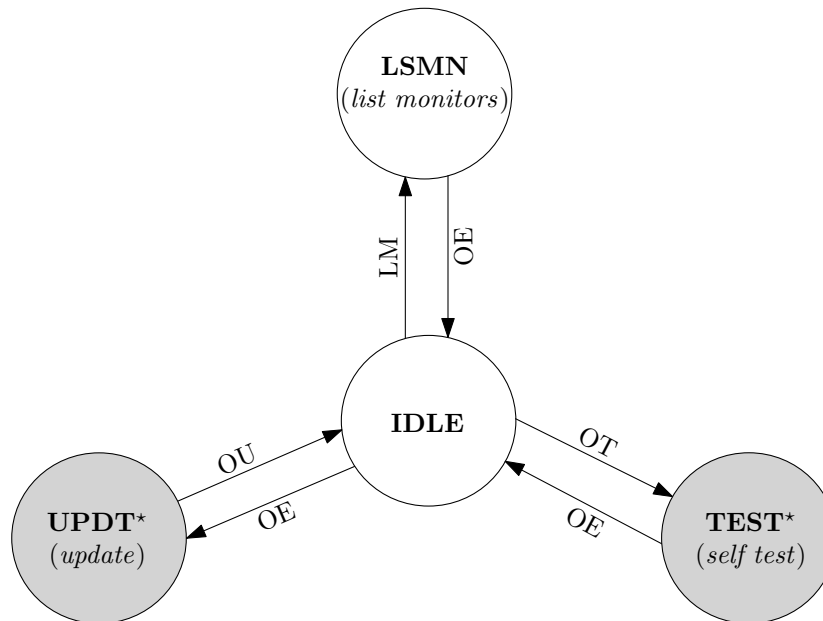


Figure 4: State diagram of the SHM system operating modes.

\* Operating modes shown in light gray are reserved for future support.

## 2.9 Process Description

The SHM system connects to the host either directly or indirectly through the OSDAM. If the OSDAM unit is used to connect the SHM system to the host, the OSDAM info 'OI' is sent to the OSDAM unit to verify the identify of the OSDAM device. When an OSDAM info response 'oi' is received, the host recognizes the OSDAM and a connection is established. Then, a list monitors 'LM' command is sent to the OSDAM which broadcasts the command to all local SHM systems connected to RS-232, RS-485 or Zigbee. All SHM systems reply with the list monitors response

'Im' which includes information about each unit. Next, the SHM system configures the local network by setting the Map ID for each SHM system by sending a monitor set 'MS' command to each SHM system with a unique Map ID ranging from 1-16 and verified by receiving a monitor send 'ms' response. This can also be verified by sending the monitor get 'MG' command and receiving a monitor get 'mg' response. Any additional SHM system settings are set or retrieved during this by sending the same commands with the appropriate parameter fields. Before entering any other operating mode for a particular SHM system, the host needs information about the sensing groups by issuing the monitor info 'MI' command. The SHM system replies with the 'mi' response which contains all of the sensing groups by name, data format, units and number of sensors along with the current operating mode. The host can now request that a SHM system enter the 'LGNG' or 'RLTM' modes by sending either the monitor log 'ML' or monitor realtime 'MR' commands along with parameters to indicate the sensing groups to monitor and the desired sampling rate for each. In the case of the 'RLTM' mode, a monitor realtime 'mr' response is sent with header information to identify the sensing groups and corresponding sample rates that will be sent with each subsequent 'mr' response. In both cases, the 'LGNG' and 'RLTM' modes are exited when the monitor end 'ME' command is sent by the OSDAM. Finally, data can be downloaded by sending the monitor download 'MD' command while the SHM system is operating in 'LGNG' or 'IDLE' mode. In the case of the 'LGNG' mode unit enters 'LGDL' mode where data is being simultaneously transmitted to the OSDAM and logged remotely by the SHM system; whereas in the 'IDLE' mode the unit enters 'DWLD' mode where the data that is locally stored is transmitted to the OSDAM. In both cases, the SHM system responds with the monitor download 'md' command with with header information to identify the sensing groups and corresponding sample rates that will be sent with each subsequent 'md' response. The SHM system exits the 'DWLD' mode by receiving a monitor end 'ME' command; this command is typically sent when the OSDAM has verified all of the data has been transmitted successfully but can also be issued during data transmission to terminate data download.


## 3 SHM System Commands

This section provides a description for each of the SHM System commands.

### 3.1 LM (List Monitors)

Issued by the host or OSDAM to obtain a list with descriptions of the active SHM monitoring systems. This is a broadcast type of command that is sent to and received by all SHM systems simultaneously. There is no parameter field in this command.

 Format(s): <start> <'LM'> <len> <len> <checksum>


 Example:    \$2F \$4C \$4D \$00 \$00 \$FF \$FF \$98


### 3.2 MD (Monitor Download)


A flowchart of the interaction between the host and the SHM system during the monitor download command and responses is provided in Figure 5.

#### 3.2.1 Initiation

Issued by the host or OSDAM to an SHM system corresponding to a specified mapID <mapID> and serial number <ser> to initiate data downloading.


 Format(s): <start> <'MD'> <len> <len> <mapID> <ser> <\$00> <checksum>

 Example:    \$2F \$4D \$44 \$0A \$00 \$F5 \$FF \$0C \$53 \$2F \$4E \$20 \$30 \$30 \$30 \$31 \$00 \$E3

 **Note:** As the <datetime> is the start time for all sensor data readings, the “time stamp” for a specific sensor reading can be calculated by adding a multiple of that sensing group’s actual sampling period.

#### 3.2.2 Retransmit Data

If the host finds a sensor data sample set transmission is corrupted or missing, it can request a retransmission by sending a short-form “MD” command with a <txcntr> field containing the counter value (1-255; never 0) for that corrupted/missing response.

 Format(s): <start> <'MD'> <len> <len> <mapID> <ser> <\$00>  
                  <txcntr>  
                  <checksum>

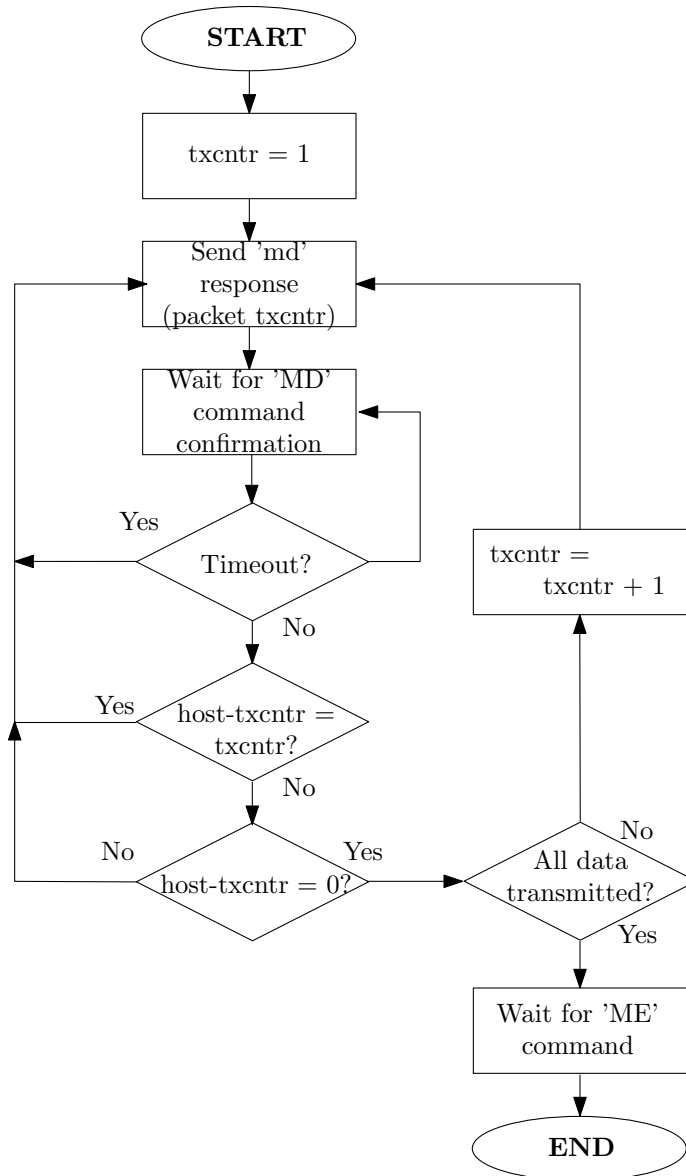


Figure 5: Flowchart of monitor download command and response sequence.

✂ Example: <mapID> = 12, <ser> = 'S/N 0001', <txcntr> = 44  
 \$2F \$4D \$44 \$0B \$00 \$F4 \$FF \$0C \$53 \$2F \$4E \$20 \$30 \$30 \$30 \$31 \$00 \$2C  
 \$B7

### 3.2.3 Data Received Confirmation

Issued by the host or OSDAM to an SHM system corresponding to a specified mapID <mapID> and serial number <ser> to indicate the last 'md' response was received successfully. This is also used to confirm when a packet to



offset the datetime is received (discussed in Section 4.2.3 on page 24).

Format(s): <start> <'MD'> <len> <len> <mapID> <ser> <\$00>  
<\$00>  
<chksum>

Example: \$2F \$4D \$44 \$0B \$00 \$F4 \$FF \$0C \$53 \$2F \$4E \$20 \$30 \$30 \$30 \$31 \$00 \$00  
\$E3

**Note:** The second <\$00> character corresponds to <txcntr> = 0, which implies the 'MD' command is sending a confirmation response and no request to retransmit data is being made.

### 3.3 ME (Monitor End)

Issued by the host or OSDAM to end an SHM system's current operating mode (except 'IDLE'). The target SHM system is identified by a specified mapID <mapID> and serial number <ser> along with the requested operating mode <opmode> to end. If the current operating mode does not match <opmode> then no action is taken by the SHM system. Valid options for the <opmode> with this command are "DNLD", "LGDL", "LGNG", "RLTM", "TEST", or "UPDT".

Format(s): <start> <'ME'> <len> <len> <mapID> <ser> <\$00> <opmode> <\$00>  
<chksum>

Example: <mapID> = 12, <ser> = 'S/N 0001', <opmode> = 'RLTM'  
\$2F \$4D \$45 \$0F \$00 \$F0 \$FF \$0C \$53 \$2F \$4E \$20 \$30 \$30 \$30 \$31 \$00 \$52  
\$4C \$54 \$4D \$00 \$A3

### 3.4 MG (Monitor Get)

Issued by the host or OSDAM to retrieve a parameter from a connected SHM system.


Format(s): <start> <'MG'> <len> <len> <\$00> <man> <\$00> <mod> <\$00>  
<ser> <\$00> <pname> <\$00> <ptype> <chksum>  
<start> <'MG'> <len> <len> <mapID> <ser> <\$00> <pname> <\$00>  
<ptype> <chksum>


Example: <man> = 'Analatom', <mod> = 'AN110', <ser> = 'S/N 0001',  
<pname> = 'mapID', <ptype> = 1.

```
$2F $4D $47 $20 $00 $DF $FF $00 $41 $6E $61 $6C $61 $74 $6F $6D $00 $41
$4E $31 $31 $30 $00 $53 $2F $4E $20 $30 $30 $30 $31 $00 $6D $61 $70 $49
$44 $00 $01 $D2
```

### 3.5 MI (Monitor Info)

Issued by the host or OSDAM to an SHM system corresponding to a specified mapID <mapID> and serial number <ser> to get the current operating mode, the amount of free memory for sensor data storage, the start time for a current logging mode or the previous logging mode and data format.


 Format(s): <start> <'MI'> <len> <len> <mapID> <ser> <\$00> <chksum>

 Example: <mapID> = 12, <ser> = 'S/N 0001'


```
$2F $4D $49 $0B $00 $F4 $FF $0C $00 $53 $2F $4E $20 $30 $30 $30 $31 $00
$DE
```

### 3.6 ML (Monitor Logging)

Issued by the host or OSDAM to an SHM system corresponding to a specified mapID <mapID> and serial number <ser> to initiate date logging. The current UTC start time for the real-time logging mode <datetime> and number of sensor groups to monitor <numgrps> followed by packets defining which sensing groups to initiate realtime monitoring for. Each sensing group is uniquely identified by a name <sgname> and assigned the real sample period <sgper>.

 Format(s): <start> <'ML'> <len> <len> <mapID> <ser> <\$00>

```
<datetime> <$00>
<numgrps>
<sgname1> <$00> <sgper1>
<sgname2> <$00> <sgper2>
<sgname3> <$00> <sgper3>
:
<chksum>
```

 Example: <mapID> = 12, <ser> = 'S/N 0001', <datetime> = '2013-04-10 18:06:28Z', <numgrps> = 2, <sgname1> = 'LPR', <sgper1> = 60, <sgname2> = 'Temp', <sgper2> = 60.

```
$2F $4D $4C $31 $00 $CE $FF $0C $53 $2F $4E $20 $30 $30 $30 $31 $00 $32
$30 $31 $33 $2D $30 $34 $2D $31 $30 $20 $31 $38 $3A $30 $36 $3A $32 $38
$5A $00 $02 $4C $50 $52 $00 $3C $00 $00 $00 $54 $65 $6D $70 $00 $3C $00
$00 $00 $D1
```

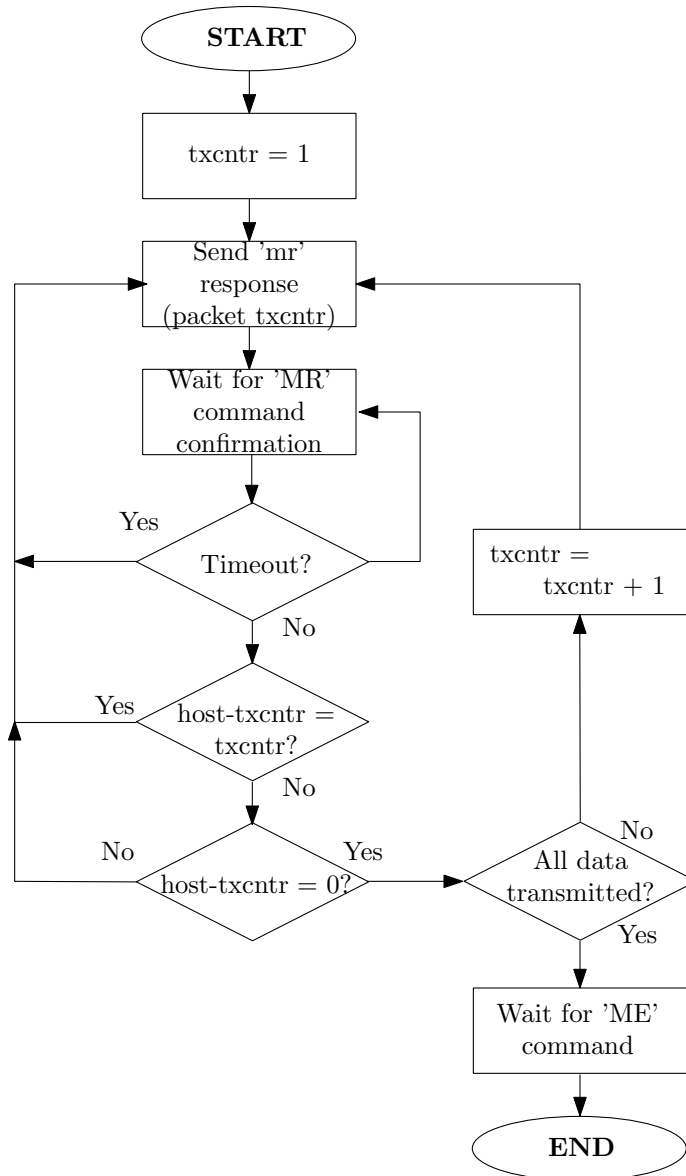


Figure 6: Flowchart of monitor realtime command and response sequence.

**Note:** A sensing group is omitted from data logging if (i) the corresponding sensing group line (<sg-name#> <\$00> <sgper#>) is not sent or (ii) <sgper> is set to 0.

### 3.7 MR (Monitor Realtime)

A flowchart of the interaction between the host and the SHM system during the monitor realtime command and responses is provided in Figure 6.

### 3.7.1 Initiation

Issued by the host or OSDAM to an SHM system corresponding to a specified mapID <mapID> and serial number <ser> to initiate realtime monitoring. The current UTC start time for the real-time logging mode <datetime> and number of sensor groups to monitor <numgrps> followed by packets defining which sensing groups to initiate real-time monitoring for. Each sensing group is uniquely identified by a name <sgname> and assigned the real sample period <sgper>.

```

Format(s): <start> <'MR'> <len> <len> <mapID> <ser> <$00>
           <$00>
           <datetime> <$00>
           <numgrps>
           <sgname1> <$00> <sgper1>
           <sgname2> <$00> <sgper2>
           <sgname3> <$00> <sgper3>
           :
           <chksum>
    
```

```


Example:  <mapID> = 12, <ser> = 'S/N 0001', <datetime> = '2013-04-10
          18:06:28Z', <numgrps> = 2, <sgname1> = 'LPR', <sgper1> = 60,
          <sgname2> = 'Temp', <sgper2> = 60.
          $2F $4D $52 $32 $00 $CD $FF $0C $53 $2F $4E $20 $30 $30 $30 $31 $00 $00
          $32 $30 $31 $33 $2D $30 $34 $2D $31 $30 $20 $31 $38 $3A $30 $36 $3A $32
          $38 $5A $00 $02 $4C $50 $52 $00 $3C $00 $00 $00 $54 $65 $6D $70 $00 $3C
          $00 $00 $00 $CB
    
```


**Note:** As the <datetime> is the start time for all sensor data readings, the “time stamp” for a specific sensor reading can be calculated by adding a multiple of that sensing group’s actual sampling period.

**Note:** The second <\$00> character corresponds to <txcntr> = 0. This combined with additional parameters implies the 'MR' command is sending header information.

### 3.7.2 Retransmit Data


If the host finds a realtime sensor data sample set transmission is corrupted or missing, it can request a retransmission by sending a short-form “MR” command with a <txcntr> field containing the counter value (1-255; never 0) for that corrupted/missing response.


 Format(s): <start> <'MR'> <len> <len> <mapID> <ser> <\$00>  
<txcntr>  
<chksum>


 Example: <mapID> = 12, <ser> = 'S/N 0001', <txcntr> = 29  
\$2F \$4D \$52 \$0B \$00 \$F4 \$FF \$0C \$53 \$2F \$4E \$20 \$30 \$30 \$30 \$31 \$00 \$1D  
\$B8

### 3.7.3 Data Received Confirmation

Issued by the host or OSDAM to an SHM system corresponding to a specified mapID <mapID> and serial number <ser> to indicate the last 'mr' response was received successfully.


 Format(s): <start> <'MR'> <len> <len> <mapID> <ser> <\$00>  
<\$00>  
<chksum>


 Example: <mapID> = 12, <ser> = 'S/N 0001'  
\$2F \$4D \$52 \$0B \$00 \$F4 \$FF \$0C \$53 \$2F \$4E \$20 \$30 \$30 \$30 \$31 \$00 \$00  
\$D5


 **Note:** The second <\$00> character corresponds to <txcntr> = 0. This combined with no additional parameters implies the 'MD' command is sending a confirmation response and no request to retransmit data is being made.

### 3.8 MS (Monitor Set)

Issued by the host or OSDAM to set a parameter of a connected SHM system.

 Format(s): <start> <'MS'> <len> <len> <\$00> <man> <\$00> <mod> <\$00>  
<ser> <\$00> <pname> <\$00> <ptype> <pvalue> <chksum>  
<start> <'MS'> <len> <len> <mapID> <ser> <\$00> <pname> <\$00>  
<ptype> <pvalue> <chksum>

 Example: <man> = 'Analatom', <mod> = 'AN110', <ser> = 'S/N 0001',  
<pname> = 'mapID', <ptype> = 1, <pvalue> = 12  
\$2F \$4D \$53 \$21 \$00 \$DE \$FF \$00 \$41 \$6E \$61 \$6C \$61 \$74 \$6F \$6D \$00 \$41  
\$4E \$31 \$31 \$30 \$00 \$53 \$2F \$4E \$20 \$30 \$30 \$30 \$31 \$00 \$6D \$61 \$70 \$49  
\$44 \$00 \$01 \$0C \$BA

 **Note:** The long form of the command (using <man>, <mod> and <ser>) must be used when setting the 'mapID' parameter

### 3.9 MT (Monitor Test)


*Command reserved for future support.*


### 3.10 MU (Monitor Update)


*Command reserved for future support.*

### 3.11 W (Wakeup)

In certain cases, the host, OSDAM or SHM system may be sleeping to conserve power. To address this, a single wakeup character is sent to the host, OSDAM or SHM system followed by a 1 millisecond delay before transmitting the command.

 Format(s): <'W'>

 Example: \$57


 **Note:** Note: the command does not follow the general command structure as presented in Table 1. Rather, the Wake command has a 1-char form of: W or equivalently 0x57


## 4 SHM System Responses


This section provides a description for each SHM System responses.

### 4.1 lm (List Monitors)

Responds to the list monitor 'LM' command by returning the manufacturer <man>, model <mod>, serial number <ser>, firmware version <ver> and connection map ID <mapID> from the SHM system.


 Format(s): <start> <'lm'> <len> <len> <man> <\$00> <mod> <\$00> <ser>  
<\$00> <ver> <\$00> <mapID> <chksum>

 Example: <man> = 'Analatom', <mod> = 'AN110', <ser> = 'S/N 0001',  
<ver> = 'FWv1.00', <mapID> = 12.  
\$2F \$6C \$6D \$21 \$00 \$DE \$FF \$41 \$6E \$61 \$6C \$61 \$74 \$6F \$6D \$00 \$41 \$4E  
\$31 \$31 \$30 \$00 \$53 \$2F \$4E \$20 \$30 \$30 \$30 \$31 \$00 \$46 \$57 \$76 \$31 \$2E  
\$30 \$30 \$00 \$0C \$7B

 **Note:** Values for <mapID> ranges between 1-16. If the SHM system has not been assigned a mapID by the host, then a value of 0 should be returned.

### 4.2 md (Monitor Download)

Responds to the monitor download 'MD' command by transmitting all required sensor data sample sets of its sensor measurements. The SHM system remains in the 'DNLD' or 'LGDL' modes, (even after all of the data has been transmitted) until the SHM system monitor end 'ME' command is sent. Along with every transmission, a transmission counter <txcntr> is sent corresponding to a value of 1 for the first transmission and incremented by 1 for each subsequent transmission until reaching a value of 255 at which point the counter is reset to 1. Each sensing group is uniquely identified by a name <sgname>, the number of sample sets sent in the data block <sgnsamp> and a data block of sensor data samples <sgdata>. The format for <sgdata> is sgdata[<sgnsamp>][<sgnsen>] array of <sgtype> and is further described in Section 2.7.2.

 Format(s): <start> <'md'> <len> <len> <mapID> <ser> <\$00>  
<txcntr>  
<numgrps>  
<sgname1> <\$00> <sgnsamp1> <sgdata1>  
<sgname2> <\$00> <sgnsamp2> <sgdata2>  
<sgname3> <\$00> <sgnsamp3> <sgdata3>  
:  
<chksum>

```

✂ Example:  <mapID> = 12, <ser> = 'S/N 0001', <txcntr> = 1, <numgrps> = 2,
             <sgname1> = 'LPR', <sgnsamp1> = 2, sgdata1[1][1] = 10000.6,
             sgdata1[1][2] = 5230.5, sgdata1[1][3] = 4520, sgdata1[1][4] = 10000,
             sgdata1[1][5] = 80950, sgdata1[1][6] = 100035.1, sgdata1[1][7] = 5231,
             sgdata1[1][8] = 9524, sgdata1[2][1] = 11000.6, sgdata1[2][2] = 5130.5,
             sgdata1[2][3] = 4310, sgdata1[2][4] = 9687, sgdata1[2][5] = 75600,
             sgdata1[2][6] = 110000, sgdata1[2][7] = 5960, sgdata1[2][8] = 10230.

             <sgname2> = 'Temp', <sgnsamp2> = 2, sgdata2[1][1] = 27.6,
             sgdata2[2][1] = 28.0

             $2F $6D $64 $3B $00 $C4 $FF $0C $53 $2F $4E $20 $30 $30 $30 $31 $00 $01
             $02 $4C $50 $52 $00 $02 $C4 $69 $37 $62 $D4 $60 $C4 $69 $E1 $81 $36 $84
             $37 $62 $4D $69 $BE $6A $05 $62 $6B $60 $75 $69 $3A $81 $6D $85 $A4 $63
             $FD $69 $54 $65 $6D $70 $00 $02 $CC $25 $00 $26 $1D
    
```

#### 4.2.1 Termination

The SHM system remains in the 'DNLD' or 'LGNG' mode until a valid monitor end 'ME' is sent to exit the respective mode (See Section 3.3) or a transmission timeout occurs (See Section 4.2.2).

#### 4.2.2 Timeout

The following is recommended for the transmission timeout of any 'md' response (including the 'md' response to offset the datetime discussed in Section 4.2.3). First, the 'md' data packet is sent. After 20 seconds, if no response is received by the SHM System, the same 'md' data packet is sent a second time. After 10 seconds, if no response is received by the SHM System, the same 'md' data packet is sent for a third time. After 5 seconds, if no data packet is received the SHM system assumes the host or OSDAM is no longer available and exits out of either the 'LGNG' or 'DNLD' mode.

#### 4.2.3 Offset Datetime

Sometimes data packets may be collected using a fixed sampling period but recorded in asynchronous blocks requiring an an offset to the datetime. For example, suppose the SHM system records a sensor measurement between 0-2 minutes, then stops recording data, then resumes recording between 8-10 minutes at a rate of one sample per minute. One approach is to send all the samples between 0-10 minutes in one data packet where the samples recorded between 3-7 minutes are erroneous. Alternatively for the same scenario, a data packet can be sent with samples from 0-2 minutes, then an offset can be sent which indicates the start of minute 8, and finally another data packet with the samples recorded from 8-10 minutes. An example of this is provided here:

```

✂ Format(s): <start> <'md'> <len> <len> <mapID> <ser> <$00>
             <$00>
             <datetime> <$00>
             <chksum>
    
```

```

✂ Example:  <mapID> = 12, <ser> = 'S/N 0001', <datetime> = '2013-04-10
             21:09:32Z'
    
```



```
$2F $6D $64 $20 $00 $DF $FF $0C $53 $2F $4E $20 $30 $30 $30 $31 $00 $00
$32 $30 $31 $33 $2D $30 $34 $2D $31 $30 $20 $32 $31 $3A $30 $39 $3A $33
$32 $5A $00 $9F
```

Another situation may arise when the samples between sensor groups are also offset at the time of recording. For example, suppose there are three sensor groups named <sgname1>, <sgname2> and <sgname3>. The timestamp <datetime> corresponds to the time that data was recorded from <sgname1>. The data collected from <sgname2> was recorded by the SHM system 2 seconds after the data recorded for <sgname1>. This offset can be handled by passing the optional arguments <sgdelay1>=0 and <sgdelay2>=2. The specific example is provided below where the given format is given for a general case for multiple sensor group offsets:

```
Format(s): <start> <'md'> <len> <len> <mapID> <ser> <$00>
<$00>
<datetime> <$00>
<numgrps>
<sgname1> <$00> <sgdelay1>
<sgname2> <$00> <sgdelay2>
<sgname3> <$00> <sgdelay3>
:
<chksum>
```

```
Example: <mapID> = 12, <ser> = 'S/N 0001', <datetime> = '2013-04-10
21:09:32Z', <numgrps> = 2, <sgname1> = 'LPR', <sgdelay1> = 0,
<sgname2> = 'Temp', <sgdelay2> = 2.
$2F $6D $64 $31 $00 $CE $FF $0C $53 $2F $4E $20 $30 $30 $30 $31 $00 $00
$32 $30 $31 $33 $2D $30 $34 $2D $31 $30 $20 $32 $31 $3A $30 $39 $3A $33
$32 $5A $00 $4C $50 $52 $00 $00 $00 $00 $00 $54 $65 $6D $70 $00 $02 $00
$00 $00 $19
```

**Note:** Omitting the line <sgname1> <\$00> <sgdelay1> from the example and setting <numgrps> = 1 is the same as declaring <sgdelay1> = 0 for <sgname1> = "LPR".

### 4.3 me (Monitor End)

Responds to the monitor end 'ME' command by returning the map ID <mapID>, serial number <ser> and current operating mode <opmode> after the 'ME' command is executed.

```
Format(s): <start> <'me'> <len> <len> <mapID> <ser> <$00> <opmode> <$00>
<chksum>
```

```
✂ Example: <mapID> = 12, <ser> = 'S/N 0001', <opmode> = 'IDLE'
           $2F $6D $65 $0F $00 $F0 $FF $0C $53 $2F $4E $20 $30 $30 $30 $31 $00 $49
           $44 $4C $45 $00 $84
```

## 4.4 mg (Monitor Get)

Responds to the monitor get 'MG' command by returning the manufacturer <man>, model <mod>, serial number <ser>, set-parameter name <pname>, parameter type <ptype> and parameter value <pvalue> from the SHM system.

```
✎ Format(s): <start> <'mg'> <len> <len> <$00> <man> <$00> <mod> <$00>
             <ser> <$00> <pname> <$00> <ptype> <pvalue> <checksum>
             <start> <'mg'> <len> <len> <mapID> <ser> <$00> <pname> <$00>
             <ptype> <pvalue> <checksum>
```

```
✂ Example: <man> = 'Analatom', <mod> = 'AN110', <ser> = 'S/N 0001',
           <pname> = 'mapID', <ptype> = 1, <pvalue> = 12.
           $2F $6D $67 $21 $00 $DE $FF $00 $41 $6E $61 $6C $61 $74 $6F $6D $00 $41
           $4E $31 $31 $30 $00 $53 $2F $4E $20 $30 $30 $30 $31 $00 $6D $61 $70 $49
           $44 $00 $01 $0C $86
```

## 4.5 mi (Monitor Info)

Responds to the monitor info 'MI' command by returning the map ID <mapID>, serial number <ser>, current operating mode <opmode>, the amount of free memory for sensor data storage <freemem>, the start time for a current logging mode <datetime>, number of sensing groups <numgrps> followed by packets describing each sensing group. Each sensing group is uniquely identified by a name/identifier <sgname>, description of the sensor group <sgdesc>, type of units <sgunit>, the parameter type <sgptype>, number of sensors <sgnsen>, sample period <sgper> (in seconds) and the number of logged sensor sample sets <sgcount>.

```
✎ Format(s): <start> <'mi'> <len> <len> <mapID> <ser> <$00> <opmode> <$00>
             <freemem> <datetime> <$00> <numgrps>
             <sgname1> <$00> <sgdesc1> <$00> <sgunit1> <$00> <sgptype1>
             <sgnsen1> <sgper1> <sgcount1>
             <sgname2> <$00> <sgdesc2> <$00> <sgunit2> <$00> <sgptype2>
             <sgnsen2> <sgper2> <sgcount2>
             <sgname3> <$00> <sgdesc3> <$00> <sgunit3> <$00> <sgptype3>
             <sgnsen3> <sgper3> <sgcount3>
             :
             <checksum>
```

```
✂ Example: <mapID> = 12, <opmode> = ''IDLE'', <freemem> = 32564, <datetime> =  
''2013-04-10 18:06:28Z'', <numgrps> = 2,  
  
<sgname1> = ''LPR'', <sgdesc1> = ''Linear Polarization Resistance'',  
<sgunits1> = ''Ohms'', <sgptype1> = 127, <sgnsen1> = 8, <sgper1> =  
60, <sgcount1> = 3  
  
<sgname2> = ''Temp'', <sgdesc2> = ''External Temperature'',  
<sgunits2> = ''degC'', <sgptype2> = 127, <sgnsen2> = 1, <sgper2>  
= 60, <sgcount2> = 3  
  
$2F $6D $69 $84 $00 $7B $FF $0C $53 $2F $4E $20 $30 $30 $30 $31 $00 $49  
$44 $4C $45 $00 $34 $7F $00 $00 $32 $30 $31 $33 $2D $30 $34 $2D $31 $30  
$20 $31 $38 $3A $30 $36 $3A $32 $38 $5A $00 $02 $4C $50 $52 $00 $4C $69  
$6E $65 $61 $72 $20 $50 $6F $6C $61 $72 $69 $7A $61 $74 $69 $6F $6E $20  
$52 $65 $73 $69 $73 $74 $61 $6E $63 $65 $00 $4F $68 $6D $73 $00 $7F $08  
$3C $00 $00 $00 $03 $00 $00 $00 $54 $65 $6D $70 $00 $45 $78 $74 $65 $72  
$6E $61 $6C $20 $54 $65 $6D $70 $65 $72 $61 $74 $75 $72 $65 $00 $64 $65  
$67 $43 $00 $7F $01 $3C $00 $00 $00 $03 $00 $00 $00 $13
```

**Note:** If the sensor group description <sgdesc> is empty, then the group name <sgname> is used to describe the sensor group.

## 4.6 ml (Monitor Logging)

Responds to the monitor logging 'ML' command by returning the mapID <mapID>, serial number <ser>, the start time for the logging mode <datetime>, number of sensing groups <numgrps> followed by packets identifying which sensing groups were initiated for data logging. Each sensing group is uniquely identified by a name <sgname> and assigned the logging sample period <sgper>. The SHM system remains in the 'LGNG' mode until the SHM system monitor end 'ME' command is sent.

```
✂ Format(s): <start> <'ml'> <len> <len> <mapID> <ser> <$00>  
<$00>  
<datetime> <$00>  
<numgrps>  
<sgname1> <$00> <sgper1>  
<sgname2> <$00> <sgper2>  
<sgname3> <$00> <sgper3>  
:  
<chksum>
```


```
✂ Example: <mapID> = 12, <ser> = ''S/N 0001'', <datetime> = ''2013-04-10  
18:06:28Z'', <numgrps> = 2, <sgname1> = ''LPR'', <sgper1> = 60,  
<sgname2> = ''Temp'', <sgper2> = 60.
```


\$2F	\$6D	\$6C	\$32	\$00	\$CD	\$FF	\$0C	\$53	\$2F	\$4E	\$20	\$30	\$30	\$30	\$31	\$00	\$00
\$32	\$30	\$31	\$33	\$2D	\$30	\$34	\$2D	\$31	\$30	\$20	\$31	\$38	\$3A	\$30	\$36	\$3A	\$32
\$38	\$5A	\$00	\$02	\$4C	\$50	\$52	\$00	\$3C	\$00	\$00	\$00	\$54	\$65	\$6D	\$70	\$00	\$3C
\$00	\$00	\$00	\$91														

## 4.7 mr (Monitor Realtime)


### 4.7.1 Initiation

Responds to the monitor realtime 'MR' command by returning the mapID <mapID>, serial number <ser>, the start time for the real-time logging mode <datetime>, number of sensing groups <numgrps> followed by packets identifying which sensing groups were initiated for realtime monitoring. Each sensing group is uniquely identified by a name <sgname> and assigned the real sample period <sgper>.

 Format(s): <start> <'mr'> <len> <len> <mapID> <ser> <\$00>  
<\$00>  
<datetime> <\$00>  
<numgrps>  
<sgname1> <\$00> <sgper1>  
<sgname2> <\$00> <sgper2>  
<sgname3> <\$00> <sgper3>  
:  
<chksum>

 Example: <mapID> = 12, <ser> = 'S/N 0001', <datetime> = '2013-04-10 18:06:28Z', <numgrps> = 2, <sgname1> = 'LPR', <sgper1> = 60, <sgname2> = 'Temp', <sgper2> = 60.

\$2F	\$6D	\$72	\$32	\$00	\$CD	\$FF	\$0C	\$53	\$2F	\$4E	\$20	\$30	\$30	\$30	\$31	\$00	\$00
\$32	\$30	\$31	\$33	\$2D	\$30	\$34	\$2D	\$31	\$30	\$20	\$31	\$38	\$3A	\$30	\$36	\$3A	\$32
\$38	\$5A	\$00	\$02	\$4C	\$50	\$52	\$00	\$3C	\$00	\$00	\$00	\$54	\$65	\$6D	\$70	\$00	\$3C
\$00	\$00	\$00	\$8B														

 **Note:** The second <\$00> character corresponds to <txcntr> = 0, which implies the 'mr' command is responding with header information and no actual data is transmitted with the response.

### 4.7.2 Periodic Realtime Response

Once initiation of realtime monitoring is complete, the SHM system responds with a sensor data sample set. The rate of transmission is SHM system dependent and may be a multiple of the actual realtime sampling period(s). The SHM system will transmit all required sensor data sample sets of its sensor measurements until the SHM system monitor end 'ME' command is sent. Along with every transmission, a transmission counter <txcntr> is sent corresponding to a value of 1 for the first transmission and incremented by 1 for each subsequent transmission until reaching a value

of 255 at which point the counter is reset to 1. Each sensing group is uniquely identified by a name <sgname>, the number of sample sets sent in the data block <sgnsamp> and a data block of sensor data samples <sgdata>. The format for <sgdata> is sgdata[<sgnsamp>][<sgnsen>] array of <sgtype> and is further described in Section 2.7.2. The SHM system remains in 'RLTM' modes until the SHM system monitor end 'ME' command is sent.

```

Format(s): <start> <'mr'> <len> <len> <mapID> <ser> <$00>
           <txcntr>
           <numgrps>
           <sgname1> <$00> <sgnsamp1> <sgdata1>
           <sgname2> <$00> <sgnsamp2> <sgdata2>
           <sgname3> <$00> <sgnsamp3> <sgdata3>
           :
           <chksum>
    
```

```

Example:  <mapID> = 12, <ser> = 'S/N 0001', <txcntr> = 1, <numgrps> = 2,
          <sgname1> = 'LPR', <sgnsamp1> = 2, sgdata1[1][1] = 10000.6,
          sgdata1[1][2] = 5230.5, sgdata1[1][3] = 4520, sgdata1[1][4] = 10000,
          sgdata1[1][5] = 80950, sgdata1[1][6] = 100035.1, sgdata1[1][7] = 5231,
          sgdata1[1][8] = 9524, sgdata1[2][1] = 11000.6, sgdata1[2][2] = 5130.5,
          sgdata1[2][3] = 4310, sgdata1[2][4] = 9687, sgdata1[2][5] = 75600,
          sgdata1[2][6] = 110000, sgdata1[2][7] = 5960, sgdata1[2][8] = 10230.
          <sgname2> = 'Temp', <sgnsamp2> = 2, sgdata2[1][1] = 27.6,
          sgdata2[2][1] = 28.0

          $2F $6D $72 $3B $00 $C4 $FF $0C $53 $2F $4E $20 $30 $30 $30 $31 $00 $01
          $02 $4C $50 $52 $00 $02 $C4 $69 $37 $62 $D4 $60 $C4 $69 $E1 $81 $36 $84
          $37 $62 $4D $69 $BE $6A $05 $62 $6B $60 $75 $69 $3A $81 $6D $85 $A4 $63
          $FD $69 $54 $65 $6D $70 $00 $02 $CC $25 $00 $26 $0F
    
```

### 4.7.3 Termination

The SHM system remains in the 'RLTM' mode until a valid monitor end 'ME' is sent to exit the 'RLTM' mode (See Section 3.3) or a transmission timeout occurs (See Section 4.7.4).

### 4.7.4 Timeout

The transmission timeout depends on the number of retries and minimum sample time. For a typical transmission with a sample period of 1min, a 'mr' data packet is sent three times before timing out. The first 'mr' data packet is sent. After 20 seconds, if no response is received by the SHM System, the same 'mr' data packet is sent a second time. After 10 seconds, if no response is received by the SHM System, the same 'mr' data packet is sent for a third time. After 5 seconds, if no data packet is received the SHM system assumes the host or OSDAM is no longer available and exits out of the 'RLTM' mode to conserve power.

## 4.7.5 Debug (AN110 Only!)

Debug information for the Linear Polarization Resistance (LPR) can be acquired during real-time mode when the AN110 is set in debug-mode. The following data packet is appended with an additional 151 bytes at the end of the last sensor group as:

```
Format(s): <start> <'mr'> <len> <len> <mapID> <ser> <$00>
<txcntr>
<numgrps>
<sgname1> <$00> <sgnsamp1> <sgdata1>
<sgname2> <$00> <sgnsamp2> <sgdata2>
:
<sgnameN> <$00> <sgnsampN> <sgdataN>
'LPR1diag' <$00>
<VirtualGndChan1> (UINT16)
<CurrentOffsetVoltageLoGainChan1> (INT16)
<CurrentOffsetVoltageHiGainChan1> (INT16)
<VocChan1> (UINT16)
<LSCounterChan1> (UINT16)
<LprIVpairRejectMapChan1> (UINT32)
<LprIVpairCurrentChan1(1)> <LprIVpairVoltageChan1(1)> (2×FLOAT32)
<LprIVpairCurrentChan1(2)> <LprIVpairVoltageChan1(2)> (2×FLOAT32)
:
<LprIVpairCurrentChan1(16)> <LprIVpairVoltageChan1(16)> (2×FLOAT32)
<chksum>
```

## 4.8 ms (Monitor Set)

Responds to the monitor set 'MS' command by returning the manufacturer <man>, model <mod>, serial number <ser>, set-parameter name <pname>, parameter type <ptype>, and new parameter value <pvalue> from the SHM system.

```
Format(s): <start> <'ms'> <len> <len> <$00> <man> <$00> <mod> <$00>
<ser> <$00> <pname> <$00> <ptype> <pvalue> <chksum>
<start> <'ms'> <len> <len> <mapID> <ser> <$00> <pname> <$00>
<ptype> <pvalue> <chksum>
```

```
Example: <man> = 'Analatom', <mod> = 'AN110', <ser> = 'S/N 0001',
<pname> = 'mapID', <ptype> = 1, <pvalue> = 12.
```

\$2F	\$6D	\$73	\$21	\$00	\$DE	\$FF	\$00	\$41	\$6E	\$61	\$6C	\$61	\$74	\$6F	\$6D	\$00	\$41
\$4E	\$31	\$31	\$30	\$00	\$53	\$2F	\$4E	\$20	\$30	\$30	\$30	\$31	\$00	\$6D	\$61	\$70	\$49
\$44	\$00	\$01	\$0C	\$7A													

**Note:** The long form of the command (using <man>, <mod> and <ser>) must be used when responding with the 'mapID' parameter

#### 4.9 mt (Monitor Test)

Response reserved for future support.

#### 4.10 mu (Monitor Update)

Response reserved for future support.

#### 4.11 W (Wakeup)

See Section 3.11.

#### 4.12 Unsupported Response

Any response ID <id> the SHM system does not support should be returned with the mapID <mapID> and serial number <ser> with no additional parameters. This indicates that a specific command (eg. 'md', 'mr', etc...) is not supported by the SHM system.

**Format(s):** <start> <id> <len> <len> <mapID> <ser> <\$00> <chksum>


**Example:** <id> = 'mr', <mapID> = 12, <ser> = 'S/N 0001'  
\$2F \$6D \$72 \$0A \$00 \$F5 \$FF \$0C \$53 \$2F \$4E \$20 \$30 \$30 \$30 \$31 \$00 \$95

## 5 SHM System Parameters

This section provides a description for each of the generic SHM system parameters.

### 5.1 mapID


The mapID parameter is used by the OSDAM and end-user software to reference SHM systems. The mapID is set with the 'MS' command. An example of a command that sets the mapID is given in Section 3.8 on page 21.

 **Note:** A valid mapID is required to use the 'MD', 'ME', 'MI', 'ML', and 'MR' commands.



## 6 OSDAM Commands

This section provides a description for each of the OSDAM commands issued by the host.

 **Note:** A majority of the OSDAM commands are similar to the SHM system commands as the OSDAM serves as a relay between the host and SHM system. Unless otherwise specified, see Section 3 on page 15 for the format and example corresponding to each command.

### 6.1 LM (List Monitors)

See Section 3.1.

### 6.2 ME (Monitor Download)

See Section 3.2.

### 6.3 ME (Monitor End)

See Section 3.3.

### 6.4 MG (Monitor Get)

See Section 3.4.

### 6.5 MI (Monitor Info)

See Section 3.5.

### 6.6 MI (Monitor Info)

See Section 3.7.

### 6.7 ML (Monitor Logging)

See Section 3.6.

### 6.8 MR (Monitor Realtime)

See Section 3.7.

### 6.9 MS (Monitor Set)

See Section 3.8.

### 6.10 MT (Monitor Test)


See Section 3.5.


## 6.11 MU (Monitor Update)

See Section 3.10.

## 6.12 OE (OSDAM End)


Issued by the host to end the OSDAM's current operating mode (except "REDY"). Valid options for the <opmode> with this command are "TEST", or "UPDT".


 Format(s): <start> <'OE'> <len> <len> <opmode> <\$00> <chksum>

 Example:     <opmode> = 'TEST'  
                  \$2F \$4F \$45 \$05 \$00 \$FA \$FF \$54 \$45 \$53 \$54 \$00 \$5D

## 6.13 OI (OSDAM Info)

Issued by the host to obtain the OSDAM unit's manufacturer, model, serial number, and firmware version. There is no parameter field in this command.

 Format(s): <start> <'OI'> <len> <len> <chksum>

 Example:     \$2F \$4F \$49 \$00 \$00 \$FF \$FF \$99

## 6.14 OT (OSDAM Test)

*Command reserved for future support.*

## 6.15 OU (OSDAM Update)

*Command reserved for future support.*

## 6.16 W (Wakeup)

See Section 3.11.

## 7 OSDAM Responses

This section provides a description for each SHM System responses.

**Note:** A majority of the OSDAM responses are similar to the SHM system responses as the OSDAM serves as a relay between the host and SHM system. Unless otherwise specified, see Section 4 on page 23 for the format and example corresponding to each response.

### 7.1 lm (List Monitors)

Responds to the list monitor 'LM' command similar to the SHM system response in Section 4.1 except two additional parameters are returned by the OSDAM, the port <port> and effective communication speed <cspd> (in kBytes) to the host.

**Format(s):** <start> <'lm'> <len> <len> <man> <\$00> <mod> <\$00> <ser>  
<\$00> <ver> <\$00> <mapID> <port> <\$00> <cspd> <chksum>

**Example:** <man> = 'Analatom', <mod> = 'AN110', <ser> = 'S/N 0001',  
<ver> = 'FWv1.00', <mapID> = 12, <port> = 'RS485', <cspd> =  
10.

```
$2F $6C $6D $28 $00 $D7 $FF $41 $6E $61 $6C $61 $74 $6F $6D $00 $41 $4E
$31 $31 $30 $00 $53 $2F $4E $20 $30 $30 $30 $31 $00 $46 $57 $76 $31 $2E
$30 $30 $00 $0C $52 $53 $34 $38 $35 $00 $0A $2B
```

**Note:** Values for <mapID> ranges between 1-16. If the SHM system has not been assigned a mapID by the host, then a value of 0 should be returned.

### 7.2 md (Monitor Download)

See Section 4.2.

### 7.3 me (Monitor End)

See Section 4.3.

### 7.4 mg (Monitor Get)

See Section 4.4.

### 7.5 mi (Monitor Info)

See Section 4.5.

## 7.6 ml (Monitor Logging)

See Section 4.6.

## 7.7 mr (Monitor Info)

See Section 4.7.

## 7.8 ms (Monitor Set)

See Section 4.8.

## 7.9 mt (Monitor Test)


See Section 4.9.


## 7.10 mu (Monitor Update)

See Section 4.10.

## 7.11 oe (OSDAM End)


Responds to the osdam end 'OE' command by returning the current operating mode <opmode> after the 'OE' command is executed.


 Format(s): <start> <'oe'> <len> <len> <opmode> <\$00> <chksum>

 Example: <opmode> = 'REDY'  
\$2F \$6F \$65 \$05 \$00 \$FA \$FF \$52 \$45 \$44 \$59 \$00 \$29

## 7.12 oi (OSDAM Info)

Responds to the OSDAM info 'OI' command by returning the manufacturer <man>, model <mod>, serial number <ser>, and firmware version <ver> from the OSDAM.

 Format(s): <start> <'oi'> <len> <len> <man> <\$00> <mod> <\$00> <ser>  
<\$00> <ver> <\$00> <chksum>

 Example: <man> = 'Analatom', <mod> = 'OSDAM I', <ser> = 'S/N 0003',  
<ver> = 'FWv1.00'.  
\$2F \$6F \$69 \$22 \$00 \$DD \$FF \$41 \$6E \$61 \$6C \$61 \$74 \$6F \$6D \$00 \$4F \$53  
\$44 \$41 \$4D \$20 \$49 \$00 \$53 \$2F \$4E \$20 \$30 \$30 \$30 \$33 \$00 \$46 \$57 \$76  
\$31 \$2E \$30 \$30 \$00 \$CA

**7.13 ot (OSDAM Test)**

*Response reserved for future support.*

**7.14 ou (OSDAM Update)**

*Response reserved for future support.*

**7.15 W (Wakeup)**

See Section 3.11.

**7.16 Unsupported Responses**

See Section 4.12.