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DeepSea Power & Light SeaSense® Serial Protocol Specification

PRELIMINARY

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Scope

This document shall be the guiding document for all implementations of the SeaSense protocol for DeepSea Power & Light products. All devices using the SeaSense protocol shall conform to the requirements outlined herein.

Introduction

The DeepSea Power & Light SeaSense serial protocol controls enabled products in real-time over standard EIA-485 and EIA-232 industrial serial interfaces.

While the physical topology of these serial interfaces can differ, this protocol operates in both environments. The SeaSense protocol uses ASCII character commands, making them human readable. Strict command string formatting and an optional checksum field offer robust and error-tolerant communications in harsh environments and mixed-protocol installations.

1 Definitions

Host

The host is a specific function within the SeaSense datalink environment and refers to the operating control system interacting with the SeaSense enabled product. The SeaSense protocol uses a strict command/response model where the host initiates all communications and asynchronous communications from a node to the host are not allowed.

For communication bus topologies that support multiple host roles (such as EIA-485), more than one host may operate on the bus at a time if a bus activity monitoring and collision detection is used.

Channel

The term channel refers to the physical serial interface connection between the host system and the product or products using the SeaSense protocol as a control mechanism. For EIA-232 channels, this refers to the point-to-point topology connecting the host and peripheral and in EIA-485 can refer to either a point-to-point connection or a multi-drop topology as defined within the EIA-485 specification.

Node

A node is a virtual role in the SeaSense protocol and may or may not have a one to many relationship with physical devices on the channel. For instance, a device may be equipped with a camera but also with a sensor package and would have two nodes accessible over a single serial interface: one for the camera functions and another for the sensor functions. In most cases, a node represents a single physical device in the system.

Peripheral

The term peripheral refers to a single physical device in the SeaSense system. A peripheral may be a camera, a light, a sensor, or a device that contains more than one class of peripherals.

User Preset

A User Preset is a peripheral parameter stored in non-volatile memory. These preset parameters are grouped and stored in up to sixteen available memory blocks. The "PSET" Common Configuration Command can save or recall these memory blocks and the preset parameters stored within.

2 Conventions

2.1 Character Formats

All protocol characters enclosed in quotes, “ ”, the following sections are interpreted as ASCII character codes: “!001:info?*01”

The SeaSense protocol is not case sensitive, and recognizes alphabet characters regardless of capitalization, however, using lowercase characters are recommended.

Special non-printable ASCII characters such as Carriage Return, Line Feed, or a Tab are represented by enclosing the ASCII abbreviation in less-than/greater-than symbols, “< >”: <CR>, <LF>, <TAB>

All protocol characters enclosed in square brackets [] shall be interpreted as a hexadecimal byte value: [0x0D]

3 Channel Configuration

3.1 Data Format

All data sent over the SeaSense data link should conform to the following format:

- Data Bits: 8
- Start Bits: 1
- Stop Bits: 1
- Parity: None
- Flow Control: None

3.2 Baud Rate

The following baud rates are available:

- 9600 bps
- 19200 bps
- 57600 bps

The baud rate can be set using the BAUD command. See 6.1.3 for more information.

3.3 EIA-485 Physical Channel Interface

The standard EIA-485 or RS-485 channel is built on a half-duplex, 2-wire differential interface comprised of a non-inverted signal (+/A), inverted signal (-/B), and a signal reference (GND). DeepSea Power & Light recommends carrying the differential signal over either a shielded or an unshielded twisted-pair of conductors to improve common mode noise immunity.

3.4 EIA-232 Physical Channel Interface

The EIA-232 or RS-232 serial interface is a full-duplex topology with a single conductor host transmit signal (TxD), a single conductor host receive signal (RxD), and a common signal reference (GND). Convention specifies that TxD designates the host transmitter output and the peripheral receiver input whereas the RxD designates the host receiver input and the peripheral transmitter output. None of the hardware flow control mechanisms of EIA-232 are implemented, as flow control is managed by the SeaSense protocol through strict command/response interactions.

3.5 Character Limit

SeaSense command strings are limited to 31 characters in length. Most commands do not require this

4 Host Command Format

Each host command string must conform to a strict formatting for proper interpretation by the target node. Enforcing the strict formatting prevents misinterpretation of commands and ensures fault-tolerant communications. Further packet integrity verification is available through an optional checksum value calculated by the host and sent at the end of the packet.

Each valid command string contains between 5 and 9 frame fields:

Field:	Character Length:	Example:	Required:
Start-of-Frame (SoF)	1	"!"	Yes
Node Address (ADR)	3	"010"	Yes
Address Separator (A/S)	1	":"	Yes
Command ID (CMD ID)	4	"lout"	Yes
Access Code (ACS)	1	"="	Required for most commands
Data Payload	<16	"100"	Required for some commands
Data Separator (D/S)	1	"*"	Required for checksum
Checksum (CS)	2	"A8"	Optional
End-of-Frame (EoF)	2	<CR><LF>	Yes

Table 1 - Host Command Frame Fields

!010:lout=100*A8<CR><LF>

SoF	ADR	A/S	CMD ID	ACS	Data	D/S	CS	EoF
!	010	:	lout	=	100	*	A8	<CR><LF>

Table 2 - Example Host Command

4.1 Start-of-Frame (SoF)

Every valid protocol shall start with the Start-of-Frame character, "!", [0x21] in hex.

4.2 Node Address (ADR)

Each node on the channel shall be assigned a unique node address comprised of a 3-digit numeric value: "010"

Node Address:	Function:
"000"	Broadcast commands (all nodes)
"001" through "255"	Valid range for individual nodes
"256" through "300"	Reserved for future use
"301" through "332"	Node group addresses
"333" through "999"	Reserved for future use

Table 3 - Valid Node Address Ranges

The valid node addresses range is from "001" to "255". Address "000" is reserved for broadcast commands to all active nodes on the channel. The broadcast address cannot be used with the READ access type.

32 node group addresses are available from "301" through "332" and, as with broadcast commands, cannot be used with the READ access type.

Values from "256" through "300" and "333" through "999" are reserved for future use. See Appendix B for more information on alternate addressing modes.

4.3 Address Separator (A/S)

The 3-character node address is followed by the address separator character, ":".

4.4 Command ID (CMD ID)

A valid command ID consisting of four ASCII alpha characters follows the address separator. Example: "info", "INFO", "STAT", "stat"

See Section 0 for more information on supported command IDs for each type of peripheral node type or Appendix C for a summary of command IDs for different DeepSea Power & Light products.

4.5 Access Code (ACS)

The access code transmitted after the Command ID tells the target node what action is required in response to the specific command. If no access code is sent with the command, the node will assume the command is an immediate execution command type and respond accordingly.

Access Type:	Access Code:	Notes:
WRITE	"="	Sets the parameter referenced by the Command ID to the value in the following Data field
READ	"?"	Queries the parameter referenced by the Command ID
INCREMENT / ADD	"+"	Access code is command specific. 1) For Command IDs which modify system parameters "+" will INCREMENT the parameter by the value in the data field. If no value is passed, then a coarse increment value is implied (nominally 10%). 2) For Command IDs which access parameter lists, "+" is used to ADD items to the list.
DECREMENT / REMOVE	"-"	Access code is command specific. 1) For Command IDs which modify system parameters "-" will DECREMENT the parameter by the value in the data field. If no value is passed, then a coarse decrement value is implied (nominally 10%). 2) For Command IDs which access parameter lists, "-" is used to REMOVE items from the list.
IMMEDIATE¹	-OMITTED- "␣"	Immediate access type commands have no data payload and trigger a specific immediate behavior in the target node. No access code or data is sent.

Table 4 - Command Access Types

4.6 Data Payload

Command IDs with WRITE access adjust system values (i.e. light output level, zoom, or focus) and use the data field to send the new value. The data field is required for WRITE access type, optional for INCREMENT and DECREMENT access, and invalid for the READ or IMMEDIATE access types.

See Section 6 for details on the format and valid range for data payloads in the individual command summaries.

NOTE: This protocol ignores leading zeros in numerical data payloads.

¹ The IMMEDIATE access type is represented as a "␣" character for command access.

4.7 Data Separator (D/S)

A single “*” character demarcates the end of the data payload and the start of the two character checksum field when using the checksum calculation for enhanced data validation. Omit the data separator field if the checksum field is not used.

4.8 Checksum (CS)

The optional checksum field has a 2-character ASCII encoded hexadecimal value. This value represents the lower 8-bits of the running numeric total of the preceding characters up to and including the data separator. In critical applications, it provides additional data validation and a means for the receiving node to detect bit errors that may otherwise go undetected. See Appendix A for more information and examples of calculating checksum values.

If the checksum feature is not used, omit the Data Separator and any characters between the end of the data field and the End-of-Frame marker.

4.9 End-of-Frame Marker (EoF)

Each command string ends with the End-of-Frame marker consisting of a Carriage Return (<CR>, [0x0D]) followed by a Line Feed (<LF>, [0x0A]).

5 Node Response Format

There are three valid responses from a node to the bus host: acknowledge (ACK), acknowledge with data (ACK+DATA), and not acknowledge (NAK).

- **ACK** – confirms the receipt, proper interpretation, and execution of a valid message by the node at the command message’s node address. ACK is represented by the EoF marker, a Carriage Return (<CR>, [0x0D]) followed by a Line Feed (<LF>, [0x0A]).
- **ACK+DATA**– A data string follows node address commands with the READ, “?”, access type. The message consists of alphanumeric ASCII characters containing the requested data followed by an End-of-Frame marker. A READ access type with broadcast or group addressed commands is not permitted because multiple simultaneous responses would collide and cause an error on the bus.
- **NAK** – Not acknowledge returns if a node receives a properly addressed and formatted command that the node was unable to carry out. This may indicate that the receiving node does not recognize the Command ID or that it received an invalid or out of range data payload. A NAK response consists of a “?” [0x3F] character followed by the EoF marker: “?” + <CR><LF>.

NOTE: SeaSense nodes will not respond to commands containing checksum errors, even if the address and format are otherwise correct.

6 Peripheral Configuration Commands

There are two types of Command IDs in the SeaSense protocol: Common Configuration Commands and Node Configuration Commands. All SeaSense enabled products respond to Common Configuration Commands, while Node Configuration Commands are specific to different products and product types such as LED Lights or HD Cameras. SeaSense protocol enabled products respond to Node Configuration Commands that match the type of product in use. See Appendix C for a command compatibility summary of SeaSense enabled product families.

6.1 Common Configuration Commands

All SeaSense serial protocol enabled products respond to Common Configuration Commands.

Command:	Type:	Description	Access Type:	Broadcastable:	User Preset:
"ADDR"	Common	read or set the node ADD ress	?, =	NO	NO
"ADGR"	Common	set or read AD dress GR oup associations	?, =,+,-	YES	NO
"BAUD"	Common	set or read the peripheral BAUD rate	?, =	YES	NO
"BOOT"	Common	BOOT up configuration at power on	?, =	YES	NO
"INFO"	Common	request device INFO rmation string	?	NO	NO
"PSET"	Common	set node PreSET configuration	?, =,+,-	YES	NO
"RHUM"	Common	Query internal Relative HUM idity	?	NO	NO
"RSET"	Common	factory configuration ReSET	?, =	NO	NO
"STAT"	Common	Read device STAT us string	?	NO	NO
"STBY"	Common	enter or exit ST and BY power mode	?, =,+,-	YES	YES
"TEMP"	Common	request internal system TEMP erature	?	NO	NO

6.1.1 addr: Node Address Configuration

The "addr" command reads or writes a node address. When setting up a channel topology with multiple connected nodes, the "addr" command configures each node with a unique node address.

Command	Description	Access Type	Address Range	Data Range
"addr", "ADDR"	Read or set the node address	READ: ?	"001" – "255"	-
		WRITE: =,+,-	"001" – "255"	"001" – "255"

The READ access type queries the node address. This can be used in node discovery by confirming the presence of a node at the specified address on the channel.

READ EXAMPLE	COMMAND	REPLY
Read the node address back from the node at "010"	!010:addr?*F0<CR><LF>	010<CR><LF>

The WRITE access type changes the addressed node to a different node address.

WRITE EXAMPLE	COMMAND	REPLY
Set the node address of the node at "010" to "001"	!010:addr=001*7F<CR><LF>	ACK/NAK

The effect of this command is immediate changing the node address to the new value. The node will no longer respond to commands sent to the previous address.

6.1.2 adgr: Group Address Associations

The “adgr” Group Address Associations command sets and reads node group addresses. See Appendix B for more information on group addressing modes.

Command	Description	Access Type	Address Range	Data Range
“adgr”, “ADGR”	Set or read group address associations	READ: ?	“001–255”	-
		WRITE: =,+,-	“000–255”, GRP	“301” – “332”

A READ command queries the addressed node to reply with a comma-delimited list of the active group address associations terminated by the EoF marker. If no group address associations are set, the node replies with an empty list and the EoF marker.

READ EXAMPLE	COMMAND	REPLY
Read the active group addresses for the node at “010”	!010:adgr?*F3<CR><LF>	301,320<CR><LF>

NOTE: The group address list returns a comma-delimited string in numerical order.

WRITE commands access the list to add or remove group address associations for the addressed node or group. Both the WRITE and ADD access commands add the addressed node to the indicated group address while the REMOVE access code removes the node from the list.

For the WRITE/ADD access method, the node will return ACK if it added the specified group address. If the node is already associated with that group address, a NAK response is sent. For the REMOVE access method, the node will return ACK if it removes specified group association and NAK if the node is not already associated with that group address.

WRITE EXAMPLES	COMMAND	REPLY
Set a “301” group address for the node at “010”	!010:adgr=301*85<CR><LF>	ACK/NAK
Set a “301” group address for the node at “010”	!010:adgr+301*73<CR><LF>	ACK/NAK
Add all nodes in group “302” to address group “301”	!302:adgr+301*77<CR><LF>	-
Remove the node at “010” from group address “301”	!010:adgr-301*75<CR><LF>	ACK/NAK

6.1.3 baud: Baud Rate Selection

The “baud” command provides read and write access to a node baud rate setting and changes the baud rate between a limited set of values. The codes in Table 5 specify the baud rates.

Command	Description	Access Type	Address Range	Data Range
“baud”, “BAUD”	Set or read the peripheral baud rate	READ: ?	“001” – “255”	-
		WRITE: =	“000” – “255”	1 - 3

Baud Rate	Code
9600	1
19200	2
57600	3

Table 5 - Baud Rate Codes

READ access to the BAUD parameter returns the code corresponding to the current BAUD rate setting.

READ EXAMPLE	COMMAND	REPLY
Read the baud rate setting for the node at "010"	!010:baud?*F1<CR><LF>	1<CR><LF>

Set a new baud rate with a WRITE access command.

WRITE EXAMPLE	COMMAND	REPLY
Change the baud rate of the node at "010" to 57600	!010:baud=3*22<CR><LF>	ACK

NOTE: The node responds with an ACK at the current BAUD rate before changing the BAUD rate setting. Further commands sent to the node must use the new baud rate.

6.1.4 boot: Power On Boot Mode Configuration

At power up, each node can be configured to boot in either the factory default Node Configuration Settings, preset "0", or one of the 16 user presets stored in the system memory: presets "1" through "16". See section 6.1.6 for more information about the user preset function.

Command	Description	Access Type	Address Range	Data Range
"boot", "BOOT"	Read or set the node boot configuration mode	READ: ?	"001" – "255"	-
		WRITE: =	"001–255", GRP	"0" – "16"

READ access will query the node for the node configuration preset loaded at power up and the configuration settings for the saved configuration state. Since each node type has different configuration parameters, the order and format of the configuration parameter list will vary between products. See Appendix E for a description of the parameter list format for each node type.

READ EXAMPLE	COMMAND	REPLY
Query the power up mode for the node at "010"	!010:boot?*09<CR><LF>	See Appendix D

Example generic BOOT query response format:

```
(PRESET_#): <TAB>(PARAMETER_1) <TAB>(PARAMETER_2) ... <TAB>(PARAMETER_N)<CR><LF>
```

The WRITE access type sets the startup boot configuration to a stored user preset. The data field specifies the node preset configuration state to load at power up.

WRITE EXAMPLE	COMMAND	REPLY
Set the node at "010" to boot up in factory default mode	!010:boot=0*37<CR><LF>	ACK/NAK
Set the nodes in group "301" to boot up with preset 1	!301:boot=1*3B<CR><LF>	-

6.1.5 info: Peripheral Device Information

Each peripheral device in the system responds to an INFO query with a text string that contains identifying information about the type of device, serial number, firmware revision, and installed system options.

Command	Description	Access Type	Address Range	Data Range
"info", "INFO"	Request information string	READ: ?	"001" – "255"	-

Only READ access is available for the “INFO” command.

READ EXAMPLE	COMMAND	REPLY
Read the information string from the node at “010”	!010:info?*01<CR><LF>	See Below

The “INFO” query response includes a multi-field string containing product type and configuration information.

Example INFO query response:

010,SLS-5100,45-00101,0A,1.0.1,W60,FLD,A05<CR><LF>

ADR	FAM	-	MODEL	S/N	PCB Ver.	FW Ver.	[Option 1]	[Option 2]	[Option 3]	EoF
010,	SLS	-	5100,	45-00101,	0A,	1.0.1	[W60]	[FLD]	[A05]	<CR><LF>

- **ADR: Node Address** – 3-digit node address
- **FAM-MODEL: Product Family – Model** – DeepSea product family and model number
- **S/N: Serial Number** – Unique factory programmed serial number
- **PCB VER.: PCB Version** – Interface PCB version
- **FW VER.: Firmware Version** – RS-485 interface firmware version
- **OPTION 1-N: Configuration optional fields** – Product options fields, number and definition vary per product
- **EoF: End of Frame** – End of frame marker to indicate the end of the information string.

6.1.6 pset: Node Configuration Presets

Each node contains a set of sixteen user configurable presets that the “PSET” command saves and recalls. To save a node configuration preset, set up the node as desired and then issue a “PSET” ADD access type command along with a number identifying which preset number to save the current configuration to. Recalling a node configuration preset uses the WRITE access type by specifying the saved preset state to load.

NOTE: Node Configuration Presets only include some system configuration parameters and do not save the node address, baud rate, or any group address associations. The only Common Configuration Command saved in the node configuration preset is the STBY setting, allowing the standby state to be configured as a preset condition or even as the boot condition.

Command	Description	Access Type	Address Range	Data Range
“pset”, “PSET”	Save or recall node preset configuration	READ: ?	“001” – “255”	-
		WRITE: =,+,-	“000-255”, GRP	“1”-“16”

READ access queries the node to provide a list of the presets and their stored parameters. Since the available configuration parameters may differ for each peripheral and node type, the number and order of parameters varies between products. See Appendix E for a description of the PSET query response format for each peripheral type.

While the contents of the PSET query response vary between products, the formatting is consistent. The information sends as a tab-delimited table. The first row lists column headers with the system preset parameters. The following rows contain the information stored for each active preset, starting with the preset number, followed by a “:” and the tab delimited parameter list. Each row ends with a <CR><LF> and the end of the table is marked by another <CR><LF>.

READ EXAMPLE	COMMAND	REPLY
Query the node at "010" to list all configured preset states	!010:pset?*11<CR><LF>	See Appendix D

```
Preset<TAB> PARAMETER_1_NAME <TAB>PARAMETER_2_NAME ... <TAB>PARAMETER_N_NAME<CR><LF>
(PRESET_#): <TAB>(PARAMETER_1) <TAB>(PARAMETER_2) ... <TAB>(PARAMETER_N)<CR><LF>
...
(PRESET_N): <TAB>(PARAMETER_1) <TAB>(PARAMETER_2) ... <TAB>(PARAMETER_N)<CR><LF>
<CR><LF>
```

Figure 1 – Generic PSET query response format

Specifying a preset number with the WRITE access loads the stored state memory into the active state memory.

The ADD access type saves the current system state to a specific preset. A value must be present in the data field specifying the preset to store the current system state in.

The REMOVE command access type clears the specified preset and restores the factory default state at that preset.

WRITE EXAMPLES	COMMAND	REPLY
Recall preset 1 for node "010"	!010:pset=1*40<CR><LF>	ACK/NAK
Recall preset 2 for group "301"	!301:pset=2*44<CR><LF>	-
Save the current state of node "010" to preset 16	!010:pset+16*64<CR><LF>	ACK/NAK
Clear the node configuration state saved at preset 3	!010:pset-3*32<CR><LF>	ACK/NAK

NOTE: A preset number must be in the data field for both ADD or REMOVE access types. Failure to provide a preset number results in a NAK response from the addressed node.

6.1.7 rhum: Peripheral Device Relative Humidity

All SeaSense enabled products monitor the relative humidity inside of the peripheral device enclosure and can report the relative humidity back in % through the "rhum" command.

Command	Description	Access Type	Address Range	Data Range
"rhum", "RHUM"	Request internal system relative humidity	READ: ?	"001" – "255"	-

RHUM is a read only command. The node responds with an ACK followed with data containing the internal relative humidity reported in %.

READ EXAMPLE	COMMAND	REPLY
Read the relative humidity from the node at "010"	!010:rhum?*11<CR><LF>	40<CR><LF>

6.1.8 rset: Factory Settings Reset

WARNING: A node reset restores the node back to the factory set configuration. All user-editable parameters—such as the baud rate, node address, group address associations, and device specific parameters—will reset, and any saved presets will be lost.

A factory setting reset initiates by querying a node for a unique one-time use 4-character reset key and writing that key back to the node before issuing any other commands. If another command is issued to the node between a reset key query and the reset command, the factory reset will be unsuccessful and the reset command sequence must restart.

After transmitting a valid reset key the node responds with an ACK and then performs the factory reset operation.

Command	Description	Access Type	Address Range	Data Range
"rset", "RSET"	Recall factory default system settings	READ: ?	"001" – "255"	-
		WRITE: =	"001" – "255"	4: 0-9, a-z, A-Z

RESET COMMAND EXAMPLE	COMMAND	REPLY
1) Query the node at "010" for the reset key	!010:rset?*13<CR><LF>	4a93<CR><LF>
2) Write the reset password to the node at "010"	!010:rset=4a93*DF<CR><LF>	ACK/NAK

6.1.9 stat: Device Status Data

Products equipped with the SeaSense protocol collect and report status information about the device, including total run time, thermal data, and diagnostic information. Each product family tracks different metrics relevant to the particular class of device and summarizes this data in a readable text string accessed with the STAT command.

Command	Description	Access Type	Address Range	Data Range
"stat", "STAT"	Request device status string	READ: ?	"001–255"	-

Only READ access is available for the "STAT" command.

READ EXAMPLE	COMMAND	REPLY
Read the device status string from the node at "010"	!010:stat?*01<CR><LF>	See Below

While the contents of the "STAT" query response change from one product to the next, the format is consistent. The information is sent as a tab-delimited table. The first row lists the column headers with the status parameters. The following row contains the real-time node status values. Each row ends with a <CR><LF> and the end of the table is marked by another <CR><LF>. See Appendix F for more information on the data contained in the node status string for each product class.

6.1.10 stby: Standby Power State Control

Each SeaSense node can enter a standby power mode minimizing power draw by shutting down the main node functions. Common Configuration Commands will still function but Node Configuration Commands may not. Putting the node into standby does not affect other system parameters. The node returns to the same state and configuration it was in when standby was initiated, once standby mode is exited.

Command	Description	Access Type	Address Range	Data Range
"stby", "STBY"	Enter or exit the node standby power mode	READ: ?	"001–255"	-
		WRITE: =,+,-	"000–255", GRP	0,1

The READ access method queries the standby status of a node, returning "0" if the node is not in standby mode and "1" if the node is in standby mode.

READ EXAMPLE	COMMAND	REPLY
Read the standby state of the node at "010" (full power)	!010:stby?*17<CR><LF>	0<CR><LF>
Read the standby state of the node at "010" (in standby)	!010:stby?*17<CR><LF>	1<CR><LF>

To enter standby mode, use the WRITE access method to set the standby parameter to "1", or use the INCREMENT access method.

WRITE EXAMPLE - ENTER STANDBY	COMMAND	REPLY
Put the node at "010" into standby power mode	!010:stby=1*46<CR><LF>	ACK/NAK
Put all nodes in group "301" into standby power mode	!301:stby+*06<CR><LF>	-
Put all nodes on the channel into standby power mode	!000:stby=1*45<CR><LF>	-

Exit standby mode using the WRITE access type to set the standby parameter to "0" or use the DECREMENT access code.

WRITE EXAMPLE - EXIT STANDBY	COMMAND	REPLY
Wake up the node at "010" from standby power mode	!301:stby=0*48<CR><LF>	ACK/NAK
Wake up all nodes in group "301" from standby mode	!301:stby-*08<CR><LF>	-
Wake up all nodes on the channel from standby mode	!000:stby=0*44<CR><LF>	-

NOTE: Since the node saves the "STBY" parameter in the node configuration presets, PSET can also be used to enter and exit standby power mode by recalling a preset where the node was in standby or active.

6.1.11 temp: Peripheral Device Temperature

All SeaSense enabled products monitor the internal operating temperature of the peripheral device and can report the temperature back in degrees Celsius through the "temp" command.

Command	Description	Access Type	Address Range	Data Range
"temp", "TEMP"	Request internal system temperature	READ: ?	"001" – "255"	-

TEMP is a read only command. The node responds with an ACK followed with data containing the internal temperature reported in degrees Celsius.

READ EXAMPLE	COMMAND	REPLY
Read the temperature from the node at "010"	!010:temp?*0B<CR><LF>	27<CR><LF>

6.2 LED Light Control Commands

LED Light Commands control the output level and dimming characteristics of SeaSense serial protocol enabled LED lighting products.

Command:	Type:	Description	Access Type:	Broadcastable:	User Preset:
"CURV"	LED Light	read or adjust the dimming CURV e	?, =	NO	NO
"LOUT"	LED Light	read or set the Light OUT put level	?, =,+,-	YES	YES

6.2.1 curv: Dimming Curve Configuration

To adapt to the wide variety of analog control systems throughout the industry, the "CURV" command modifies the output dimming curve mapping control inputs to light output levels. This command sets the shape of the dimming curve for all control methods of the light, including serial control (see section 6.2.2), analog inputs (0-5V, 0-10V, 4-20mA), and phase angle (TRIAC) power controllers.

The default dimming curve is tailored to match the luminous response of a halogen light and is scaled for compatibility with most equipment control ranges. This default dimming curve also provides finer resolution at the lower end of the output range. There will be no need to adjust the default dimming curve for most users.

Some applications benefit from having control of the dimming curve. For instance, if a TRIAC phase angle dimmer only supports a maximum phase angle of 170°, the dimming curve could be adjusted to allow the light to reach full output even with the compressed controller output range.

Another possibility is to set a linear mapping between the input and output so that a control value of 50% of full scale results in a light output level of approximately 50%.

Command	Description	Access Type	Address Range	Data Range
"curv", "CURV"	Read or adjust the dimming curve shape and configuration	READ: ?	"001" – "255"	-
		WRITE: =,+,-	"000–255", GRP	See below

The dimming curve is defined by seven parameters: YMIN, YMAX, A, B, C, D, e

Parameter	Description	Range	Limits	Default
YMIN	Minimum output level as % of full scale	1-100	-	1
YMAX	Maximum output level as % of full scale	1-100	>YMIN	100
A	Turn on threshold, from YMIN to OFF and OFF to YMIN.	0-100	A≤B	1
B	Transition point for linear dimming segment	0-100	A≤B≤C	5
C	Transition point for exponential dimming segment	0-100	B≤C≤D	70
D	Maximum output threshold for YMAX	0-100	C≤D	95
e	Exponent value for exponential dimming segment	1-6	-	4.5

The curve segments between points A and B, and between D and the end of the curve help achieve and maintain stability at the minimum and maximum output levels for analog dimming control schemes. At the ends of the dimming curve, small changes in the control signal could otherwise result in large output changes.

A SeaSense Dimming Curve Configuration tool is available from DeepSea Power & Light to assist in defining valid dimming curve parameters.

A "CURV" READ access command requests the current dimming curve parameters from the addressed device and reports as a comma-delimited list of values.

READ EXAMPLE	COMMAND	REPLY
Read the current dimming curve from the node at "010"	!010:curv?*19<CR><LF>	1,100,1,5,70,95,4.5<CR><LF>

Where the reply string contains the dimming curve parameters in the following order:

YMIN	YMAX	A	B	C	D	e	EoF
1,	100,	1,	5,	70,	95,	4.5	<CR><LF>

A WRITE access command allows the operator to change the parameters that define the dimming curve. A comma delimited list of the curve parameters discussed above must accompany the WRITE command. The node will NAK any command containing an incomplete or improperly formatted list of dimming curve parameters.

WRITE EXAMPLES	COMMAND	REPLY
Set the light at node "001" to the default dimming curve	!001:curv=1,100,1,5,70,95,4.5<CR><LF>	ACK/NAK
Set the light at node "005" to a linear dimming curve	!005:curv=1,100,1,1,100,100,1<CR><LF>	ACK/NAK

SeaSense™ Default Dimming Curve

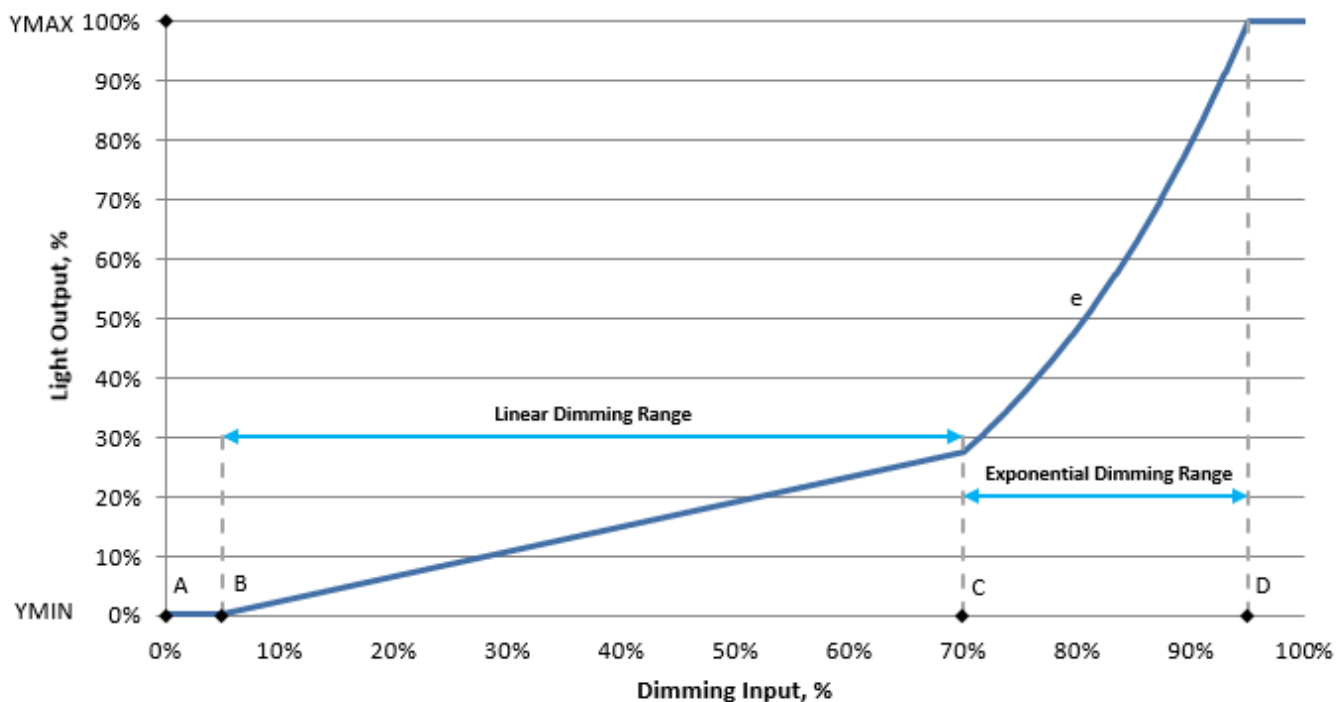


Figure 2 - Default dimming curve and the parameters that describe it

6.2.2 lout: Light Output Level

SeaSense enabled LED lights are dimmable using the “lout” command.

NOTE: Since serial dimming is digital and not subject to noise or interference in the same way analog signals are, the plateaus at the minimum and maximum ends of the dimming curve are not present when using the “LOUT” command to control the light output. LOUT = 1 is at point B of the dimming curve as described in the previous section and LOUT=100 is at point D.

Command	Description	Access Type	Address Range	Data Range
“lout”, “LOUT”	Read or set the LED Luminaire output set point	READ: ?	“001” – “255”	-
		WRITE: =,+,-	“000–255”, GRP	“0” – “100”

If queried with a READ access command, LED light responds with the current light output set point as an integer value from “0” to “100” followed by an ACK, <CR>.

READ EXAMPLE	COMMAND	REPLY
Read the light output set point from the node at “010”	!010:lout?*19<CR><LF>	100<CR>

A WRITE access command must be accompanied by the new set point value in the data field and formatted as an integer value from “0” to “100”. Any value passed outside of the 0-100 range will be ignored and replied to with a NAK response. INCREMENT and DECREMENT access methods can be used to add or subtract a value from the current set point, or if not accompanied by data, coarse increment or decrement the set point (usually 10 steps). The set point will not increment above 100 or decrement below 0.

WRITE EXAMPLES	COMMAND	REPLY
Set the light output of the node at “010” to “100”	!010:lout=100*A8<CR><LF>	ACK/NAK
Coarse increment the light output at node “005”	!005:lout+*09<CR><LF>	ACK/NAK
Increment the light output at node “010” by “2”	!010:lout+2*37<CR><LF>	ACK/NAK
Set the output of lights in address group “301” to “50”	!301:lout=50*7F<CR><LF>	-

6.3 Dual Output LED Light Control Commands

Some DeepSea Power & Light LED lighting products are available with a dual output configuration that can be set up to mix and match two arrays of LED to combine different colors and beam patterns. These LED arrays can be switched on and off and controlled independently using SeaSense protocol commands. The following section describes the commands available for controlling these Dual Output options.

All other commands defined in section 6.2 for LED lights work as described for which ever LED array channel is active.

Command:	Type:	Description	Access Type:	Broadcastable:	User Preset:
"CHSW"	DualOutput LED Light	change the active LED array channel	?,=,+,-	YES	YES

6.3.1 chsw: Active LED Array Channel Switch

The Channel Switch, "CHSW", command switches the LED driver channel between the two LED arrays. It can also be used in some configurations to turn on both arrays simultaneously.

LED lights not configured with a Dual Output LED array will respond with a NAK to the "CHSW" command.

Command	Description	Access Type	Address Range	Data Range
"chsw", "CHSW"	Read or set the active LED array channel	READ: ?	"001" – "255"	-
		WRITE: =,+,-	"000–255", GRP	"1, 2, 3"

READ access methods query the node for the current active channel parameter value and the node responds with a numeric value corresponding the current active channel per Table 6.

READ EXAMPLE	COMMAND	REPLY
Read the active LED array channel from the node at "010"	!010:chsw?*0A<CR><LF>	1<CR>

Channel Selection	Value
Channel 1 active	"1"
Channel 2 active	"2"
Both channels active	"3"

Table 6 - Dual Output Active Channel Values

WRITE access commands set the active LED channel to the specified value. INCREMENT and DECREMENT access methods also work with the CHSW command and will increment or decrement the active LED channel value between the available values, rolling over to the last or first value once the end is reached.

WRITE EXAMPLES	COMMAND	REPLY
Switch to channel "2" at node "010"	!010:chsw=2*3A<CR><LF>	ACK/NAK
Increment the active channel selection by 1 at node "005"	!005:chsw+*FC<CR><LF>	ACK/NAK
Decrement the active channel selection by 1 at node "010"	!010:chsw-*F8<CR><LF>	ACK/NAK

6.4 Camera OSD Control Commands

The table below outlines the commands for cameras that support OSD configuration menu navigation.

Command	Type:	Description	Access Type:	Broadcastable:	User Preset:
“OSDD”	Camera OSD	Move OSD cursor Down	IMMEDIATE	NO	NO
“OSDL”	Camera OSD	Move OSD cursor Left	IMMEDIATE	NO	NO
“OSDR”	Camera OSD	Move OSD cursor Right	IMMEDIATE	NO	NO
“OSDS”	Camera OSD	OSD menu Select / open OSD menu	IMMEDIATE	NO	NO
“OSDU”	Camera OSD	Move OSD cursor Up	IMMEDIATE	NO	NO

6.4.1 osdd: On-Screen Display – Cursor Down

Navigates the on-screen display configuration menu. When the OSD configuration menu is active, this command will move the focus cursor down one position. This command is not broadcastable and only works when addressing a single node.

Command	Description	Access Type	Address Range	Data Range
“osdd”, “OSDD”	Command the OSD cursor down	IMMEDIATE	“001” – “255”	-

COMMAND EXAMPLE

COMMAND	REPLY
Move the OSD cursor down for the camera at node “005”	!005:osdd*C4<CR><LF> ACK/NAK

6.4.2 osdl: On-Screen Display – Cursor Left

Navigates the on-screen display configuration menu. When the OSD configuration menu is active, this command will move the focus cursor left one position to change a configuration parameter. This command is not broadcastable and only works when addressing a single node.

Command	Description	Access Type	Address Range	Data Range
“osdl”, “OSDL”	Command the OSD cursor down	IMMEDIATE	“001” – “255”	-

COMMAND EXAMPLE

COMMAND	REPLY
Move the OSD cursor left for the camera at node “005”	!005:osdl*CC<CR><LF> ACK/NAK

6.4.3 osdr: On-Screen Display – Cursor Right

Navigates the on-screen display configuration menu. When the OSD configuration menu is active, this command will move the focus cursor right one position to change a configuration parameter. This command is not broadcastable and only works when addressing a single node.

Command	Description	Access Type	Address Range	Data Range
"osdr", "OSDR"	Command the OSD cursor right	IMMEDIATE	"001" – "255"	-

COMMAND EXAMPLE	COMMAND	REPLY
Move the OSD cursor right for the camera at node "005"	!005:osdr*D2<CR><LF>	ACK/NAK

6.4.4 osds: On-Screen Display – Select Item / Open OSD Menu

Opens the on-screen display configuration menu and selects options within the menu. When the OSD configuration menu is not active, this command will open the menu on the screen. If the OSD menu is active, this command will act as a "select" operation to enter sub-menus, initiate events, or exit the OSD menu. This command is not broadcastable and only works when addressing a single node.

Command	Description	Access Type	Address Range	Data Range
"osds", "OSDS"	Open OSD menu / select item	IMMEDIATE	"001" – "255"	-

COMMAND EXAMPLE	COMMAND	REPLY
Open the OSD menu for the node at "005"	!005:osds*D3<CR><LF>	ACK/NAK
Select a sub-menu item in the OSD menu for the node at "001"	!001:osds*CF<CR><LF>	ACK/NAK

6.4.5 osdu: On-Screen Display – Cursor Up

Navigates the on-screen display configuration menu. When the OSD configuration menu is active, this command moves the focus cursor up one position. This command is not broadcastable and only works when directly addressing a single node.

Command	Description	Access Type	Address Range	Data Range
"osdu", "OSDU"	Command the OSD cursor up	IMMEDIATE	"001" – "255"	-

COMMAND EXAMPLE	COMMAND	REPLY
Move the OSD cursor up for the camera at node "005"	!005:osdu*D5<CR><LF>	ACK/NAK

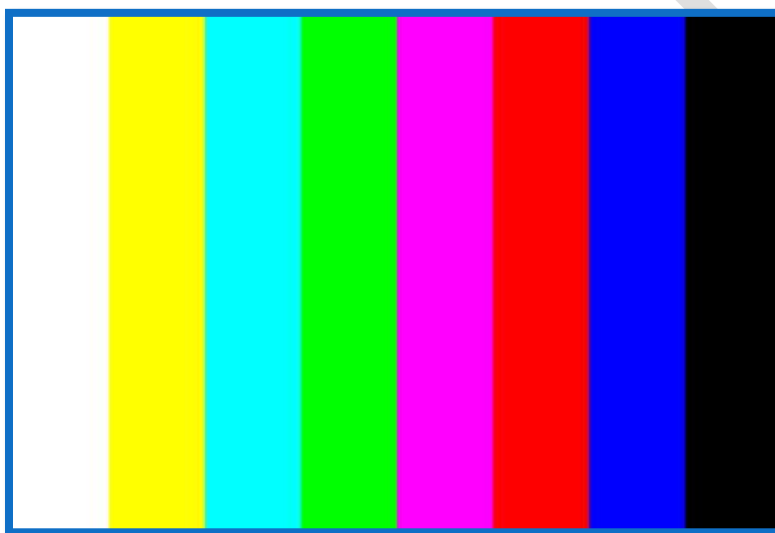
6.5 Camera Configuration Commands

For cameras that support on screen display (OSD) configuration controls

Command	Type:	Description	Access Type:	Broadcastable:	User Preset:
“VTST”	Camera	Enable/disable Video TeST pattern	?, =, +, -	NO	NO
“WBPS”	Camera	White Balance Push to Set	IMMEDIATE	NO	NO

6.5.1 vtst: Video Test Pattern

A video test pattern generator is included with some cameras for troubleshooting video transmission systems as well as identify video feeds from a control console through the SeaSense interface. Typically, this pattern will be a SMPTE color bar as depicted below.



Command	Description	Access Type	Address Range	Data Range
“vtst”, “VTST”	Video test pattern control	?, =, +, -	“001” – “255”	“0”, “1”

READ access queries the status of the video test pattern control parameter indicating if the test pattern is active or not.

READ EXAMPLE	COMMAND	REPLY
Query the video test pattern generator status of node “020”	!020:vtst?*27<CR><LF>	0<CR><LF>

WRITE EXAMPLES	COMMAND	REPLY
Turn on the video test pattern	!005:vtst=1*59<CR><LF>	ACK/NAK
Turn on the video test pattern	!005:vtst+*16<CR><LF>	ACK/NAK
Turn off the video test pattern	!005:vtst=0*58<CR><LF>	ACK/NAK
Turn off the video test pattern	!005:vtst-*18<CR><LF>	ACK/NAK

NOTE: If the video test pattern generator is not available for a particular camera, the device will respond with a NAK for all read or write messages for the VTST command.

6.5.2 wbps: White Balance Push to Set

The white balance push to set feature allows the user to trigger an auto white balance adjustment that will persist until another push to set command is issued or the white balance setting is changed. Once the WBPS command is acknowledged, the camera will not respond to new commands for 10 seconds while the white balance settings change.

Command	Description	Access Type	Address Range	Data Range
"wbps", "WBPS"	Trigger white balance "push to set"	IMMEDIATE	"001" – "255"	-

COMMAND EXAMPLE	COMMAND	REPLY
Trigger an Auto White Balance Push to Set for node "002"	!002:wbps*D3<CR><LF>	ACK/NAK

NOTE: The WBPS command is only accessible from outside the OSD menu. The node responds to WBPS commands with a NAK if the OSD menu is currently active.

Appendix A – Checksum Calculations

The optional checksum field provides a basic data integrity check by comparing a value calculated from the preceding characters in a command to the value in the checksum field. If these values match, the command string is validated and the node proceeds to process and respond to the command. If the checksum does not match the value in the checksum field the node ignores the command and waits for the next SoF symbol, “!”.

A checksum value is calculated by summing the hexadecimal value of the ASCII characters contained in the command string starting with the SoF symbol, “!”, and ending with the data separator, “*”. The two character ASCII checksum field is converted to an 8-bit hexadecimal value and then compared to the lower 8 bits of the total from the summing operation.

Example

The following example shows the checksum calculation for a light output query command sent to the node at address “010”.

Command:	!	0	1	0	:	l	o	u	t	?	*
HEX:	0x21	0x30	0x31	0x30	0x3A	0x6C	0x6F	0x75	0x74	0x3F	0x2A
Total:	0x21	0x51	0x82	0xB2	0xEC	0x158	0x1C7	0x23C	0x2B0	0x2EF	0x319

The sum of the ASCII values for each character in the command string is 0x319. Since the checksum field in the protocol only compares the lower 8-bits from this total, the calculated checksum value is 0x19 in hexadecimal. The correct checksum value to complete this command sting would be “19” followed by the End-of-Frame marker: “!010:lout?*19<CR><LF>”.

Code Example

The following example code snippet, written in C, calculates the checksum value from a given command string. Note: the example assumes the command string is validated and properly formatted.

```
uint_8 ucCalculateChecksum( uint_8 * pcCommandString )
{
    uint_32    uiRunningTotal = 0;
    uint_32    i;

    /*Calculate checksum*/
    for( i = 0; i < strlen( pcCommandString ); i++)
    {
        /*Add character to running total*/
        uiRunningTotal += ( uint_32 ) pcCommandString[i];
    }
    /*Mask the lower byte and return the value to the caller*/
    return (uint_8) ( uiRunningTotal & 0xFF);
}
```

Appendix B – Alternate Addressing Modes

Broadcast Mode

In addition to direct address commands, the SeaSense protocol supports a broadcast addressing mode that directs a command to every available node on the channel. Since a broadcast command targets multiple nodes, no ACK, NAK, or ACK with data is sent to prevent potential collisions from simultaneous response attempts.



Group Addressing Mode

Group addressing is available for all SeaSense protocol enabled products. It allows for flexible command and control interfaces by grouping individual nodes together in logical sets. This feature can be used in conjunction with the user presets feature of SeaSense enabled products to switch between mission operating modes.

32 group addresses are available. Individual nodes must be individually assigned to groups, however, groups of nodes may be nested in other groups by the same “adgr” command.

Any command sent with a broadcast type can also address groups. Since multiple nodes are addressed by a group command, no ACK, NAK, or ACK with data is sent to prevent potential collisions from simultaneous response attempts.

Appendix C – SeaSense Command Summary

Device Type: Command:		Command Compatibility by Product Family	
		LED SeaLite	HD Multi SeaCam 3000 Series
			
COMMON	"ADDR"	✓	✓
	"ADGR"	✓	✓
	"BAUD"	✓	✓
	"BOOT"	✓	✓
	"INFO"	✓	✓
	"PSET"	✓	✓
	"RHUM"	✓	✗
	"RSET"	✓	✓
	"STAT"	✓	✗
	"STBY"	✓	✓
	"TEMP"	✓	✓
LED LIGHT	"CURV"	✓	○
	"LOUT"	✓	○
	"CHSW"	✓ ²	○
CAMERA OSD	"OSDD"	○	✓
	"OSDL"	○	✓
	"OSDR"	○	✓
	"OSDS"	○	✓
	"OSDU"	○	✓
CAMERA	"VTST"	○	✗
	"WBPS"	○	✓

✓ = Supported command, ✗ = Unsupported command, ○ = Command not applicable

² This command only available in product configurations supporting this feature.

Appendix D – Node Information Query Response Formatting

LED SeaLite

Applicable Models: LSL-10XX, LSL-20XX	
Option 1: LED Color	Cool White: CW00, Daylight White: DW00, Warm White: WW00, Red: R625, Blue: BL475, Green: G528, Ultra Violet 365nm: U365, Ultra Violet 405nm: U405, Infrared 850nm: R850,
Option 2: Beam Pattern	Wide Flood: WFD, Flood: FLD, Medium Spot: MED, Narrow Spot: SPT, 75°/40° Dual Beam: 75/40, 115°/75° Dual Beam: 115/75
Option 3: Dimming Control	Analog 0-5V: A05, Analog 0-10V: A10, Analog 4-20mA: A20, Multi-protocol RS232/485: SER

Example “INFO” response:

010,LSL-1000,12-049-000101,0A,1.1.1686,DW00,FLD,SER<CR><LF>

ADR	FAM	-	MODEL	S/N	PCB Ver.	FW Ver.	LED Color	Beam Pattern	Dimming	EoF
010	LSL	-	1000	12-049-000101	0A	1.1.1686	DW00	FLD	SER	<CR><LF>

HD Multi SeaCam 3000 Series

Applicable Models: HDMSC-3085, HDMSC-3145	
Option 1: Lens Horizontal FoV	85°: 85, 145°: 145
Option 2: Control Interface	EIQ/RS-485: RS4, EIA/RS-232: RS2, Tristate: 3S
Option 3: SDI Output Type	Coax: CX, Fiber Optic: FO, Flexlink UTP: UTP
Option 4: Wavelength, λ [Fiber Only]	Laser wavelength in nano meters (nm)

Example “INFO” response:

010,HDMSC-3085,40-092-00101,0A,0.1.3,85,RS4,UTP<CR><LF>

ADR	FAM	-	MODEL	S/N	PCB Ver.	FW Ver.	Lens	Control	SDI Output	[λ]	EoF
010	HDMSC	-	3085	40-093-00101	0A	0.1.3	85	RS4	UTP	1550	<CR><LF>

010,HDMSC-3145,40-092-00102,0A,0.1.3,145,RS4,FO,1550<CR><LF>

ADR	FAM	-	MODEL	S/N	PCB Ver.	FW Ver.	Lens	Control	SDI Output	[λ]	EoF
010	HDMSC	-	3145	40-093-00101	0A	0.1.3	145	RS4	FO	1550	<CR><LF>

Appendix E – User Preset Query Parameter Table Formatting

The PSET command READ access is used to query the list of system configuration presets. The queried node responds with an ASCII text string formatted as a tab delimited table of values. Each node type may have different saved preset configuration parameters available so the designation and order of the columns may vary from one type of node to another.

While the information in the preset parameter table may vary between node types, the basic structure is the same. The first row contains the column headings for the type of node queried and is immediately followed by the factory default configuration stored in preset “0”. The factory default settings row is followed by one additional row for each of the available system presets. The end of the table is marked by a final carriage return and line feed. <CR><LF>.

```
Preset<TAB> PARAMETER_1_NAME <TAB>PARAMETER_2_NAME ... <TAB>PARAMETER_N_NAME<CR><LF>
(PRESET_#): <TAB>(PARAMETER_1) <TAB>(PARAMETER_2) ... <TAB>(PARAMETER_N)<CR><LF>
...
(PRESET_N): <TAB>(PARAMETER_1) <TAB>(PARAMETER_2) ... <TAB>(PARAMETER_N)<CR><LF>
<CR><LF>
```

LED SeaLite

Applicable Models: LSL-10XX, LSL-20XX

Preset Parameters:

- “STBY” – Standby power state
- “LOUT” – Light output level
- “CHSW” – Active LED channel

Example PSET Query Response:

```
Preset    STBY    LOUT    CHSW<CR><LF>
0:         0       100     1<CR><LF>
1:         0       50      2<CR><LF>
2:         0       25      3<CR><LF>
<CR><LF>
```

NOTE: the “CHSW” column is only included for LED SeaLite units configured with dual output channels.

HD Multi SeaCam 3000

Applicable Models: HDMSC-3085, HDMSC-3145

Preset Parameters:

- “STBY” – Standby power state

Example PSET Query Response:

```
Preset    STBY <CR><LF>
0:         0 <CR><LF>
1:         0 <CR><LF>
2:         0 <CR><LF>
<CR><LF>
```

Appendix F – Device Status Data Query Formatting

Products equipped with the SeaSense protocol collect and report status information about the device, including total run time, thermal data, and diagnostic information. Each product family tracks different metrics relevant to the particular class of device and summarizes this data in a readable text string accessed with the STAT command.

While the contents of the “STAT” query response change from one product to the next, the format is consistent. The information is sent as a tab-delimited table. The first row lists the column headers with the status parameters. The following row contains the real-time node status values. Each row ends with a <CR><LF> and the end of the table is marked by another <CR><LF>.

```
PARAMETER_1_NAME <TAB>PARAMETER_2_NAME ... <TAB>PARAMETER_N_NAME<CR><LF>
PARAMETER_1      <TAB>PARAMETER_2 ...      <TAB>PARAMETER_N<CR><LF>
<CR><LF>
```

The specific parameter list for different products are described below.

LED SeaLite

Applicable Models: LSL-10XX, LSL-20XX

Status Parameters:

- RunTime – Total runtime in hours
- PrCycle – Power cycle count
- MaxTemp – Maximum internal temperature measured
- Humid – Maximum internal humidity measured
- FLAGS – system status flags, for factory use

Example STAT Query Response:

```
!001:STAT?<CR><LF>
RunTime <TAB>PrCycle <TAB>MaxTemp <TAB>Humid <TAB>FLAGS<CR><LF>
0.5hr <TAB>24 <TAB>93.7C <TAB>44% <TAB>0x0001<CR><LF>
<CR><LF>
```


Revision History

Rev. No.	Date	Change Summary
A	June 2017	Initial release

PRELIMINARY