Third-party Light Source

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Learn the hazard and information symbols used in the product documentation.

	Danger messages indicate a hazardous situation which, if not avoided, results in death or serious injury.
	Warning messages indicate a hazardous situation which, if not avoided, could result in death or serious injury.
	Caution messages indicate a hazardous situation which, if not avoided, could result in minor or moderate injury.
	Notice messages indicate a hazardous situation which, if not avoided, may result in equipment or property damage.
	Information messages provide additional information, emphasize or provide a useful tip.

Content

Integrating a third-party light source with a Christie projector

This guide is intended for the third-party light source (TPLS) vendors to provide the information to integrate their equipment with a Christie projector system.

While the Christie projector systems control the third-party light source at a high level, the third-party light source vendor must provide a setup, configuration, and management system for the light source. Additionally the projector only supports a connection to a single third-party light source. If the light source has multiple modules needing to be controlled, the vendor must provide the control system.

Only a subset of projectors support third-party light source integrations. Contact Christie for details on specific models.

This document is intended to be read and understood by product developers.

What's new in the guide?

The following updates have been made to the guide.

- Made the following updates to the *LSC–Light Source Control* (on page 19) command:
  - Added the <parm11> to the `LSC+CALB` subcommand.
  - Changed the parm0 values to 0 to 26 for the `LSC+CALB` subcommand.
  - Changed the index values to 0 to 26 for the `LSC+CALB? <index>` subcommand.
  - Added the `LSC+CSTG?`, `LSC+CSWP? <sector>`, and `LSC+CSWP <sector>` subcommands.
  - Added additional examples for the new subcommands.
- Made the following updates to the *Light source calibration sequence* (on page 50) topic:
  - Updated the light source calibration sequence image and workflow to include information about sectors.
  - Added two example workflow images: sequence calibrating all the sectors together and sequence for calibrating only the sector 2.

Messaging protocol overview

All information is passed in and out of the device as messages. Messages sent to and from a third-party light source can take four basic forms.

Message type	Description
Set	The message sent to the device to set the parameter to a specified value. Usually contains the same data in the same format as Reply messages.
Request	The message sent to the device requesting it to return the current value of a parameter. Requests usually do not have any data unless additional data is used to narrow the scope of the request.
Reply	The message returned from the device containing the requested value. Usually contains the same data in the same format as Set messages.
Acknowledge	The message sent to acknowledge the receipt of the command.

Example message

The following message is sent from the projector to turn on power for the light source and the light source acknowledges receipt of the command:

```
(pwr 1)
(pwr!001)
```

Message format

All information is passed in and out of the device as messages.

To set a parameter to a specific value, the host controller (projector) sends a message to the third-party light source. To read the current value of a parameter, the host controller sends a message asking for the information and the device returns the data in a message.

When a controller wants to get information from the device, it sends a message requesting the information and the device responds by sending a message with the requested information. Both messages have the standard message format and use the same message code used to set the parameter.

All numeric parameters returned by the device have a fixed length of either three, five, or seven characters regardless of the actual value (values are padded with leading zeros as required). For a specific parameter, the length is also the same, such as power is always returned as three characters. Parameters sent to the device do not require padding.

All the text parameters must be in the English language and in escaped data format.

Basic message structure

Understand the component fields that comprise a standard ASCII message.

Components	Description
Start and end of message	Every message begins with the left parenthesis character and ends with the right parenthesis character.

Components	Description
	If the start character is received before an end character of the previous message, the partial (previous) message is discarded.
Function code	The third-party light source function to be worked with is represented by a three-character ASCII code (A-Z, upper or lower case). This function code appears immediately after the leading parenthesis that starts the message. In messages sent to third-party light source that do not have a subcode, a space between the function code and the first parameter (or special character) is optional.
+Subcode (optional)	The subcode is used to further define the function code and is optional. The subcode is represented by a four-character ASCII code (A-Z, upper or lower case, and 0-9). This subcode appears immediately after the function code, with a plus sign (+) character to separate the function code and subcode. If no subcode exists, the plus sign (+) is also omitted. In messages sent to third-party light source that have a subcode, a space between the subcode and the first parameter (or special character) is optional.
Request/reply symbols (optional)	A request for information is represented by a question mark (?) that appears directly after the function code. A reply is represented by an exclamation mark (!) that appears directly after the function code or subcode, if one is provided. The first parameter located after the exclamation mark (!) reply character cannot have a space, for example (PWR!000).
Data (optional)	The value for a given third-party light source state, such as on or off, appears in ASCII-decimal format directly after the request/reply symbol. The light source can add an optional space after the symbol—such as before the data—in a set message, but data in replies follow the exclamation mark (!) symbol without a space. Other details to remember about data: • All values returned by third-party light source (reply messages) have a fixed length, regardless of the actual value. For a specific parameter, the length is always the same (for example, contrast is always returned as three characters, third-party light source number is always returned as five characters). The minimum parameter size is three characters. Values less than the predefined size are padded with leading zeros as needed. Parameters which have negative signs are zero padded after the negative sign, and have one less digit to make space for the sign. • Data in set messages to third-party light source do not require padding with zeros. • Within each message, multiple parameters of data must be separated by one space character. • Text parameters such as channel names are enclosed in double quotes following the data, as in "Name".
Text parameters	Most data is a numerical value; however, some messages also require text. Use all characters as required except for special characters—these require a two-character combination.

Special characters for text

To use special characters in the API commands, the light source must use a two-character combination.

Special character	Two-character combination	Description
"	\"	Double quotation mark
\	\\	Backslash
(	\(	Left parenthesis
)	\)	Right parenthesis

Understanding the message format

Commands sent to and from third-party light source projectors are formatted as simple text messages consisting of a three letter function code, an optional four letter subcode, and optional data.

Message format	Function	Example
(Code Data)	SET	(PWR1)
(Code+Subcode Data)	SET with subcode	(LSC+WHTP "80.00")
(Code?)	REQUEST	(PWR?)
(Code+Subcode?)	REQUEST with subcode	(SST+HLTX?)
(Code!Data)	REPLY	(PWR!001)
(Code+Subcode!Data)	REPLY with sub code	(SST+HLTX!000 000 "Standby" "Power State")

What is sent in a message

Although the light source sends and reads messages as strings of ASCII characters, the actual message travels as a sequence of bytes. Each character in this sequence requires one byte.

The following example illustrates a power (PWR!000) message:

ASCII =	(	P	W	R	!	0	0	0	)
HEX =	0x28	0x43	0x57	0x52	0x21	0x30	0x30	0x30	0x29

Message notifications

Message notifications are an extension to the standard FYI command.

Examples of standard notification

- (FYI 001 011 "Powering Up")
- (FYI 001 001 "Power On")

where:

- 001 = Power FYI
- 011 = State—In this example the state is Warming Up.

Message response time and frequency

All responses to API messages are expected to be returned as soon as possible and no command should take longer than two seconds.

To prevent the system from being overloaded with API requests, the average rate of transmission must be below one message per 0.5 seconds. During state transitions, more messages are transmitted but when completed, the sustained rate slows to the above limit.

Command protocols

The third-party light source commands can be used to modify product settings.

📝 Some commands have been deprecated and are noted in the guide.

DWN–Download

Upgrades the third-party light source software.

Download sequence diagram

Parameters

- **Access level:** Operational

Commands

Command	Description	Values
DWN+CMPT <parm0> <parm1> <parm2>	Returns the firmware upgrade complete message. After the download complete message is received, the projector queries the programming mode and expects the light source to go into standard operating mode.	• parm0 = lastPacketNumber • parm1 = fizeFileSize—Total file size of raw data • parm2 = CRC16 of full file—Raw non-escaped data
DWN+PROG?	Returns the programming mode. (Read-only)	—
DWN+PROG <0 | 1>	Sets the standard operating/programming mode.	• 0 = Standard operating mode • 1 = Programming mode
DWN+PCKT <parm0> <parm1> <parm2> <parm3>	Transmits the programming data.	• parm0 = Packet number—Starting packet number is 0 • parm1 = Packet size—Maximum bytes of raw data is 256 bytes • parm2 = CRC16—raw non-escaped data + packetNumber + packetSize • parm3 = Fully escaped data, in string format
DWN+STAT? <parm0>	Returns the upgrade packet status. Returned status are: • 0x00 = Ready for next packet • 0x01 = Busy programming packet • 0x02 = Not in programming mode • 0x03 = Incorrect packet number, the packet number is replaced with the expected packet number. • 0x04 = CRC Failed • 0x05 = Error programming • 0xFE = General Error With the expected packet number: • 0x04 = CRC Failed • 0x05 = Error programming • 0xFE = General Error	• parm0 = lastPacketNumber

Examples

Query the programming mode: (DWN+PROG?) Result:

`(DWN+PROG!1)` Indicates ready for programming.
Set the mode to programming mode: `(DWN+PROG 1)`
Transmit one chunk of programming data: `(DWN+PCKT "packetNumber" "packetSize" "CRC16" "data(0) ...... data(n-1)" )`
Get the upgrade packet status: `(DWN+STAT? lastPacketNumber)` Result: `(DWN+STAT!lastPacketNumber 0)`—Indicates ready for next packet `(DWN+STAT!lastPacketNumber 1)`—Indicates busy programming `(DWN+STAT!packetNumber 3)`—Indicates an incorrect packet number, `packetNumber` is the expected packet number.
Send the firmware upgrade complete message: `(DWN+CMPT lastPacketNumber fizeFileSize CRC16 )` Result: `(DWN+CMPT!1)`—Indicates success or `(DWN+CMPT!0)`—Indicates failure

ERR–Error Message

Generates this message from the third-party light source when an error is detected.

The error message contains an error code, message specifier (such as, PWR), and a text parameter that explains the error code. The message specifier and text parameter are included in quotes and separated by a colon and a space.

Parameters

- **Access level:** Status

Commands

Error code	Error text	Description
003	Invalid parameter	Used when a message is received and it contains parameters not expected by the software.
004	Too many parameters	Used when a message is received with more parameters than expected.
005	Too few parameters	Used when a message is received that is missing a number of parameters.
007	Could not be executed	Used when the system is in a state when the command is not allowed.

Error code	Error text	Description
009	Unknown request	Used when the system receives a message with a specifier that is not defined.
010	General communication error	Used as a catch all for any other communication errors.
011	Busy	Used when the third-party light source is busy and cannot respond to the request at the time.
012	Interlock tripped	Used when the third-party light source is detecting an interlock trip, and cannot respond to the requests.
013	Profile does not exist	Used when the third-party is instructed to activate a profile that does not exist. (Deprecated)

Examples

Generate a power on message with an invalid parameter:

```
(pwr "On")
```

Result:

```
(ERR 003 "PWR: Invalid parameter – Expected a numeric value")
```

Generate a power on message with too many parameters:

```
(pwr 1 4)
```

Result:

```
(ERR 004 "PWR: Too Many Parameters")
```

Generate a power message with not enough parameters:

```
(pwr )
```

Result:

```
(ERR 005 "PWR: Too Few Parameters")
```

FCT–Factory

Allows programming of factory information to the light source.

Commands

Command	Description	Values
FCT+LOHR?	Returns the light on hours for the light source.	—
FCT+LOHR "<hours>"	Sets the light on hours for the light source.	hours= Represented in string format (double value)
FCT+SERN?	Returns the serial number for the light source.	—

Command	Description	Values
FCT+SERN "<serial number>"	Sets the serial number for the light source.	serial number = Represented in string format

Examples

Return the light on hours:
`(FCT+LOHR?)`
Result:
`(FCT+LOHR!"268.5")`

Set the light on hours: `(FCT+LOHR "253.3")`

Return the light source serial number:
`(FCT+SERN?)`
Result:
`(FCT+SERN!"VM23589596")`

Set the light source serial number: `(FCT+SERN "VM23589596")`

FYI–For Your Information

Generates a message from the third-party light source whenever a state change occurs.

Some third-party light sources may not have all states listed. The case state must be matched to one of the items below.

The third-party light source generates this message when a state change occurs (such as the PWR command). It is expected some light sources may not have all the states listed. In this case, the state should be matched to one of the items below.

Parameters

- **Access level:** None

Commands

FYI code	FYI subcode	State	Description
001	000	Power Off	Transmitted when the device reaches the powered off state. Light source is off.
	001	Power On	Transmitted when the device reaches the powered on state. Light source is on and active.
	003	Power Standby	Transmitted when the device reaches the standby state. Light source is off but illuminates instantly when on is sent.

FYI code	FYI subcode	State	Description
	010	Power Cool Down	Transmitted between the Power On and Power Standby states, informing the projector the light source is cooling down after it has been on.
	011	Power Warmup	Transmitted between the Power Off and Power Standby states, informing the projector the light source is warming up.
002	000	Profile List Changed	The third-party light source issues this when the profile list or profile contents have changed. (Deprecated)
	001	Profile Changed	The third-party light sourced issues this when the active profile is changed. (Deprecated) The text consists of the following: "Profile Changed: %s" where %s is replaced by the name of the active profile.
003	000	Interlock Tripped	The third-party light sourced issues this when the interlock is tripped on the light source.
004	000	Overall Health OK	The third-party light source issues this when the overall health of the light source returns to a normal range.
	001	Overall Health Warning	The third-party light source issues this when the overall health of the light source is at a warning state. The projector interface displays a yellow warning message.
	002	Overall Health Critical	The third-party light source issues this when the overall health of the light source is at a critical error state. The projector interface displays a red critical error message.
005	000	LiteLOC OK	The third-party light source issues this when LiteLOC™ of the light source returns to a normal range.
	001	LiteLOC Brightness Not Reachable	The third-party light source issues this when the LiteLOC feature cannot achieve the requested brightness. The projector interface displays a yellow warning message.
	002	LiteLOC Color Not Reachable	The third-party light source issues this when the LiteLOC feature cannot achieve the requested white point. The projector interface displays a yellow warning message.
006	000	Drive Limit Changed	The third-party light source issues this whenever the Maximum or Minimum Drive Limit has been changed.

Examples

Generate a power off message:
`(FYI 001 000 "Power Off")`
Generate a power on message:
`(FYI 001 001 "Power On")`
Generate a power standby message:

(FYI 001 003 "Power Standby")
Generate a cool down message:
(FYI 001 010 "Power CoolDown")
Generate a warmup message:
(FYI 001 011 "Power WarmUp")
Generate a profile list changed message:
(FYI 002 000 "Profile List Changed")
Generate an interlock tripped message:
(FYI 003 000 "Interlock Tripped")
Generate a profile changed message:
(FYI 002 001 "Profile Changed: 2D Setup")

LOG–Logging

Allows logging of relevant light source messages into the projector's logging system.

Note the following:

- This command should only transmit relevant information that would be useful for diagnostics/ isolation of issues.
- Only root cause failures should be logged. Cascaded failure logs are minimized.
- If an action is taken because of a failure (such as, an over temperature that causes the light source to turn off), this should also be logged.
- When system is running normally, no logs are generated. The only exception is on start-up where critical information may be logged.
- All warnings and alarms have hysteresis to prevent log spamming.
- The third-party light source provider provides a list of all possible log messages to Christie.

Parameters

- **Access level:** None

Commands

Command	Description	Values
LOG <sequence number> <ELogTypes> <ELogLevel><Unique error code> <message>	Sets the log.	Sequence number = 001-999 (auto rollover)
		ELogTypes: • LOG_TYPE_ENGINEERING = 0— Resolution to event messages, any useful logs that help isolate issues.

Command	Description	Values
		• LOG_TYPE_OPERATIONAL = 10—Power state changes, light source file changes, interlock trips, and so on • LOG_TYPE_MAINTENANCE = 20—Software upgrades or any maintenance logs • LOG_TYPE_SECURITY = 30—Anything related to security • LOG_TYPE_EVENT = 40—All Warnings and alarms
		ELogLevel: • LOG_LEVEL_TRACE = 0—Trace level, all useful information for debugging • LOG_LEVEL_DEBUG = 1—Debug information level, all useful information for debugging at this level • LOG_LEVEL_INFO = 2—Information level, all useful information to a technician is at this level • LOG_LEVEL_NOTICE = 3—Notice (FYI) level such as User switched channel, Power off, and so on • LOG_LEVEL_WARNING = 4—Warning level indicating something is wrong but system may be recoverable • LOG_LEVEL_ERROR = 5—Error level and the system is malfunctioning
		Unique error code = Numeric number for the unique error code representing the descriptive message. Its primary use is for language translations.
		Message = English description of the message. The description is in English and should be typically less than 30 characters while maintaining readability.
LOG+ENAB	Enables or disables asynchronous log messages.	• 0 = Disable asynchronous log messages • 1 = Enables asynchronous log messages (Default)
LOG+LEVL	Sets the logging level. Only messages of said level (or below) are transmitted. For example, if the logging level is set to LOG_LEVEL_NOTICE, only logs of type LOG_LEVEL_NOTICE,	• 0 = LOG_LEVEL_TRACE—Something happens often but do not want to fill up the logs at debug level; do not use where command did not execute properly

Command	Description	Values
	LOG_LEVEL_WARNING and LOG_LEVEL_ERROR are transmitted.	• 1 = LOG_LEVEL_DEBUG—Items to track even though they executed properly; do not use where command did not execute properly • 2 = LOG_LEVEL_INFO—Displays information from the system; for example, version of software • 3 = LOG_LEVEL_NOTICE—Items returning to OK state; general operational logs; meaningful event or state change has occurred but is not a warning or an error • 4 = LOG_LEVEL_WARNING—Hardware exceeding warning levels; received a message that is not understood; message has been retired • 5 = LOG_LEVEL_ERROR—Hardware exceeding alarm levels; something caused the hardware to turn off; hardware not in expected state; wanted to do something but it did not happen

Examples

Log the engineering-type info level message from the light source:
`(LOG 1 000 002 0 "Light source turning ON")`
Log the operational-type info level message from the light source:
`(LOG 2 010 002 0 "Light source turning OFF")`
Log the maintenance-type debug level message from the light source:
`(LOG 4 020 001 0 "Light source hours reaching 1000 hours")]`

LSC–Light Source Control

Controls the light source.

Parameters

- **Access level:** Operational

Commands

Command	Description	Values
LSC+CALB <parm0> <parm1> <parm2>	Sends light source calibration information.	• parm0 = 0 to 26

Command	Description	Values
<parm3> <parm4> <parm5> <parm6> <parm7> <parm8> <parm9><parm10> <parm11>		• parm1 = Red drive level as a percentage • parm2 = Green drive level as a percentage • parm3 = Blue drive level as a percentage The following color sensor values are empty if no color sensor is connected to the light source: • parm4 = Red color sensor value • parm5 = Green color sensor value • parm6 = Blue color sensor value • parm7 = Light meter x color point • parm8 = Light meter y color point • parm9 = Light meter luminance (foot-lamberts) • parm10 = Additional calibration data • parm11 = Settling time in seconds for the calibration stage
LSC+CALB? <index>	Gets the light source calibration information of a specified index. This command is used by the projector to get the drive levels for the calibration.	• index = 0 to 26—See the values for the LCS+CALB command
LSC+CALP?	Returns the calibration parameter for the calibration set sent using the LSC+CALB command. On success in calculating the calibration parameter: Parm0 = Calibration parameter in escaped string format On failure in calculating the calibration parameter: Parm0 = "Failed"	—
LSC+CALP <parm0>	Sends the calibration data to the third-party light source. On receiving calibration parameter, light source can keep the LiteLOC™ it is calibrated to.	parm0= Calibration parameter in escaped string format
LSC+CALS?	Returns whether the calibration is started or not.	—
LSC+CALS <0 | 1>	Starts or stops the light source calibration.	• 0 = Stops light source calibration • 1 = Starts light source calibration

Command	Description	Values
LSC+CBEN?	Gets whether the LiteLOC is enabled or disabled.	—
LSC+CBEN <0 | 1>	Enables or disables the LiteLOC for diagnosing the light source. On disabling the LiteLOC, the light source is expected to be at the current RGB levels.	• 0 = Disables LiteLOC • 1 = Enables LiteLOC (Default)
LSC+ CDAT?	Returns any additional calibration data (such as laser temperatures) to be sent to the light source as part of calibration process using the `LSC+CALB` command. The data is returned in a single string. If no additional information is required, it sends an empty string.	—
LSC+CSTG?	Returns the calibration stage/sector information. This command returns the number of stages in each sector of calibration.	—
LSC+CSWP? <sector>	Returns the remaining warmup time in seconds for a calibration sector.	sector = Sector for which the warmup time should be returned
LSC+CSWP <sector>	Starts the warmup of a particular sector. The light source must set the required drive levels and control its fan speeds for proper warmup.	sector = Sector for which the warmup should be performed
LSC+DRVL?	Returns the minimum and maximum RGBW drive limits (Read-only): • Parm0 = Red minimum drive percentage • Parm1 = Green minimum drive percentage • Parm2 = Blue minimum drive percentage • Parm3 = Minimum brightness (white) percentage • Parm4 = Red maximum drive percentage • Parm5 = Green maximum drive percentage • Parm6 = Blue maximum drive percentage • Parm7 = Maximum brightness (white) percentage If the light source does not support the control of individual RGB laser drive levels,	—

Command	Description	Values
	return zero as the RGB minimum and maximum values. For system using a single white bar control (Deprecated). **Note:** Newer designs should respond with RGBW drive limits explained above. • Parm0 = Minimum brightness (white) percentage • Parm1 = Maximum brightness (white) percentage The minimum drive level is defined as the minimum recommended power at which the light source should be operated at. These values are not enforced by the user interface but give the end user an indicator the system may not behave the way it was intended, if the drive level is lower than this value. The minimum limits are usually based on the following: • Minimum power required for light source to start eliminating light. • At low powers, some lasers emit unwanted IR light until a certain power is exceeded. • The lowest light source power at which the required color can be maintained. The maximum drive level is the maximum power at which the light source can be operated at a given operating condition(s). In most cases a maximum limit of 100% is expected. The maximum limits are usually based on the following: • Ambient temperature • Humidity	
LSC+MAXB <parm0>	Sets the maximum brightness value of the projector during the light source calibration.	parm0= Maximum brightness value in foot-lamberts
LSC+MEAS?	Gets the color sensor values from the third-party light source. • parm0 = SX sensor value • parm1 = SX gain (0 to 7) • parm2 = SY sensor value • parm3 = SY gain (0 to 7)	—

Command	Description	Values
	• parm4 = SZ sensor value	
	• parm5 = SZ gain (0 to 7)	
	If no color sensor is available, this command is not sent to the third-party light source.	
	The projector queries the values from the third-party light source once every 2 seconds.	
	The color sensor and gain values represent an uncalibrated XYZ color coordinate with each value being scaled differently based on the projector optics. These color sensor values are relative values that are a function of brightness and wavelength.	
LSC+OVDR?	Returns whether the laser overdrive is enabled or disabled on the light source. Refer to projector product specification for more details on the laser overdrive function.	—
LSC+OVDR <0 | 1>	Enables or disables the laser overdrive on the light source.	• 0 =Disables the laser overdrive (Default) • 1 =Enables the laser overdrive
LSC+RGBP?	Gets the light source RGB drive levels as a percentage. (Read-only)	—
LSC+RGBP <parm0> <parm1> <parm2>	Sets the light source RGB drive levels as a percentage.	• parm0 = Red drive percentage • parm1 = Green drive percentage • parm2 = Blue drive percentage
LSC+WHTP?	Gets the light source set and actual brightness percentage and white point. (Read-only) Returns zero as the white point parameters, if the light source does not support the white point setting. • parm0 = Set brightness percentage • parm1 = Set white point x coordinate • parm2 = Set white point y coordinate • parm3 = Actual brightness percentage • parm4 = Actual white point x coordinate • parm5 = Actual white point y coordinate	—
LSC+WHTP <parm0> <parm1> <parm2>	Sets the light source brightness percentage and white point.	• parm0 = Brightness percentage • parm1 = White point x coordinate

Command	Description	Values
	The light source can ignore the white point parameters parm1 and parm2, if the light source does not support the white point setting.	• parm2 = White point y coordinate

Examples

Get the color sensor values from the light source:

`(LSC+MEAS?)`

Result:

`(LSC+MEAS!"0003283" 001 "0004106" 001 "0001641" 001)`

Set the maximum brightness value:

`(LSC+MAXB "26.53")`

Set the calibration data:

`(LSC+CALB 0 "90.00" "80.00" "80.00" "30000" "28000" "28000" "0.314" "0.351" "14.20" "23.5 36.2 27.8 35.4 25")`

Request calibration information for index 0:

`(LSC+CALB? 0)`

Result:

`(LSC+CALB!000 "90.00" "80.00" "80.00" "30000" "28000" "28000" "0.314" "0.351" "14.20" "23.5 36.2 27.8 35.4 25")`

Request the calibration stage/sector information:

`(LSC+CSTG?)`

Result:

`(LSC+CSTG!9 8 5)`

This means a total of three sectors. Sector 1, sector 2, sector 3 have nine, eight, and five calibration stages respectively.

Request the remaining warmup time for the calibration sector 2:

`(LSC+CSWP? 2)`

Result:

`(LSC+CSWP!1200)`

This means the remaining warmup time for sector 2 is 1200 seconds.

Starts the warmup of sector 2:

`(LSC+CSWP 2)`

Request calibration parameter for the set of calibration data sent to the light source:

`(LSC+CALP?)`

Result on a successful calibration:

Note: This is an example. The light source can send their own calibration parameter in the escaped string format.

`(LSC+CALP!"\"398.00000\" \"-543.00000\" \"40.00000\" \"0.00000\" \"906.00000\" \"2164.00000\" \"58.00000\" \"0.00000\" \"68.00000\" \"191.00000\" \"868.00000\"`

\"0.00000\" \"−134098.00000\" \"−177524.00000\" \"−29827.00000\" \"1.00000\" \"5063.28906\"") Result on a failed calibration: (LSC+CALP!"Failed")
Set calibration parameter to the light source: (LSC+CALP "\"398.00000\" \"−543.00000\" \"40.00000\" \"0.00000\" \"906.00000\" \"2164.00000\" \"58.00000\" \"0.00000\" \"68.00000\" \"191.00000\" \"868.00000\" \"0.00000\" \"−134098.00000\" \"−177524.00000\" \"−29827.00000\" \"1.00000\" \"5063.28906\"")
Set command to start calibration: (LSC+CALS 1)
Request the calibration status: (LSC+CALS?) Result: (LSC+CALS!001)
Request LiteLOC information: (LSC+CBEN?) Result when LiteLOC is enabled: (LSC+CBEN!1) Result when LiteLOC is disabled: (LSC+CBEN!0)
Enable LiteLOC: (LSC+CBEN 1)
Disable LiteLOC: (LSC+CBEN 0)
Return any additional calibration data to be sent back to the light source as part of the calibration process: (LSC+CDAT?) Result: (LSC+CDAT!"23.5 36.2 27.8 35.4 25")
Return the RGBW drive limits: (LSC+DRVL?) Result: (LSC+DRVL!"5.00" "5.00" "5.00" "30.00" "100.00" "100.00" "100.00" "100.00") If the light source does not support the control of individual RGB laser drive levels: (LSC+DRVL!"0.00" "0.00" "0.00" "5.00" "0.00" "0.00" "0.00" "95.00")
Request laser overdrive information: (LSC+OVDR?) Result when the laser overdrive is enabled: (LSC+OVDR!1) Result when the laser overdrive is disabled:

`(LSC+OVDR!0)`
Enable the laser overdrive: `(LSC+OVDR 1)`
Disable the laser overdrive: `(LSC+OVDR 0)`
Set RGB light source to red = 56.50%, green = 66.50%, blue = 67.50%:   `(LSC+RGBP "56.50" "66.50" "67.50")`
Set the light source target brightness and white point: `(LSC+WHTP"82.00" "0.313" "0.329")`

Return the brightness setting on a system that supports white point control:
 `(LSC+WHTP?)`
 Result:
 `(LSC+WHTP!"80.00" "0.313" "0.329" "79.35" "0.313" "0.329")`

Return the brightness setting on a system that does not support white point control:
 `(LSC+WHTP?)`
 Result:
 `(LSC+WHTP!"80.00" "0.000" "0.000" "80.00" "0.000" "0.000")`

PNG–Ping

Returns basic projector information to the user, including the type of device and main software version.

This command is used for two purposes:

- Determines if the third-party light source is communicating. Devices are polled at a predefined interval (usually 1s) until communications is established.
- Uses the device type to determine the protocol used to communicate to the device.

Parameters

- **Access level:** Status

Commands

Command	Description	Values
PNG?	Returns basic projector information (Read-only): • Device type • Major software version • Minor software version • Maintenance version	—

Command	Description	Values
	• Build number Valid devices: 63 = Third-party light source	

Examples

Send a ping: (PNG?) Result: (PNG!063 001 000 002 00234) Indicates this is a third-party light source (063) and the software version is: 1 major, 0 minor, 2 maintenance, 234 build.

PWR–Power

Changes the power state of the product.

Parameters

- **Power level (minimum):** Power Down
- **Access Level:** Operational

Commands

Command	Description	Values
PWR?	Returns the power state. The light source can be commanded into three basic power states: • 0 = Power Off—Indicates the projector light source is off and only minimal electronics are running. In this state it is expected that the third-party light source (TPLS) has entered into a low power operational mode, which preserves operational life of the TPLS components. For example, it turns off the diffuser/phosphor wheel motors as appropriate, reduces cooling to the minimum acceptable level for environmental conditions, and so on. • 1 = Power On—Indicates the projector power is on and the light source is on.	—

Command	Description	Values
	• 3 = Standby—Indicates the projector is in standby mode and ready to turn on the light source. In addition to the power commands, two interim feedback power states exist: • 10 = Cool Down—Indicates the light source is cooling down. If the light source does not need to cool down before shutting down, this state is skipped. • 11 = WarmUp—If the transition from the off state to the standby state takes longer than a second, the light source must indicate this by showing the power state as warmup.	
PWR <value>	Changes the power mode. When turning on the light source, note the following: • If the light source is already in standby, no visible delay occurs. • If the light source is powered off, the delay should not exceed the time it normally takes to go from power off to standby mode.	• 000 = Power off—minimal electronics are on, light source is off • 001 = Power on—turns the light source on • 003 = Standby—ready to turn on the light source at any point without delay
RED+ENBL?	Returns whether the red laser bank is enabled or disabled. (Read-only)	—
RED+ENBL <value>	Enables or disables the red laser bank. Only applies to RGB laser systems.	• 000 = Disables all the modules in the red laser bank • 001 = Enables all modules in the red laser bank
GRN+ENBL?	Returns whether the green laser bank is enabled or disabled. (Read-only)	—
GRN+ENBL <value>	Enables or disables the green laser bank. Only applies to RGB laser systems.	• 000 = Disables all the modules in the green laser bank • 001 = Enables all modules in the green laser bank
BLU+ENBL?	Returns whether the blue laser bank is enabled or disabled. (Read-only)	—
BLU+ENBL <value>	Enables or disables the blue laser bank. Only applies to RGB laser systems.	• 000 = Disables all the modules in the blue laser bank • 001 = Enables all modules in the blue laser bank

Examples

Request the power state:
`(PWR?)`
Result—the power is on for the device:
`(PWR!001)`
Request the power state:
`(PWR?)`
Result—the device is warming up:
`(PWR!011)`
Power off the device:
`(PWR 000)`
Turn on the light source:
`(PWR 001)`
Go to the standby state, ready to turn on the light source:
`(PWR 003)`
Enable all modules in the red laser bank:
`(RED+ENBL 001)`
Disable all modules in the green laser bank:
`(GRN+ENBL 001)`
Request the state of the blue laser bank:
`(BLU+ENBL?)`
Result—the blue laser bank is disabled (OFF):
`(BLU+ENBL!000)`
Request the state of the blue laser bank:
`(BLU+ENBL?)`
Result—the blue laser bank is enabled (ON):
`(BLU+ENBL!001)`

RGB–Color Management

Selects light setup profiles and provides feedback from the color sensor of the projector.

This command has been deprecated. See the *LSC–Light Source Control command* (on page 19).

Parameters

- **Access level:** Operational

Commands

Command	Description	Values
RGB+DRVL	Gets the RGB drive limits (DRVL) as a percentage (in 0.01% steps). (Read-only) where: • parm0 = Red minimum drive level as a percentage • parm1 = Green minimum drive level as a percentage • parm2 = Blue minimum drive level as a percentage • parm3 = Red maximum drive limit as a percentage • parm4 = Green maximum drive level as a percentage • parm5 = Blue maximum drive level as a percentage	—
RGB+PROF?	Requests the currently active third-party light source configuration profile.	—
RGB+PROF?L	Requests a list of available profiles.	—
RGB+PROF "\<profile>"	Selects a light source configuration profile.	profile = Name of the light source configuration file
RGB+MEAS \<parm0> \<parm1>\<parm2> \<parm3>\<parm4> \<parm5>	Sets the color sensor values and gains. These values represent an uncalibrated XYZ color coordinate with each value being scaled differently based on the projector optics. In addition, the color sensor values are relative values that are a function of brightness and wavelength. The values are transmitted from the projector to the third-party light source once every 0.5 seconds.	• parm0 = SX sensor value • parm1 = SX gain (0 to 7) • parm2 = SY sensor value • parm3 = SY gain (0 to 7) • parm4 = SZ sensor value • parm5 = SZ gain (0 to 7)
RGB+SETP?	Returns the RGB laser power as a percentage (in 0.01% steps). (Read-only)	—
RGB+SETP \<parm0> \<parm1> \<parm2>	Sets the RGB laser power as a percentage (in 0.01% steps).	• parm0 = Red drive level as a percentage • parm1 = Green drive level as a percentage • parm2 = Blue drive level as a percentage

Examples

Select a configuration profile on the third-party light source: `(RGB+PROF "14fRect709")`
Request the currently active third-party light source configuration profile: `(RGB+PROF?)`

Result:
`(RGB+PROF! "14fRect709")`

Request a list of available profiles:
`(RGB+PROF?L)`
Result:
`(RGB+PROF!000 "14fRect709")`
`(RGB+PROF!001 "12fRect709")`
`(RGB+PROF!002 "21fRect709")`
`(RGB+PROF!"--END--")`

Set the color sensor values and gains:
`(RGB+MEAS 0003283 001 0004106 001 0001641 001)`

Set the RGB laser power:
`(RGB+SETP "80.00" "95.50" "40.10")`

Request the RGB drive limits:
`(RGB+DRVL?)`
Result:
`(RGB+DRVL! "5.00" "5.00" "5.00" "100.00" "100.00" "100.00")`

SST–System Status

Retrieves the various system status groups. Returns status information about the projector in read-only mode.

The SST command returns the following information:

`(SST+VERS!Index Status "Value" "Description")`

When the response to a SST request includes multiple items, the response is terminated with –END– indicator. For example, if the entire SST in requested using `(SST?)`, the last item to be transmitted is `(SST!"--END--")`. If requesting an entire subcode, such as `(SST+VERS?)`, the last item to be transmitted is `(SST+VERS!"--END--")`.

The System Status command is broken up into various subcodes. Each subcode has an index starting at 0 and increments for each item within that subcode. Following the index is a status state indicating the health of the item.

Parameter	Description
+	Indicates a subcode follows.
!	Indicates a reply message.
Index	Returns the index of the subcode, starting at 0 and incrementing for each item in the subcode.
Status	Returns the status state in numerical form. 0 = OK—Normal operation possible 1 = Warning—Operation is possible but may be approaching a limit or is operating a de-rated state 2 = Alarm—Operation is not possible

Parameter	Description
Value	Returns a description of the status state that can be either text or numerical. The value is also returned within quotation marks. For example, "20.3" or "On".
Description	Provides a brief description (30 characters or less) of the status item.

Parameters

- **Access level:** Status

Commands

Command	Description	Values
SST?	Returns all status items. (Read-only)	—
SST+CONF?	Returns the status of all status items in the Configuration subcode.	—
SST+CONF?n	Returns the status of the specified status item in the Configuration subcode.	n = Numerical value representing a status item in the CONF subcode and increments for each item in the subcode 0 = First status item
SST+DIAG?	Returns the status of all the status items in the diagnostics information subcode.	—
SST+DIAG?n	Returns the status of the specified status item in the diagnostics number information subcode.	n = Numerical value representing a status item in the DIAG subcode and increments for each item in the subcode 0 = First status item
SST+HLTX?	Returns the status of all status items in the Health Information subcode.	—
SST+HLTX?n	Returns the status of the specified status item in the Health Information subcode.	n = Numerical value representing a status item in the HLTX subcode and increments for each item in the subcode 0 = First status item
SST+MFGR?	Returns the status of all the status items in the Manufacturing Information subcode.	—
SST+MFGR?n	Returns the status of the specified status item in the Manufacturing Information subcode.	n = Numerical value representing a status item in the MFGR subcode and increments for each item in the subcode 0 = First status item
SST+SERS?	Returns the status of all the status items of the Serial Information subcode.	—
SST+SERS?n	Returns the status of the specified status item in the Serial Information subcode.	n = Numerical value representing a status item in the VERS subcode and increments for each item in the subcode 0 = First status item

Command	Description	Values
SST+VERS?	Returns the status of all the status items of the Versions Information subcode.	—
SST+VERS?n	Returns the status of the specified status item in the Versions Information subcode.	n = Numerical value representing a status item in the VERS subcode and increments for each item in the subcode 0 = First status item

Examples

Return the configuration information:

```
(SST+CONF?)
```

Result:

```
(SST+CONF!000 002 "Brightness and white point" "Brightness Control")
(SST+CONF!001 000 "9" "Number of calibration points")
(SST+CONF!002 001 "Yes" "Color Sensor Present")
(SST+CONF!"—-END-—")
```

Return the diagnostic information:

```
(SST+DIAG?)
```

Result:

```
(SST+DIAG!000 000 "111.9" "Light On Hours")
(SST+DIAG!001 001 "32.4C" "Coolant temperature")
...
(SST+DIAG!"—-END-—")
```

Return the basic health information:

```
(SST+HLTX?)
```

Result:

```
(SST+HLTX!000 000 "Standby" "Power State")
(SST+HLTX!001 001 "Warning" "Overall Health")
(SST+HLTX!002 000 "OK" "Interlocks")
...
(SST+HLTX!"—-END-—")
```

Return the basic manufacturing information:

```
(SST+MFGR?)
```

Result:

```
(SST+MFGR!000 000 "Company TPLS Inc." "Manufacturer")
(SST+MFGR!001 000 "L220R." "Model")
(SST+MFGR!002 000 "1234567890" "Serial Number")
(SST+MFGR!003 000 "2017/01/01 14:26:00" "Build Date")
(SST+MFGR!"—-END-—")
```

Return the serial number information:

```
(SST+SERS?)
```
Result:
```
(SST+SERS!000 000 "SN123456" "Main Board")
(SST+SERS!001 000 "AB9876542" "Fan Control Board")
...
(SST+SERS!009 000 "XY1234567" "Some Board Serial No")
(SST+SERS!"—-END-—")
```

Return the basic version information:
```
(SST+VERS?)
```
Result:
```
(SST+VERS!000 000 "1.0.0.0" "Software Version")
(SST+VERS!001 000 "2.3.0.1" "Hardware Version")
...
(SST+VERS!009 000 "1.0.0.0" "Some Board Version")
(SST+VERS!"—-END-—")
```

Status items responses

Learn about the available responses from the SST–Status System subcodes.

CONF–Configuration Information subcode

Index	Codes	Values	Description	Notes
000	000 001 002	RGB only Brightness only Brightness and white point	Brightness Control	Indicates the type of brightness control available on the light source.
001	000	Count	Number of calibration points	Indicates the number of calibration points used to calibrate the light source.
002	000 001	No Yes	Color Sensor Present	Indicates whether the light source has a color sensor.

DIAG–Diagnostics Information subcode

The Diagnostics Information subcode allows the third-party light source to provide specific information that can help in diagnosing light source issues. A maximum of 75 items are allowed in this category. Any warnings or critical alarms should be reflected in the overall health status item in the SST+HLTX category.

Index	Codes	Values	Description	Notes
000 ... 049	000 001 002	Text	Text	Indicates the diagnostic information of the third-party light source, for example:

Index	Codes	Values	Description	Notes
				`(SST+DIAG!000 000 "111.9" "Light On Hours")`
				The codes represent the following:
				000 = OK state
				001 = Warning alarm
				002 = Critical alarm

HLTX–Health Information subcode

The health information subcode allows the third-party light source to provide the health information. There can be a total of 30 health items, out of which first eight are mandatory items (except for the deprecated one) and the next three items are placeholders.

Index	Codes	Values	Description	Notes
000	000 001 003 010 011	Off On Standby Cool Down Warm Up	Power State	Indicates the power state of the third-party light source.
001	000 001 002	OK Warning Critical	Overall Health	Indicates the health for the third-party light source at a high-level. The state changes when the light source wants to direct someone to look at the third-party light source for diagnostic purposes. The projector produces a warning on the screen when that status is not OK.
002	000 001	OK Critical	Interlocks	Indicates when an interlocked has been tripped.
003	000 001 002	OK Brightness Not Reachable Color Not Reachable	LiteLOC	Informs the operator of a LiteLOC™ issue at a high level with the third-party light source. If the light source cannot achieve the brightness or color point requested, this item should denote the corresponding value and the LiteLOC Condition item (SST+HLTX 007) below should explain why it is not reachable.
004	000	Text	Active Profile	**Deprecated**—Contains the name of the active light source configuration profile.

005	000
	001
	002
	003
		OK
		Warning
		Critical
		N/A
			Chiller State	Indicates the high-level state of the third-party light source chiller. If the light source does not have a chiller, the value must be N/A with code 003.
				If a chiller is not present:
				`(SST+HLTX!005 003 "N/A" "Chiller State")`
				If a chiller is present and in critical state:
				`(SST+HLTX!005 002 "Critical" "Chiller State")`

Index	Codes	Values	Description	Notes
006	000 001	Not Armed Armed	Armed State	Indicates the system is ready for the light source to be turned on. This status should be set to Armed for projector to turn on the light source and projector turns off the light source if this status goes to Not Armed.

007	000	Text	LiteLOC Condition	Indicates the reason for the LiteLOC failure. This status should report OK if the LiteLOC is in OK state.
				If the LiteLOC is OK:
				`(SST+HLTX!007000 "OK" "LiteLOC Condition")`
				If the LiteLOC failed (example):
				`(SST+HLTX!007000 "Ambient Temperature Too High" "LiteLOC Condition")`

008 009 010	—	—	—	Reserved items
011 ... 029	000 001 002	Text	Text	Up to an additional 19 health status items can be defined by the light source. For example: `(SST+HLTX!013 000 "OK" "Cross Plug Detect")` The codes represent the following: 000 = OK state 001 = Warning alarm 002 = Critical alarm

MFGR–Manufacturer Information subcode

Index	Codes	Values	Description	Notes
000	000	Text	Manufacturer	Indicates the manufacturer name of the third-party light source.
001	000	Text	Model	Indicates the manufacturer model of the third-party light source.
002	000	Text	Serial Number	Indicates the serial number of the third-party light source module.
003	000	Text	Build Date	Indicates the build date of the third-party light source.

SERS–Serial Information subcode

The Serial information subcode allows the third-party light source to provide up to 10 different version values and descriptive names to be displayed in the projector status. Only send the serial numbers available in the system.

Index	Codes	Values	Description	Notes
000 001	000	Text	Text	Provides the serial number and name, for example: `(SST+SERS!000 000 "SN123456" "Main Board")`

Index	Codes	Values	Description	Notes
... 009				

VERS–Version Information subcode

The Version Information subcode allows the third-party light source to provide up to 10 different version values and descriptive names to be displayed in the projector status. The first version item is mandatory and should report the software version of the light source control software.

Index	Codes	Values	Description	Notes
000	000 001	Text	Software version	Provides the software version number with major, minor, bugfix number and build number. For example: `(SST+VERS!000 000 "1.0.0.0" "Software Version")` The codes represent the following: 000 = OK state 001 = Warning alarm
001 ... 009	000 001	Text	Text	Provides the version number and name. For example: `(SST+VERS!001 000 "2.3.0.1" "Hardware Version")` The codes represent the following: 000 = OK state 001 = Warning alarm

THM–Thermal Control

Commands are used to send and get thermal information from the light source.

Parameters

- **Access level:** Operational

Commands

Command	Description	Values
THM+AMBI?	Light source can query the projector to get the ambient temperature. The ambient temperature response is in Celsius, represented in a string format.	—
THM+HMDT?	Light source can query the projector to get the humidity percentage. The humidity response is in a percentage, represented in a string format.	—

Command	Description	Values
THM+MAXA?	Projector queries the light source to get the maximum expected ambient temperature at which the light source can maintain the requested brightness and white point. The maximum expected ambient temperature response is in Celsius, represented in a string format.	—
THM+PERF?	Returns whether the performance mode is enabled or disabled on the light source. Refer to projector product specification for more details on the performance mode.	—
THM+PERF <0 | 1>	Enables or disables the performance mode.	• 0 = Disables the performance mode (Default) • 1 = Enables the performance mode

Examples

Light source gets the ambient temperature from projector:

`(THM+AMBI?)`

Result:

`(THM+AMBI!"25.5")`

Light source gets the ambient humidity from projector which has a humidity sensor:

`(THM+HMDT?)`

Result:

`(THM+HMDT!"43.6")`

Light source gets the ambient humidity from projector which does not have a humidity sensor:

`(THM+HMDT?)`

Result:

`(THM+HMDT!"")`

Projector requests the maximum expected ambient temperature from the light source:

`(THM+MAXA?)`

Result:

`(THM+MAXA!"33.6")`

Request the performance mode information:

`(THM+PERF?)`

Result when the performance mode is enabled:

`(THM+PERF!1)`

Result when the performance mode is disabled:

`(THM+PERF!0)`

Enable the performance mode:

```
(THM+PERF 1)
```

Disable the performance mode:
`(THM+PERF 0)`

TIM–Time Information

Provides the current time on the projector so the third-party light source can synchronize its time to the projector.

The projector transmits a time update every 60 seconds.

Parameters

- **Access level:** Operational

Commands

Command	Description	Values
TIM	Specifies in a hexadecimal (hex) value, the date and time in number of seconds that have passed since 1970-01-01 00:00:00, in coordinated universal time (UTC). Parm0 = "0xFFFFFFFF" FFFFFFFF – Hex number of seconds since 1970-01-01 00:00:00 with leading zero (00000000 to FFFFFFFF)	—

Examples

Send the time information from the projector to the third-party light source:
`(TIM "0x5BF2F8D8")`
Where5BF2F8D8 is the hex value in seconds since 1970-01-01 00:00:00 and translates to 11-19-2022 5:54:32 PM UTC.
Result:
`(TIM!"0x5BF2F8D8")`
Indicates the time `0x5BF2F8D8` is received.
Have the third-party light source check the current date and time:
`(TIM?)`
Result:
`(TIM"0x5BF2F8D8")`
Where `5BF2F8D8` is the hex value in seconds since 1970-01-01 00:00:00 and translates to 11-19-2022 5:54:32 PM UTC.

UID–User ID

Logs into the device.

The third-party light source must have a single login account, which is used by the projector.

Parameters

- **Access level:** Status

Commands

Command	Description	Values
UID ?	Returns the username of the user currently logged in to the light source.	—
UID "<username>" "<password>"	Logs into the light source using the specified username and password.	username = String value password = String value

Examples

Request the currently logged in username:

`(UID?)`

Result:

`(UID!"operational")`

Indicates the username `operational` is logged in.

Request the currently logged in username:

`(UID?)`

Result:

`(UID!"")`

Indicates no users are logged in.

Log in as operational:

`(UID "operational" "<password>")`

Result:

`(UID!"operational")`

Indicates the username `operational` is logged in.

Log in as factory (`factory` user can perform all the operations that the `operational` user does):

`(UID "factory" "<password>")`

Result:

`(UID!"factory")`

Indicates the username `factory` is logged in.

Communication sequences

Communication sequences are a series of actions and reactions between the projector, third-party light source controller, and light modules.

Initial connection sequence

This sequence details the workflow for initially connecting to the third-party light source.

Initial connection sequence starts after providing power to the third-party light source

Projector → Third-party light source controller

- Connect Socket
- Time Out
- Connect Socket
- Connection Accepted
- (PNG?)
- 60 second timeout
- (PNG?) - Retry
- (PNG - Response)
- (UID - Login)
- (UID - Acknowledge)
- (TIM- Time)
- (TIM - Acknowledge)
- (SST?)
- (SST) - Full Response
- (LSC+DRVL?)
- (LSC+DRVL Response)
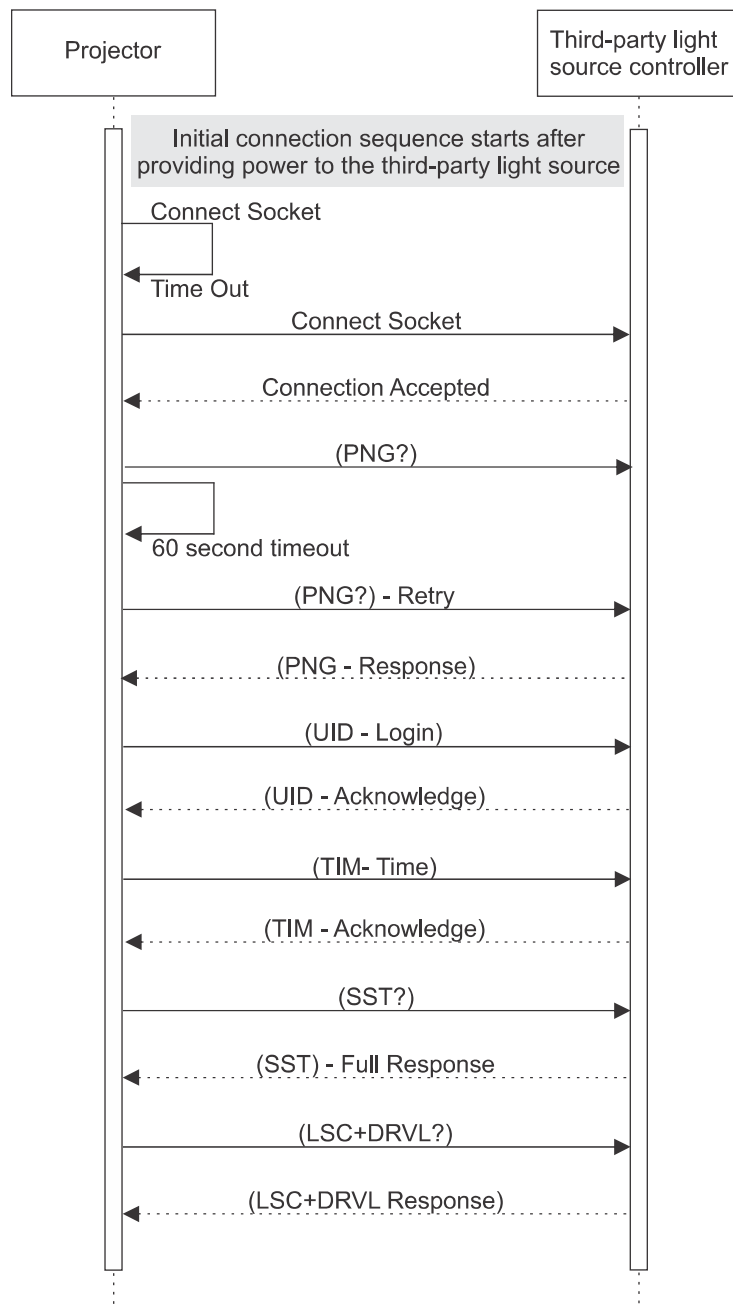
1. The projector starts the connection sequence once power is provided to the third-party light source.

2. The projector opens a connection to the third-party light source.

3. Once a connection is established, the projector issues a PNG request.

   This request verifies the projector is connecting to the third-party light source and gathers details on the version.

4. Once the projector has confirmed the device is a third-party light source, the projector logs into it using the UID command.

5. The third-party light source acknowledges the receipt of the UID command with an acknowledge response.

   All commands that do not have response data, require acknowledge of receipt.

6. Following the login, the projector sends the time information using the TIM command.

7. The projector sends a full SST request.

   This populates the projector with the third-party light source full status.

Power off > standby > power on sequence

This sequence details the workflow for changing the power states of the third-party light source.

Projector		Third-party light source controller

←AC Power Recycle

TPLS 12 V input on ⟶

If the user requests the light on directly from the Projector Off state, the projector follows the Power On sequence and then the Light On sequence automatically.

TPLS AC input on ⟶

Initial connection sequence as defined in the API guide ⟶

Projector software waits until the connection is established with the TPLS system.

Power Off (PWR 0) ⟶

⟵ (FYI 001 000 "Power Off")

←User requests projector power on

Power Standby (PWR 3) ⟶

⟵ (FYI 001 011 "Power WarmUp")

⟵ (FYI 001 003 "Power Standby")

If TPLS does not reach Power Standby within two minutes, the projector displays an error and sends the (PWR 3) again. This process continues until the TPLS reaches the Standby state or a Power Off request is issued.

Checks if the TPLS interlock status is OK

Armed line Asserted ⟶

When the Arm line (Lamp_EN_Z) is asserted, the TPLS is ready to turn on the light.

⟵ (SST+HLTX!006 001 "Armed" "Armed State")

⟵ User requests light on

Checks if the interlock status is OK

Checks if the Armed state is armed

The light on fails if the interlock state is *Critical* or the Armed state is *Not Armed*.

Power On (PWR 1) ⟶

Wait for the TPLS to go into Power On mode

The light on fails if the TPLS did not go into the Power On state within five seconds. This is expected to be instantaneous as the TPLS is already in the Armed state.

The projector turns off the light source under the following TPLS conditions:
* The interlock state goes into Critical.
* The armed state goes into Not Armed.
* The TPLS power state reports any state other than on.

⟵ (FYI 001 001 "Power On")

1. The projector and third-party light source are in a power off state after an AC recycle.

2. The third-party light source 12V input is provided to the third-party light source.

3. The third-party light source AC input is turned on.

4. The projector initiates the connection with the third-party light source following the initial connection sequence as defined in this document.

5. The projector software will wait until the connection is established with the third-party light source system.

6. The projector issues a power off `(PWR 0)` request to the third-party light source, which puts the third-party light source in to its power off state.

7. The third-party light source acknowledges the power state change request by echoing the command it received.

8. The user requests the projector to power on.

9. The projector issues a power standby `(PWR 3)` request, which puts the third-party light source in to its standby state.

10. The third-party light source acknowledges the power state change request by echoing the command it received.

11. Within a maximum of two seconds of issuing the standby request, the third-party light source responds with a `Power Warmup FYI` message indicating the light source is warming up.

12. Once the light source has warmed up and reached standby mode, it issues a FYI Power Standby message to the projector.

    The transition of the third-party light source power off state to standby state should not take more than 30 seconds.

13. If the third-party light source does not reach the power standby state within two minutes, the projector displays an error status and send the standby request again.

    This process continues until the third-party light source reaches the standby state or a power off request is issued.

14. After the third-party light source achieves the standby state, the projector asserts the Arm Line when the third-party light source interlock status is OK.

15. At some point when the user requests the light on, a Power On request is sent to the third-party light source if the interlock status is OK and armed state is *Armed*.

    The third-party light source is expected to turn on within three seconds and illuminate the light source.

16. The third-party light source acknowledges the power state change request by echoing the command it received.

17. An FYI Power On message is transmitted within three seconds of the Power On request.

18. The projector turns off the light source under the following third-party light source conditions:

    - The interlock state goes into *Critical*.
    - The armed state goes into *Not Armed*.
    - The third-party light source power state status reports any state other than *On*.

Power on > standby > power off sequence

This sequence details the workflow for powering off the third-party light source.
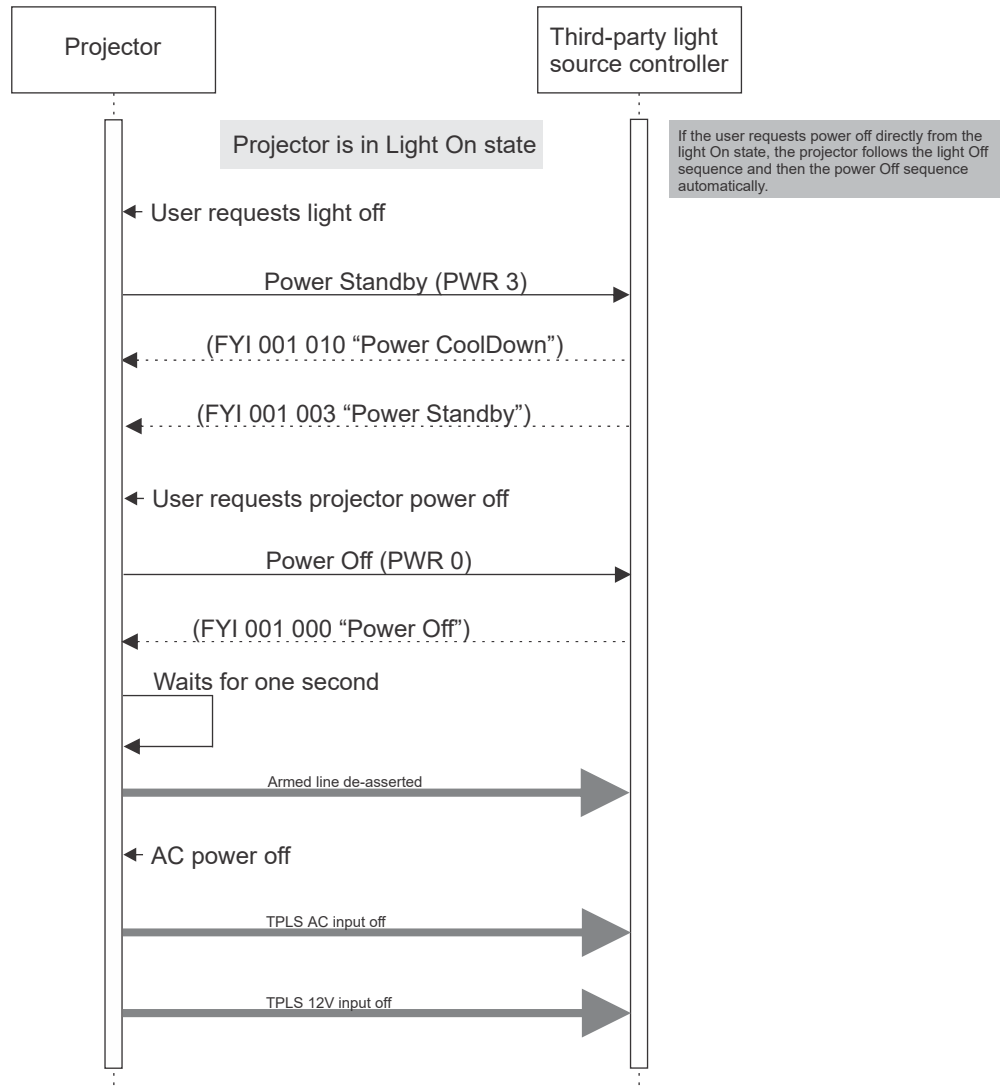
1. The projector and third-party light source are in a power on state with light active on the screen.

2. The user requests a projector light off and the projector issues a power standby request and puts the third-party light source in to its cool down state.

3. The third-party light source acknowledges the power state change by echoing the command.

4. Within a maximum of two seconds of issuing the standby request, the third-party light source responds with a `Power Cool Down FYI` message indicating the light source is cooling down.

5. Once the light source has cooled down and entered its standby state, the third-party light source transmits the `Standby FYI` message to the projector.

6. At some point when the user requests the projector power off, a Power Off request is sent to the third-party light source.

7. After one second the projector de-asserts the arm line.

8. When the user turns off the AC power, the AC input and the 12V to the third-party light source are turned off.

Power off > power on > cancel sequence

This sequence details the workflow for canceling the power off request.

State changes can occur at any point in time. The light source must be able to handle these cases by transitioning to the required state. In this example, the power is turned off but before the system reaches its power off state, a request is sent to turn the power to turn on again. However, this sequence is an example. Depending on the third-party light source supplier, the light source may be able to directly return to power on.
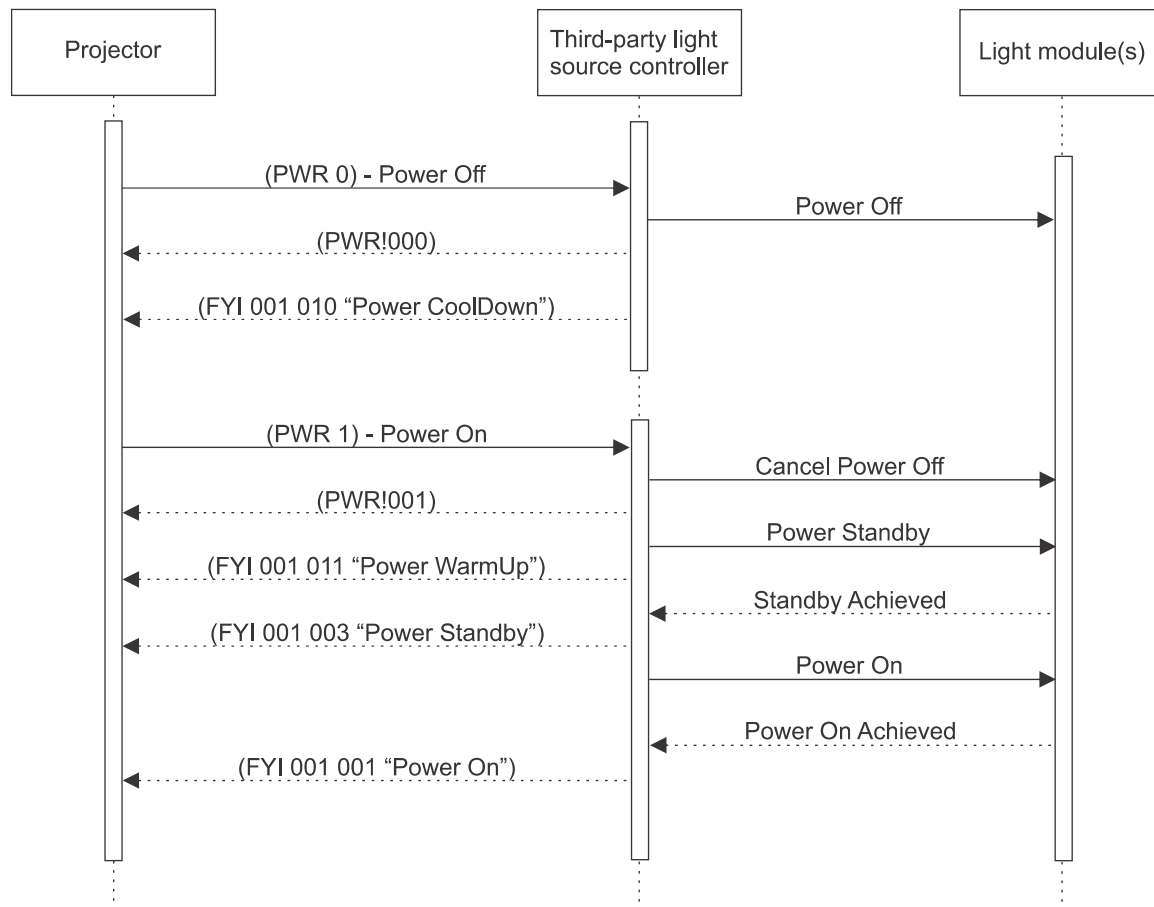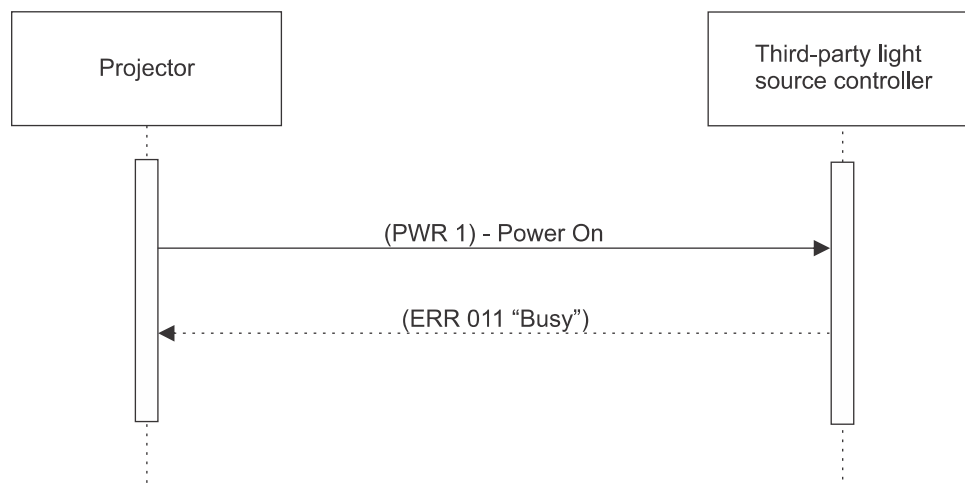

1. The projector and third-party light source are in a power on state with light active on the screen.

2. The projector issues a power off request, which immediately turns off the light source and puts the third-party light source in to its cool down state.

   This may take some time.

3. The third-party light source acknowledges the power state change by echoing the command.

4. Before the third-party light source reaches its power off state, the projector issues a power on request.

5. The third-party light source acknowledges the power state change by echoing the command.

6. The third-party light source cancels its power off operation and issues a standby request (or power on request).

7. The third-party light source transitions through all the states it requires to reach the power on state.

8. In each state transition the third-party light source provides an FYI of the state it is passing through on its way to power on.

Reject commands sequence

The third-party light source can reject requests due to safety interlocks or other restrictions. In these cases the commands respond with an ERR response indicating the third-party light source is busy and not ready to perform the action.

Profile list changed sequence

The third-party light source must inform the projector when the light source profiles have changed.

This has been deprecated. See the *LSC–Light Source Control command* (on page 19).
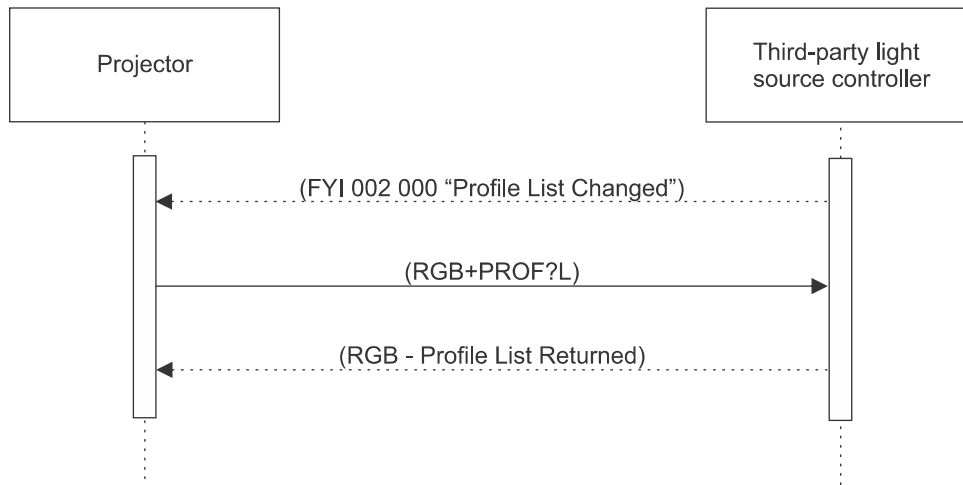
1. A light source profile is updated or configured on the third-party light source.

2. Once saved, the third-party light source issues a FYI informing the projector of the profile change.

3. The projector issues a request for a list of all available profiles and updates its cache of information.

Light source calibration sequence

This sequence details the workflow for light source calibration.
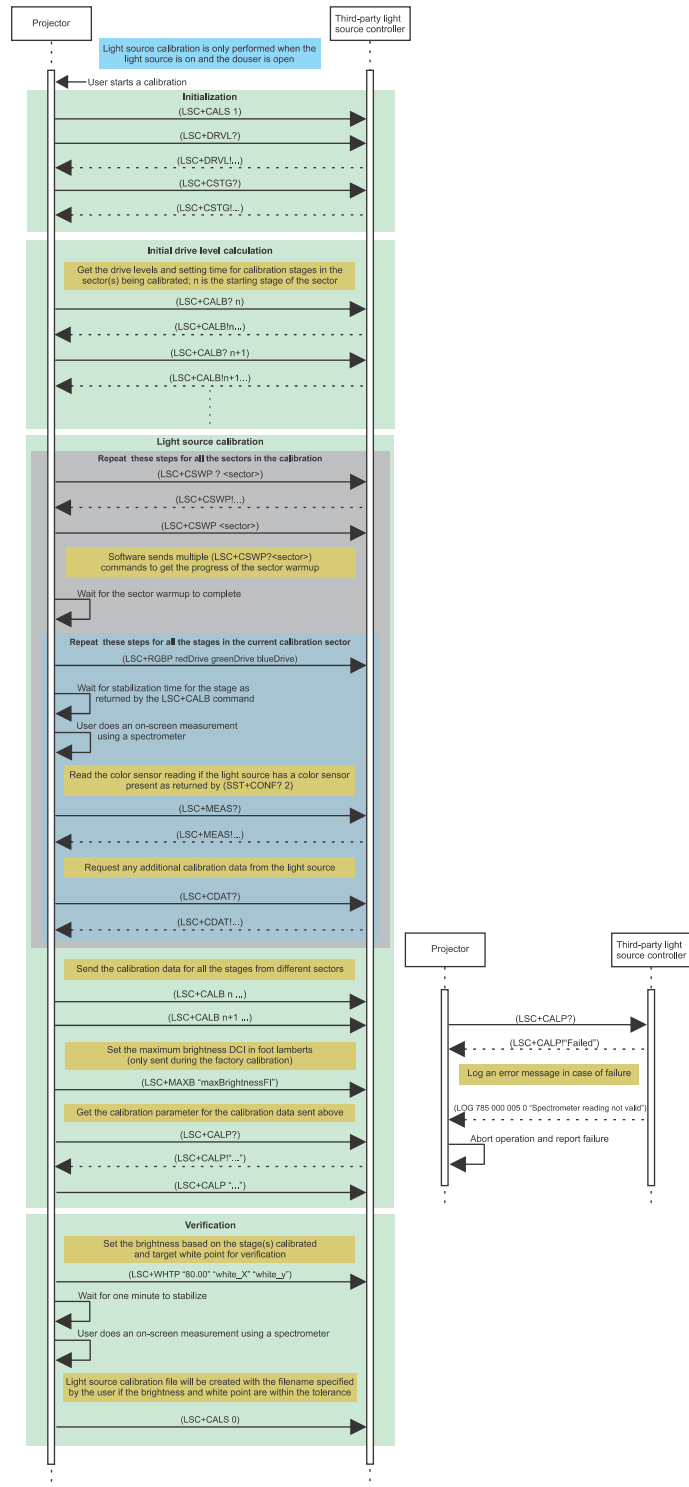
1. The projector informs the light source that the calibration has started by sending `(LSC+CALS 1)`.

2. Get the maximum and minimum RGB drive levels possible from the light source using the `(LSC+DRVL?)` command.

3. Get the calibration stage/sector information from the light source using the `(LSC+CSTG?)` command.

4. Get the calibration drive levels and settling time for each calibration point by sending the `(LSC+CALB? <index>)` command.

   The calibration user interface displays these drive levels on entering the user interface page.

5. Perform the steps below for each calibration sector:

   a) Get the warmup time for the sector using the `(LSC+CSWP? <sector>)` command.

   b) The light source starts the warmup for calibrating that sector on receiving the `(LSC+CSWP <sector>)` command.

      The light source must set the required drive levels and control its fan speeds for proper warmup.

   c) The projector software waits and checks if the warm-up is complete by sending the `(LSC+CSWP? <sector>)` command multiple times to update the progress.

      The software only waits for the maximum warmup time as returned in step 5a.

   d) Proceed with the calibration as defined in step 6 below.

6. Perform the calibration steps below for each calibration stage in the sector:
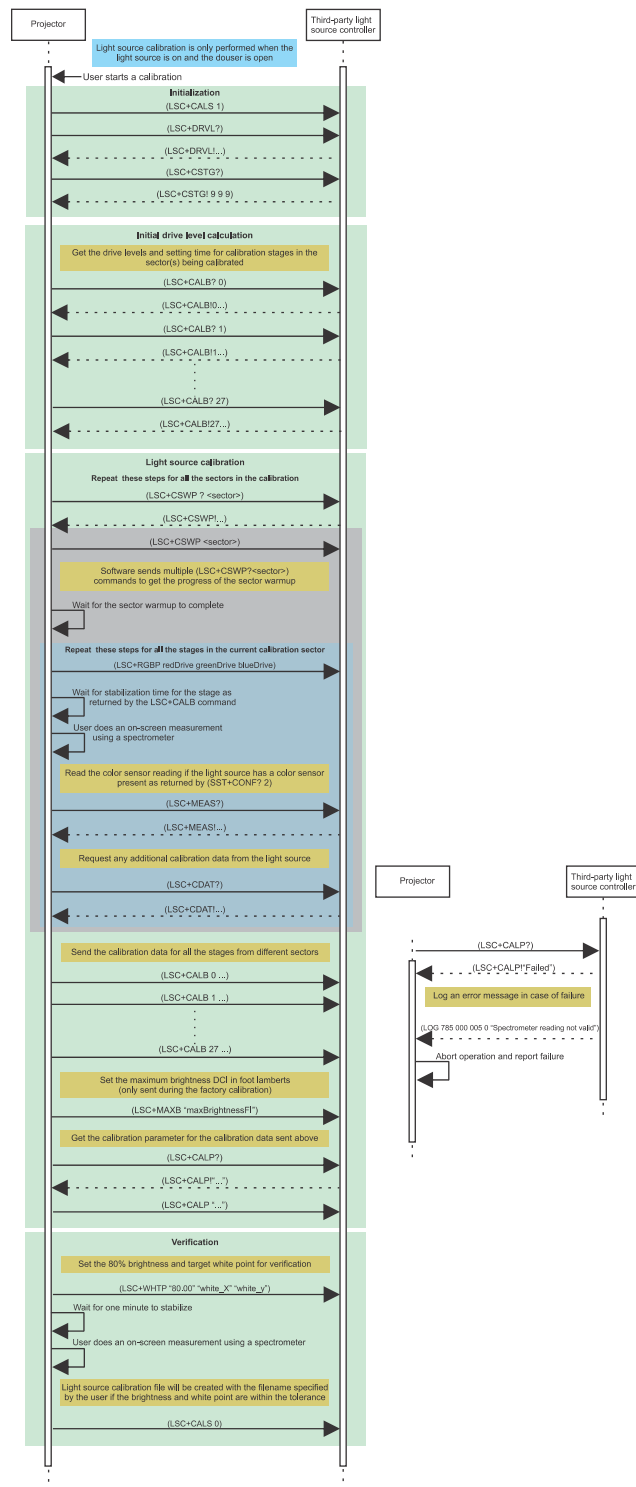
   a) Set the RGB drive levels.

   b) Wait for the stabilization time for the stage as returned by the `LSC+CALB` command.

   c) Do an on-screen measurement using a Spectrometer.

   d) If color sensor is present, read the color sensor information from the light source using the command `(LSC+MEAS?)`.

   e) The readings is updated in the user interface.

7. Repeat steps 5 and 6 to perform the calibration of all the requested sectors.

8. After getting the readings for all the calibration points and selecting **Save** in the user interface:

   a) Send the calibration points one after the other to the light source using the `(LSC+CALB)` command.

   b) If doing the factory calibration, set the maximum DCI brightness of the projector in foot lamberts using the `(LSC+MAXB)` command.

   c) Read the calibration parameter for the n set of calibration points using the `(LSC+CALP?)` command.

   d) If `LSC+CALP` returns success, save the parameter into the calibration file with the n sets of calibration points.

   e) If `LSC+CALP` returns failure, let the user know the save failed.

      The light source should send a log message to the projector denoting why it failed.

9. Perform the verification of the calibration.

   a) Set the brightness based on the sector(s) calibrated and target white point.

   b) Wait for one minute for stabilization.

   c) Do an on-screen measurement using a Spectrometer.

d) If the brightness and white point are within the tolerance, the light source calibration file is created with the filename specified by the user.

e) If the brightness and white point are not within the tolerance, the calibration is marked as failed.

10. Inform the light source the calibration has stopped by sending `(LSC+CALS 0)`.

11. On activating a calibration file, the projector sends the calibration parameter to the light source using the `(LSC+CALP)` command.

12. On aborting the calibration anytime, the projector sends `(LSC+CALS 0)` to the light source.

Example sequence calibrating all the sectors together:

Projector   Third-party light source controller

Light source calibration is only performed when the light source is on and the douser is open

User starts a calibration

Initialization
(LSC+CALS 1)
(LSC+DRVL?)
(LSC+DRVL!...)
(LSC+CSTG?)
(LSC+CSTG! 9 9 9)

Initial drive level calculation
Get the drive levels and setting time for calibration stages in the sector(s) being calibrated
(LSC+CALB? 0)
(LSC+CALB!0...)
(LSC+CALB? 1)
(LSC+CALB!1...)
⋮
(LSC+CALB? 27)
(LSC+CALB!27...)

Light source calibration
Repeat these steps for all the sectors in the calibration
(LSC+CSWP ? <sector>)
(LSC+CSWP!...)
(LSC+CSWP <sector>)
Software sends multiple (LSC+CSWP?<sector>) commands to get the progress of the sector warmup
Wait for the sector warmup to complete

Repeat these steps for all the stages in the current calibration sector
(LSC+RGBP redDrive greenDrive blueDrive)
Wait for stabilization time for the stage as returned by the LSC+CALB command
User does an on-screen measurement using a spectrometer
Read the color sensor reading if the light source has a color sensor present as returned by (SST+CONF? 2)
(LSC+MEAS?)
(LSC+MEAS!...)
Request any additional calibration data from the light source
(LSC+CDAT?)
(LSC+CDAT!...)

Send the calibration data for all the stages from different sectors
(LSC+CALB 0 ...)
(LSC+CALB 1 ...)
⋮
(LSC+CALB 27 ...)
Set the maximum brightness DCI in foot lamberts (only sent during the factory calibration)
(LSC+MAXB "maxBrightnessFl")
Get the calibration parameter for the calibration data sent above
(LSC+CALP?)
(LSC+CALP!"...")
(LSC+CALP "...")

Verification
Set the 80% brightness and target white point for verification
(LSC+WHTP "80.00" "white_X" "white_y")
Wait for one minute to stabilize
User does an on-screen measurement using a spectrometer
Light source calibration file will be created with the filename specified by the user if the brightness and white point are within the tolerance
(LSC+CALS 0)

Projector   Third-party light source controller
(LSC+CALP?)
(LSC+CALP!"Failed")
Log an error message in case of failure
(LOG 785 000 005 0 "Spectrometer reading not valid")
Abort operation and report failure

Example sequence for calibrating only the sector 2: