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Light Sequence Switch

LSS-2404

User's Manual



www.ccsamerica.com

www.computationalimaging.com

Version 2.0E

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Introduction

Getting Started

This user manual describes the set up and basic operation of the LSS-2404 lighting controller, as well as the corresponding configuration software. Before using it, please read the manual carefully to ensure proper use. After reading the manual keep it in an easily accessible location for future reference.

Read Safety and Specifications and check that the LSS-2404 controller fulfills your requirements.

An LSS quick start set up guide is available on pg. 19 once wiring and mounting is completed. This manual is specific to the computational imaging technique photometric stereo. If you need instructions for other techniques contact CCS America, Inc.

This manual was published for firmware version FW1_10_11. When firmware updates are available release notes will be included for further information.

Features

The LSS has ethernet capabilities and 4 channel outputs. Each output can control a segment of a 4-segment light or an independent light.

Included Components

One LSS controller and one instruction card are included in the package. The Instruction Card contains a link to download the latest software, manual and other resources for the LSS-2404. Make sure everything is in place before proceeding.

Required Components

To correctly set up the LSS you will need the following items:

- LSS Controller
- LSS Web based software
    - The LSS software can be accessed by the link below
        - http://bit.ly/LSSCI
    - Note: the LSS software only works with a Firefox browser (version 56 or above) or Microsoft Edge
- Compatible Lights (e.g. segmented ring light or bar light sets) and corresponding cables
- Compatible Cameras and software

Optional Accessories

An assortment of extension cables, break out cables, and mounting brackets can be purchased to accommodate various installation requirements and any CCS lights. More information is available on pg. 8.

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Safety Precautions

Read this section before using the LSS-2404. Always observe the following safety precautions. If in doubt, contact CCS America, Inc. The following symbols are used in this guide:



Warning: Read the instructions to understand the possible hazards.



Warning: Surface may get hot.



Warning: Possible hazardous voltage.

Refer to the text in this section for precautions you should take whenever the above symbols appear in this guide.

Heat



Ensure that the LSS-2404 is mounted correctly (see Mounting the LSS-2404), and that you do not exceed any of the ratings for the unit (see Specifications and Ratings).
At its maximum ratings, the LSS-2404's enclosure cannot exceed 50 °C, which is sufficient to cause a burn if touched.
Place the unit in a position where personnel cannot accidentally touch it and ensure there is a free flow of air around the unit.

Electrical



The LSS-2404 produces high energy pulses.
Take care to connect the outputs correctly and protect the output wiring and load from any short-circuits.
When switched off, energy may remain stored in the 2404 for a few seconds. Use caution with connections immediately after shut down.
The 2404 does not have complete tracking isolation of input and output. Transients caused by inductive loads must be suppressed externally to the 2404.
The LSS-2404 is a Class B device intended for industrial or commercial applications, even though it does conform within Class A emission limits which are stricter for residential use. If any unwanted interference does occur, cable shielding, grounding, and the product installation should be reviewed by the user to restrict emissions to a level that prevents interference with broadcast transmissions.

General



The LSS-2404 must not be used in an application where its failure could be a danger to personal health or damage to other equipment.

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LSS Overview

Terminology

Recipe Settings

Fixed settings for each recipe that do not vary across the frames or sequences (to be defined later). These are considered global parameters that are set once in the recipe. Trigger Type, trigger event, trigger level, trigger delay, output trigger delay, ground trigger, camera trigger voltage, and camera trigger width make up recipe settings.

Active Settings

Settings the LSS are currently running which are loaded into RAM. Active settings reside in volatile memory and will not be saved when power is lost unless stored to flash memory.

Saved Settings

Settings in persistent storage, either onboard flash memory or PC files. Active settings can become Saved settings when using the Save to Controller or Save to File commands.

Sequence Settings

Settings that are defined within each sequence thus can vary between different sequences. Executions, number of frames, and channel mapping are considered Sequence settings

Frame Settings

In most cases, these settings apply across all frames in a sequence. However, an Advanced Mode allows you to set different strobe widths from frame to frame within a sequence. Frame time, strobe width, frame rate, independent strobe widths, and independent widths make up the Frame Settings.

Frames

Every frame is an image the camera captures with the programmed lighting channels. Multiple frames are combined to create sequences and multiple sequences can be linked to create a recipe. There is a maximum of 12 frames per sequence.

Channels

Channels refer to output channels for attached lighting. Lights attached to the LSS may either be segmented lights or independent lights. Dedicated computational imaging lights, such as the HPR2-150SW2-DV04, have pre-wired segments connected to each channel. When using a breakout cable connected to any individual CCS lights, the user will connect each light to a channel. Checking the corresponding Channel box within a Frame turns that segment or connected light on for the set exposure time for that Frame.

Sequences

The number of frames and their settings make up one sequence. When a sequence is completed the camera software is able to complete one output image. There can be 10 different programmed sequences on the LSS controller, but each sequence can be programmed to execute multiple times.

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Recipe

Recipes are made up of multiple sequences. There can only be 6 defined recipes on the LSS controller. Each recipe has its own recipe settings.

Trigger

Typically, triggers are sent directly to a smart camera and light simultaneously; using the LSS, the trigger is sent to the LSS controller. The LSS controller then sends outputs to the camera and light at the programmed intervals. Timing Diagrams are available in Appendix C.

Raw Images

Images that are captured based on the settings of each frame. They are then compiled together in the camera software to create enhanced output images, sometimes referred to as “super images” because of their unique characteristics; e.g. photometric stereo (PMS) images.

Output Images

Images resulting from combining raw frame images into one final image. In the case of PMS, the 4 raw images create two output images; one shape image and one texture image.

Principle of Operation

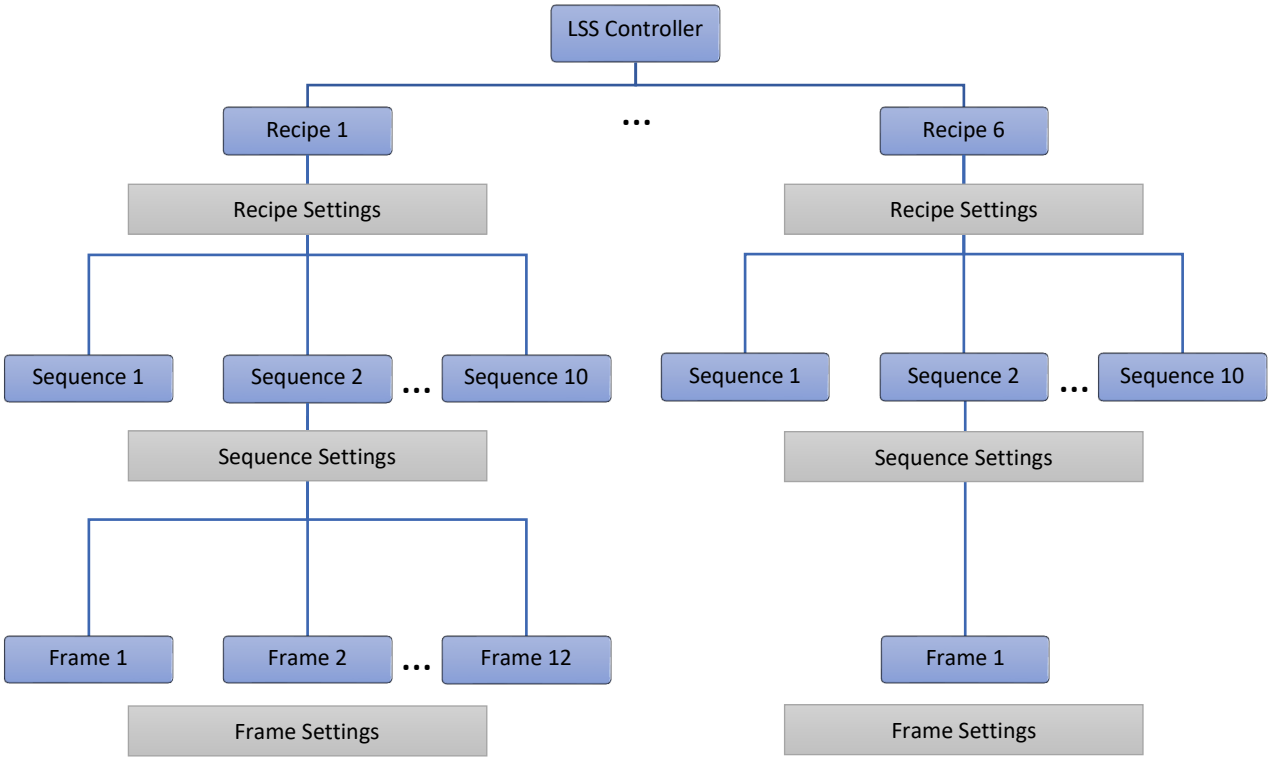
The LSS-2404 is a programmable device that can be used to create multiple types of images. It is configured from a standard web browser and can store and execute arbitrarily complex lighting sequences for multi-shot imaging. The architecture is flexible and consists of recipes, sequences, and frames. Each frame corresponds to one captured image and synchronous strobe output (light flash). Multiple frames together form a sequence and each sequence results in an inspection image (output image). This output image can result from multiple images merged via a computational imaging technique, or an image achieved with traditional lighting. Frames can have their own settings per sequence. In addition, sequences can be set to repeat multiple times and every sequence in a recipe can have different settings.

Multiple sequences combine to form a recipe. The recipe is the highest level of organization and can be thought of as the instructions for creating a set of multi-shot and/or conventional images. Each recipe can have its own global settings. The LSS-2404 can store up to 6 recipes in flash memory, but additional recipes can be created and saved to the PC and loaded into the LSS-2404 when necessary.

When the LSS-2404 controller is powered up the last saved settings are loaded from internal flash memory. A different recipe (i.e. configuration) can be uploaded from the PC via the LSS-2404 software if desired.

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The image below illustrates the LSS-2404 architecture with relation to the settings.



Once a trigger activates the LSS-2404 controller, it begins to run the programmed recipe. The recipe can have up to 10 different programmed sequences. Within one sequence, you determine how many frames to take and which lights or light segments will turn on for each frame. Multiple lighting patterns are made by enabling different channels within each frame – this is also known as channel mapping. Every sequence creates one type of image for the camera software.

Once the channel mapping of a sequence has been determined, choose the number of times the sequence executes. Once the LSS-2404 is triggered it will run the sequence through for the specified number of times before moving onto the next sequence. For example, setting a PMS sequence to execute 2 times will give the camera software 8 raw images and therefore make 2 sets of output images (2 shape images plus 2 texture images).

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Hardware Information

This information is for guidance only. Installers must perform their own risk assessment specific to each installation. While CCS America Inc. has taken extensive care in the preparations of this advice, CCS America Inc. accepts no liability for damages of any kind except those required by law. Deliberate acts of endangerment and vandalism are not covered by this document and must be considered by the installer.

Environmental Considerations



The 2404 does not have an IP rating and must be mounted so that moisture and dirt cannot enter the unit. Free air can be used as a cooling method.

Information	Limits
Operating Temp range	0° – 40° C (32° – 104° F)
Operating Humidity Range	10% – 80% (non-condensing)
Storage Temp	-10° – 50° C (14° – 122° F)

Hardware

LSS Controller

Ethernet – Connect to the computer with an ethernet cable.

Lighting Output – The M12-5 lighting output connector directly connects to dedicated CI lights or a breakout cable for use with almost any CCS light.

Power Input – Connect to 24 VDC power supply with the polarity as marked.

Trigger Out – Connect the Trigger Out terminals to the camera's trigger input pins per the wiring section below.

Trigger In – Connect the external system's trigger to Trigger In to start the lighting sequence. The trigger may be any voltage from 3.3 V to 24 VDC. See the Trigger Out section below for more information.

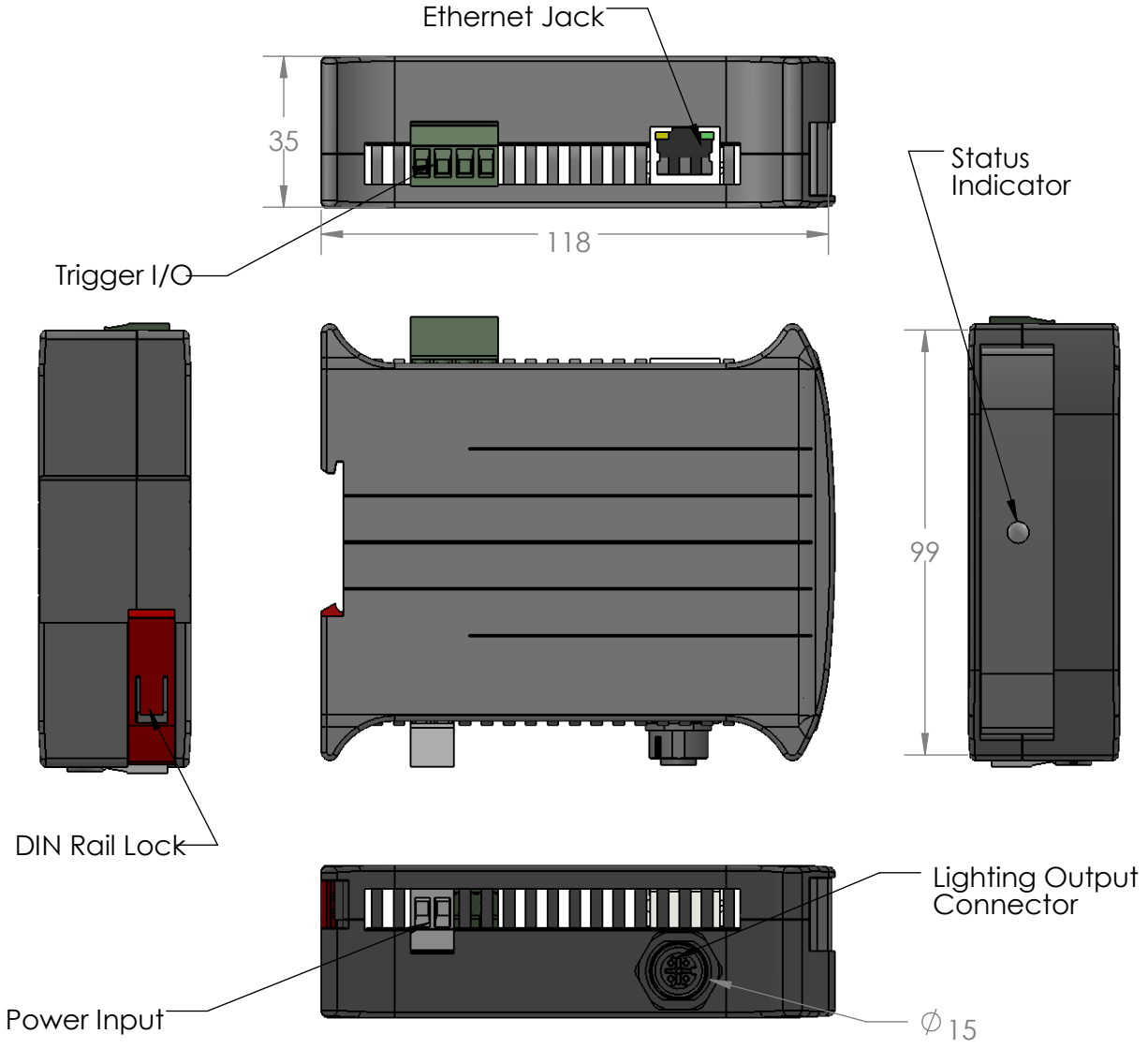


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Mounting the LSS

The LSS is intended to be mounted to a standard DIN rail. Hook the top of the DIN rail mounting groove over the rail, pull the spring loaded, red DIN rail lock to guide the bottom of the DIN rail mounting groove fully onto the DIN rail, and release the lock. Press down the unit and lightly wiggle it to ensure that it is properly secured to the DIN rail.

The illustration below shows the dimensions and key parts of an LSS controller



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Camera

Any camera that is powered over ethernet and can send and receive outputs/inputs.

Lighting

Ring Lights



Product #	Diameter
HPR2-50SW-DV04M12-5	50 mm
HPR2-75SW-DV04M12-5	75 mm
HPR2-100SW-DV04M12-5	100 mm
HPR2-150SW-DV04M12-5	150 mm
HPR2-200SW-DV04M12-5	200 mm
HPR2-250SW-DV04M12-5	250 mm

Standard HPR2 style ring lights are available in white in the sizes listed above. All ring lights use M12 style connection cables. Different color lights are available by special order (red, blue, IR).

Cables

Extension cables can be used to increase the distance from the LSS controller to the light. A summary of cable lengths is shown below.

Product #	Length
FCB-1-0.5SQM12-5M5F	1 m
FCB-3-0.5SQM12-5M5F	3 m
FCB-5-0.5SQM12-5M5F	5 m
FCB-9-0.5SQM12-5M5F	9 m

Bar Lights





A bar light configuration is used to create more contrast via adjusting the angle to produce more shade information and/or can be used to increase the field of view of the inspection. Different sizes and colors are available for square or rectangular imaging areas. A universal bar light bracket is available to accommodate almost any size bar light configuration. Please contact CCS for more information.

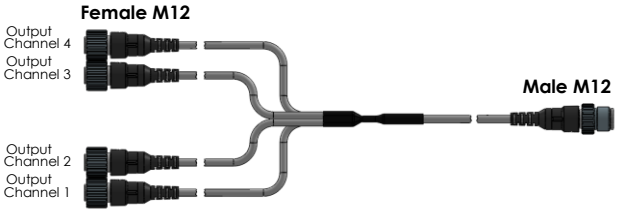
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Cables

Breakout Cables

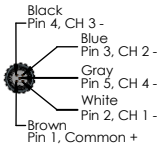
Breakout cables allow all 4 lights to connect back to the LSS controller, so each light is considered its own segment and can be controlled individually. The table below summarizes the connection types and cable lengths.

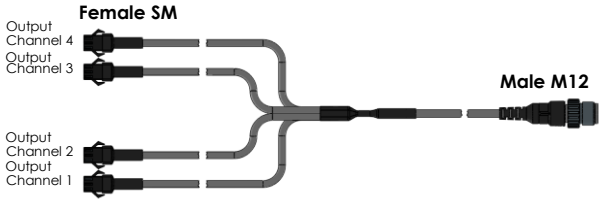
Connector Style	CCS Series	Product #	Length
M12	CCS Standard with M12 option	FCB-F-0.3-XS2	300 mm
		FCB-F-0.9-XS2	900 mm
SM	CCS Standard	FCB-F-0.3-XS2-SM3	300 mm
		FCB-F-0.9-XS2-SM3	900 mm



M12 Connection Breakout Cable

FCB-F-x-XS2





SM Connection Breakout Cable

FCB-F-x-SM3

Extension Cables

To increase distance from the LSS controller to the light, or to increase the size of the inspection area, extension cables must be used. They come in both connection styles, M12 and SM.

To increase the distance; 1 M12 cable is required to connect the end of the breakout cable to the LSS controller.

For a larger light arrangement 4 extension cables are required. One cable will connect the end of the light in the arrangement to one of the breakouts on the breakout cable and repeat for all four lights. Below is a table of the connector style and lengths.

Connector Style	CCS Series	Product #	Length
M12	Lights with M12 option or as extension cables	FCB-1-0.5SQM12-5M5F	1 m
		FCB-3-0.5SQM12-5M5F	3 m
		FCB-5-0.5SQM12-5M5F	5 m
		FCB-9-0.5SQM12-5M5F	9 m
SM	CCS Standard	FCB-1	1 m
		FCB-2	2 m
		FCB-3	3 m
		FCB-5	5 m

Please contact CCS for more information regarding custom size and configuration.

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Connection Requirements

A specification sheet of the LSS is in Appendix A.

Power Supply/Consumption

Specifications

The following specifications are for the LSS-2404 controller.



Information	Limits	Notes
Nominal Input Voltage	12 - 24 VDC	Max allows to work with most 12-24 VDC power supplies
	10.8 - 28.8 VDC Maximum	
Max Continuous Supply Current	2.0A /channel	Do not connect lighting that exceeds these limits
	4.0 A total for all channels	
Uses common ground power system*		
Thermal Fuse**	1.5A PTC per channel	Prevent damage in fault conditions related to individual channels
Main Fuse***	7A	Protects all electrical components from various issues
Power Consumption	5W	Excluding attached lighting and dependent configuration

* The (-) power supply input, the (-) trigger input, the (-) trigger output and any grounded metal enclosures are all electrically connected and treated as ground. This must be given proper consideration when making electrical connections between the control box and other system components. Ensure that all components connected are capable of having their low side (-) contacts joined and grounded without creating an electrical fault.

**PTC fuses are self-resettable and are designed to limit unsafe currents while allowing constant safe current levels. Resistance will “reset” automatically when the fault is removed, and the temperature returns to a safe level. In the event of a fault condition, remove power and the fault condition (if applicable) and wait five minutes. Power the LSS-2404 back on to restore operation. The product warranty does not cover any damage that may have occurred due to improper connection or operation.

***If the main fuse blows the LSS will appear to have no power or indicators. If this occurs the unit is not user repairable and must be sent in to CCS America for repair.

Contact techsupport@ccsamerica.com, if the LSS-2404 needs repair.

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Selecting Power Supply

Choose a power supply that fulfills the requirements below

- Well-regulated 12-24 VDC with appropriate current rating for attached lights (5V minimum)
- Absolute voltage ratings are never exceeded in any installed operating conditions
    - Damage may occur if the input exceeds the specified absolute limits.
- Total capacity at least equal to or greater than 100 mA PLUS the sum of all 4 channels of connected light
- Note: 24V with 4.1A or greater can run the maximum allowed lighting
- DO NOT USE power supplies with 10A capacity or larger

DO NOT USE THIS DEVICE WITH POWER SUPPLIES OR EXTERNAL COMPONENTS USING AN ISOLATED GROUND SYSTEM THAT CANNOT BE CONNECTED TO AC GROUND. EXTERNAL COMPONENTS MUST SUPPORT A COMMON GROUND SYSTEM.

To request configuration for use in floating or isolated ground systems, *please contact CCS America by sending an email to* ***techsupport@ccsamerica.com***

Ethernet Connection

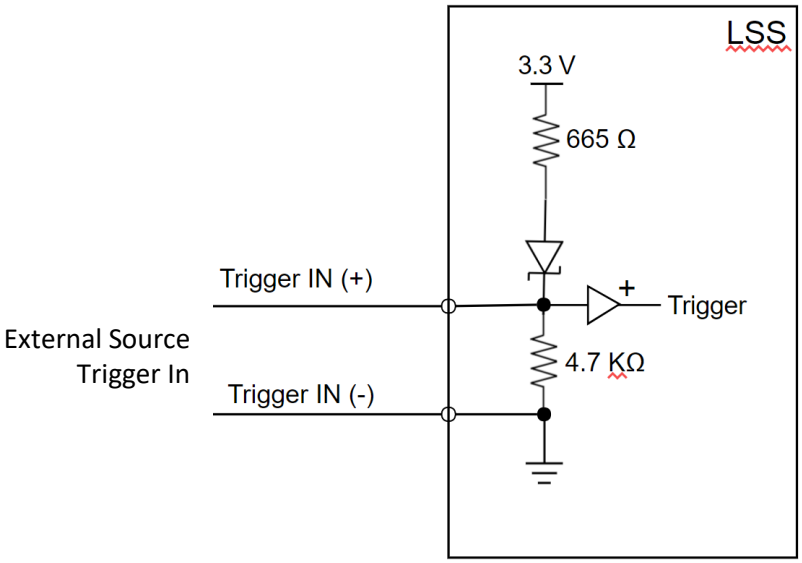
Ethernet connectivity with TCP/IP protocol is standard on the 2404 controllers. The RJ45 Ethernet connector requires a straight through cable to connect into a PC, network switch, hub or router. It operates at 100Mbits per second (100 Base-T).

The IP address on the LSS-2404 is 192.168.0.10.

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Trigger Input

The LSS-2404 trigger input is a ground referenced 4.7K ohm resistive termination. It is designed to work with most outputs on common devices. The voltage mode accepts 3.3 and 24 V logic level voltage with an adjustable trigger level. In Switched Ground Mode, Trigger Input supports opto-isolators or closed contacts via direct connection without external components.



Voltage Driven Outputs (TTL or Similar)

The external device's output can be wired directly to the input with the polarity shown. The input is designed to work with any input signal voltage level from 5 V to 24 V. Proper triggering can be achieved by adjusting the trigger level in the software to work with the input signal voltage. The default trigger level is set to 9.6 V, designed for signal levels ranging from 12 V to 24 V.

For signal levels less than 12 V the trigger level in the software may need to be lowered. The trigger level should be set to approximately 50-80% of the maximum input signal voltage. Try adjusting the software trigger level up or down to find a stable operating point.

Trigger signals must be clean and sharp at the 4.7K ohm input termination to the LSS-2404. Be sure the trigger device supplying the signal and cabling are appropriate to drive the termination. Do not exceed 30 V absolute maximum at any time or damage may occur to the input.

Switches and Mechanical Contacts

The trigger input is designed to easily work with switches or mechanical contact without any biasing or external circuitry. Simply connect the switch to the trigger input pins. In the LSS-2404 GUI, check the ground triggered mode. The LSS-2404 will trigger every time that contact is made between the 2 input pins.

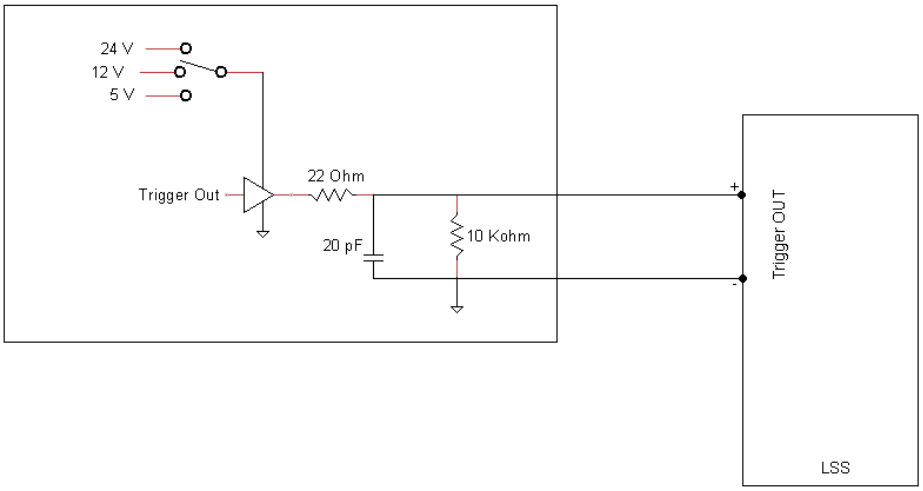
Opto-isolators or Open Collector Transistors with Internal bias

If the opto-isolator has internal biasing built in, it can be connected in parallel directly across the trigger input contacts with the polarity shown. Keep in mind that the negative trigger input pin is ground referenced.

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Trigger Output

The LSS-2404 trigger output is a ground referenced 10K ohm resistive termination. It is designed to work with most inputs on common devices. An external resistor or other circuitry may be required to drive certain cameras using opto-isolated or open collector current driven signals.



Voltage Mode

The trigger out signal from the LSS-2404 is a voltage driven source. Connect it directly to the receiving device's input with the polarity shown. Be sure that the input device can accept the ground referenced input. The signal level is software selectable to 5, 12, or 24 V and can drive up to 70 mA.

Current Mode

The driver for the LSS-2404 trigger out signal has a built-in limit and over-current protection. This makes it suitable to connect to current driven inputs such as unbiased open collector transistors, opto-isolators, or inputs with low impedance terminations. The trigger out can drive currents up to 70 mA. Current mode is automatic and does not require being enabled or selected. Simply treat it as a current source and wire the trigger output to an appropriate device with the polarity shown.

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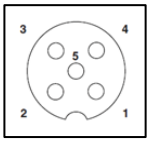
Lighting Output

For the LSS-2404, an M12-5 connector must be used. The M12-5 lighting output connector directly connects to the CCS HPR2-XXX-DV04 ring light (XXX is the size of the ring light), or a 4 bar light configuration using a breakout cable. Please make sure you have the correct cables to connect your light to the LSS controller.

The M12-5 lighting output connector has 4 channels and a switched ground; the image and table below describe the pin assignments.

Pinout	Connection
Pin1 -	+24 Vout Common
Pin 2 -	CH1-
Pin 3 -	CH2-
Pin 4 -	CH3-
Pin 5 -	CH4-

M12-5 Pin Assignments



Shown facing the connector on LSS-2404

Note: All LSS Series products use a switched ground (current sinking) output to drive the lighting channels. Take care not to connect the low side of the lighting channels (CHX-) to the power or chassis ground. If a lighting output channel is connected to ground, no harm will be done, but any segments where the low side of the lighting output is grounded will remain on continuously and won't be able to be controlled by the LSS unit.

Setup LSS Controller

Wiring

Power Supply

Wire in the power supply to the 'DC Power In' on the controller. Note: make sure to connect the + cable to the + input on the controller and – cable to the – input.

Do not plug in the power supply until all the wiring is completed.

Lighting

Connect the light cable to the 'Light Output'. If using bar lights and a breakout cable connect each branch to one of the bar lights. Take care to connect the correct light to the correct breakout cable. See Bar Light Orientation for further assistance.

Trigger

Connect the camera input/output cable to the 'Trigger' on the controller. Use the table below to assign the color of the cables to the correct input.

Trigger	Wire
Trigger IN +	Trigger Input + signal
Trigger IN –	Trigger Input - signal
Trigger OUT +	Trigger Out + signal
Trigger OUT –	Trigger Out - signal

Note: If using the LSS as the slave, instead of the master, wire the camera trigger out into the LSS Trigger IN

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Ethernet

Connect an ethernet cable from the LSS controller to a PC ethernet connection.

Camera

Connect your camera per the manufacturer's instructions.

If the PC only has 1 ethernet connection and you need a continuous Ethernet connection for the LSS-2404, an ethernet switch will be required to connect the camera (or adapter) and the LSS controller to the PC. If you are going to set-up the LSS controller once and leave it for stand-alone operation, you can connect the Ethernet to the LSS controller, program it, and then leave the Ethernet dedicated to the camera's connection. The LSS-2404 does not require a continuous connection unless you need to change settings later or on-the-fly during operation. If the PC has 2 or more Ethernet ports available, connect the camera to one and the LSS controller to the other (preferred method).



If using a POE camera, do not connect the LSS controller to a POE powered port. **The LSS-2404 IS NOT a POE device.** Connection of the LSS-2404 to a POE port is a safety and fire hazard; damage to the LSS-2404 may occur.

Operating Modes

The LSS can be set up as a master or a slave. When the LSS is the master it is responsible for sending the triggers to the camera and light in the programmed sequence once it receives one trigger from the sensor/machine. This means that one trigger can execute the entire recipe. When the LSS is the slave it receives its trigger from the camera/PLC and triggers the light for one frame. In this mode it will take multiple triggers to execute the entire recipe. When set up as the slave the trigger type must be set to 'One-Shot' and the trigger event must be set to 'Frame'. The LSS can be set up with NPN, PNP or opto-isolator signals. Reference Appendix D for connection diagrams for each type.

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Mounting

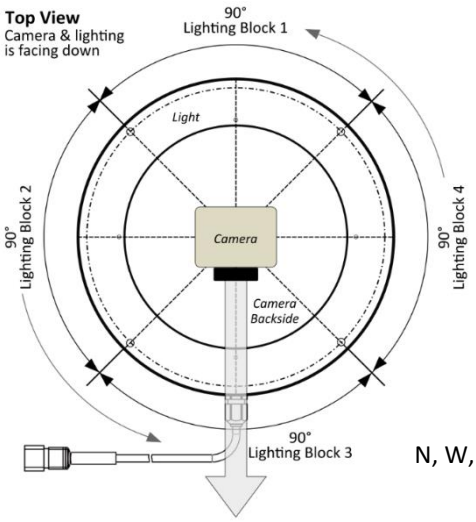
Mounting brackets are available for all standard ring and bar lights. *Please contact your local distributor or CCS at sales@ccsamerica.com for more information.*

Orientation

Most computational imaging techniques do not require a specific orientation. However, the photometric stereo technique the orientation of the light in relation to the camera is important for most image merging software. The channel order for the LSS-2404 with a camera is counterclockwise. The camera must always be mounted in the center of the light arrangement, but the rotation of the light is dependent on software. Check with the image merging software developer to determine what the orientation of the camera and light should be, if applicable.

Ring Light Orientation

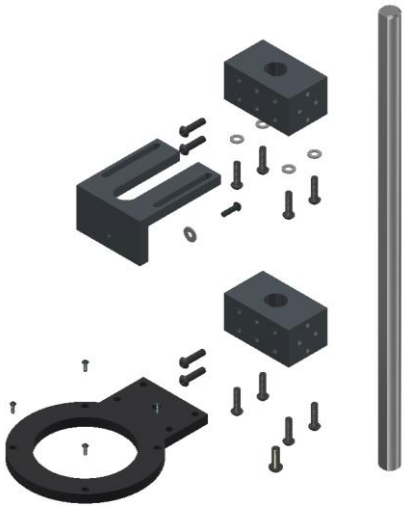
The schematic below is a top view, with the cable from the ring light exiting from the back.



N, W, S, E (counter clockwise)

An integrated ring light and camera bracket (BK-HPR2-CAM) accommodates a variety of ring lights and cameras. The working distance of both light and camera is adjustable. Assembly instructions are shown below.

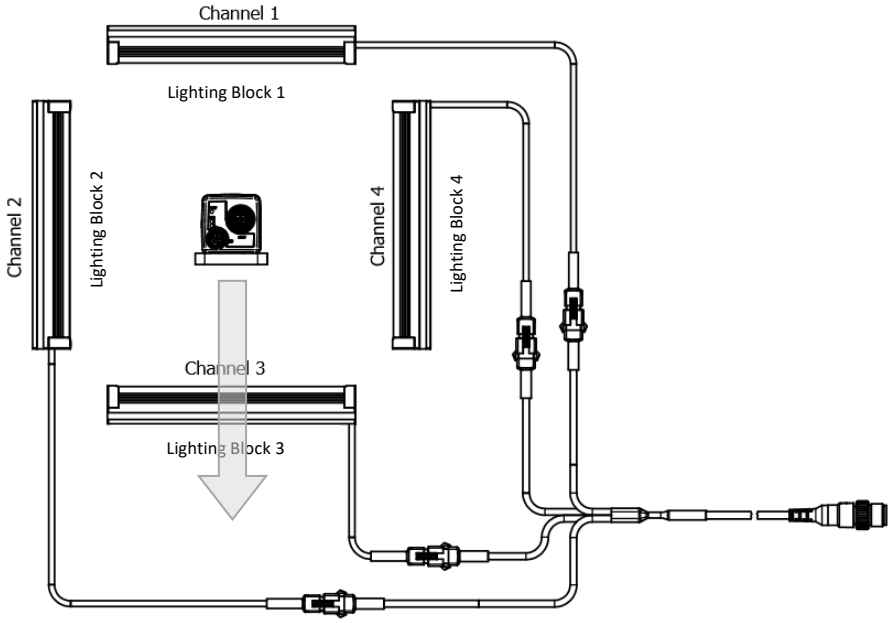




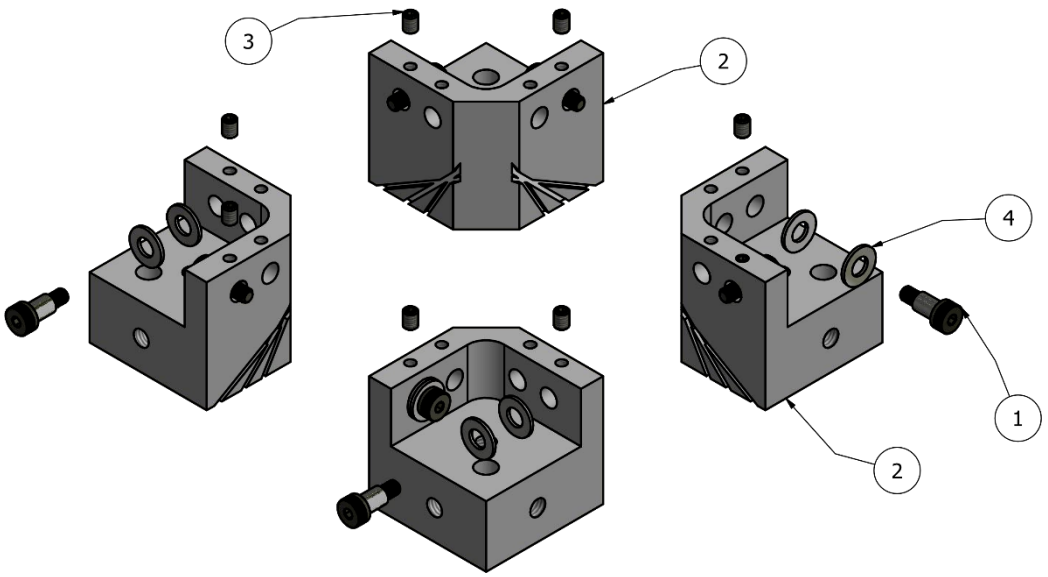
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Square Light Orientation

The top down view shows how the camera should be set up in relation to the bar lights. Each breakout cable is labeled with the channel it controls. Note: if the part being inspected is more rectangular different size lights can be used to inspect the entire part.



A universal bar light bracket (BK-QUADBAR-4C) that fits all CCS bar lights is available for mounting. Assembly instructions are shown below.



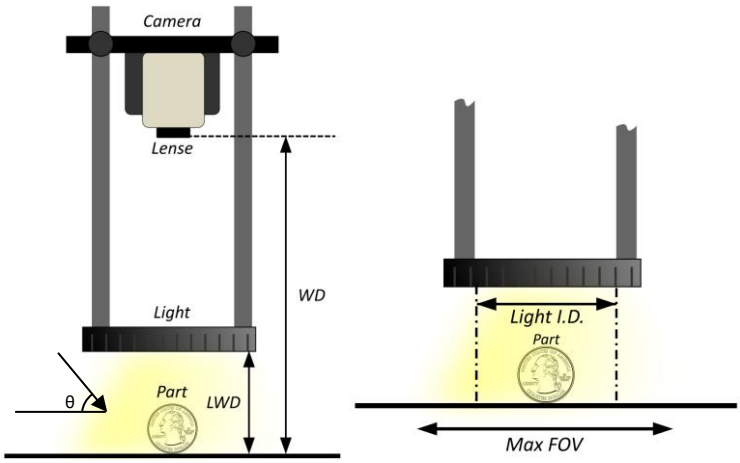
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PARTS LIST (1 KIT)			
ITEM	QTY	PART NUMBER	DESCRIPTION
1	8	M3x0.5 #92981A141	Alloy Steel Shoulder Screw
2	4	SS-1.25 inch block-V-6	Aluminum 6061
3	8	ISO 4026 - M3 x 4	Flat point Hexagon socket set screws
4	16	ISO 7089 - 4 - 140 HV	M4 Flat washers

Height

The height of the camera and light assembly depends on what is being inspected. Generally, the best contrast is created when the illumination angle of incidence (θ) is small to create more shadow information. Mount the light so the light working distance (LWD) is lower to decrease the angle the light hits the part. Tip: Make the mount flexible to move the light up and down to find the height that creates the best image.

Mount the camera so the working distance (WD) gives the desired field of view (FOV) with the chosen lens. The FOV should contain the area to be inspected and looking through the light which is centered around the part. Reference the camera manual for further assistance on selecting a field of view based on lenses.



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Software Operation

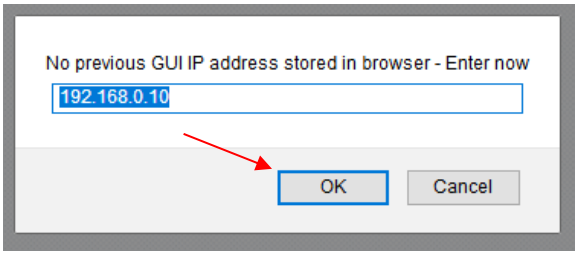
Quick Start

Make sure all the software is installed on the PC. Refer to 'Required Components' on page 1 for further information. When setting up the LSS for the first time;

Step 1. Connect LSS ethernet cable to PC
Step 2. Set PC and camera to match LSS default IP address (in the same local network of LSS)
- a. LSS Default IP address is 192.168.0.10
- b. For example, you can set PC IP address to 192.168.0.20

Step 3. Open LSS2404_GUI.html with compatible browser
- a. Right click → 'open with' → select Firefox or Microsoft Edge

Step 4. When prompted press 'OK' for 'No previous GUI IP address stored in browser' prompt

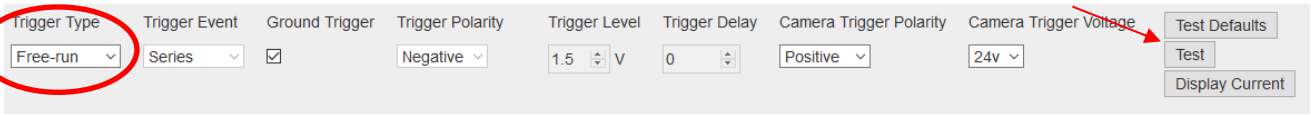


- a. A connection should automatically establish, if it does not refresh the GUI page

Step 5. Test the network connection and light functionality
- a. Verify there is an IP, Name, Product, pcb, and id

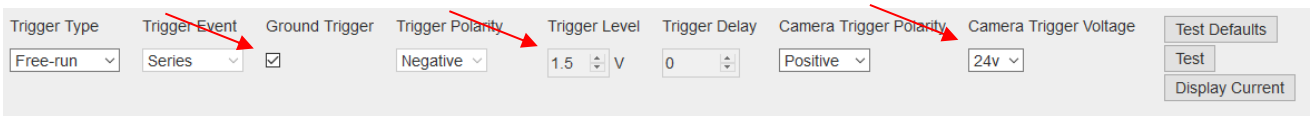


- b. To test the connection right away change 'Trigger Type' to 'Free-Run' → press 'Test'



i. You should see each light quadrant flash in the correct sequence
ii. Note: use system in Free-Run during this phase of testing only. Change to desired trigger type when executing with the camera software
iii. Turn off 'Free-Run' by changing the trigger type to 'Continuous' or 'One Shot' and press 'Test'

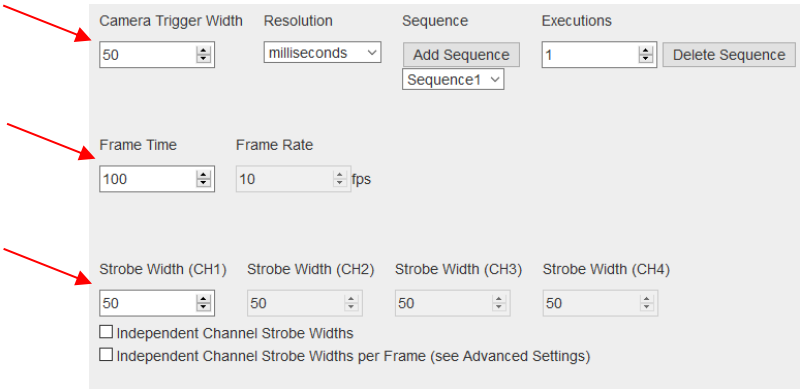
Step 6. Adjust Global Settings based on inspection/machine constraints
- a. Check ground trigger if using closed contact trigger signal
- b. If not adjust 'Trigger Level' voltage
  - i. Increase level if getting noise or false triggers
    - c. Adjust camera voltage based off camera's settings



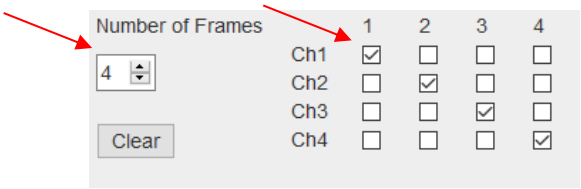
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Step 7. Adjust Sequence/Frame Settings based on the images necessary for inspection

a. If camera is lagging increase the 'Camera Trigger Width'
b. Set the frame time to be greater or equal to the Strobe Width and Camera Trigger Width
c. Set the Strobe Width of the light; this will brighten or darken your image



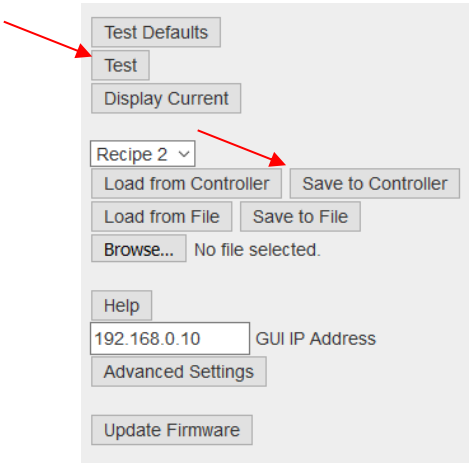
d. Use the number of frames and the channel mapping to set up the computational imaging technique being achieved
e. If a box is checked then that channel will flash during that frame



Step 8. Press 'Test' to implement the changes as you go

a. If trigger event is set to 'Free Run' the LSS will execute the series and the light will strobe. If set to 'One Shot' or 'Continuous' the LSS will wait for a trigger before beginning the series

Step 9. Press 'Save to Controller' when set up is complete



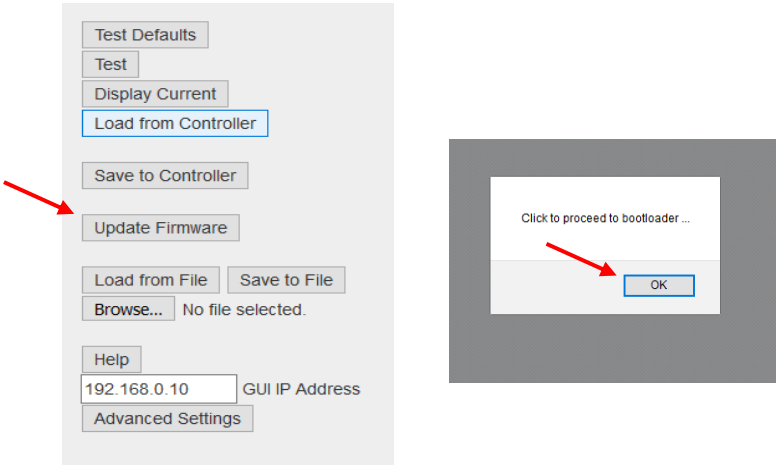
Note: the ethernet connection is only necessary to program or communicate with the LSS. Once all the recipes are complete the LSS can function independently from the PC.

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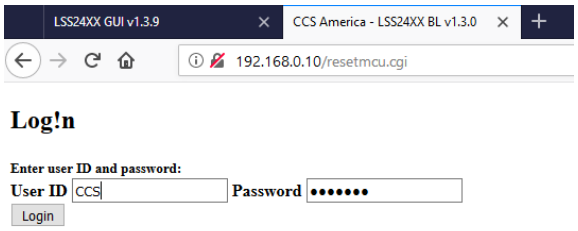
Update Firmware

CCS will release firmware updates to provide new features or bug fixes. If the new feature or bug fix is needed update the firmware to the newest release.

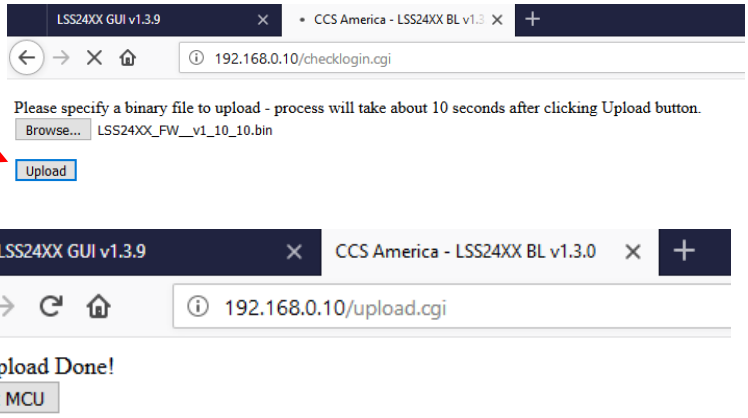
1. Save the .bin file to the PC. The .bin file can be downloaded from http://bit.ly/LSSCI
2. Select 'Update Firmware' on the GUI



3. A new tab opens → login on the tab
    a. Username: CCS / Password: America



4. Select 'Browse' and search for the saved .bin file and press Upload



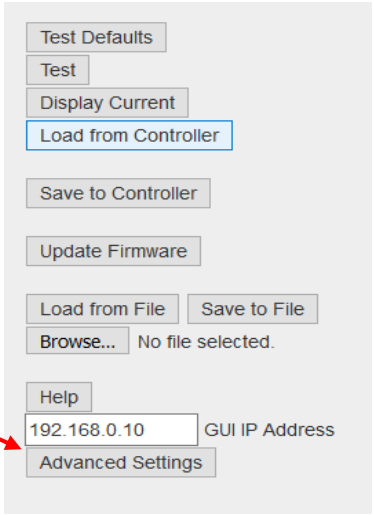
5. Press "Reset MCU' → indicator light on LSS front panel should turn green
6. Confirm update successful
    a. the product name should display the new firmware version

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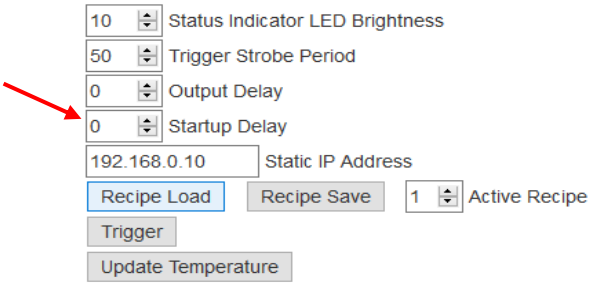
Change IP address

To change the IP address on the LSS box:

1. Change the IP address in the LSS software first
    a. Click 'Advanced Settings'



    b. Type in the desired IP address where it says, 'IP address' and click anywhere on the browser

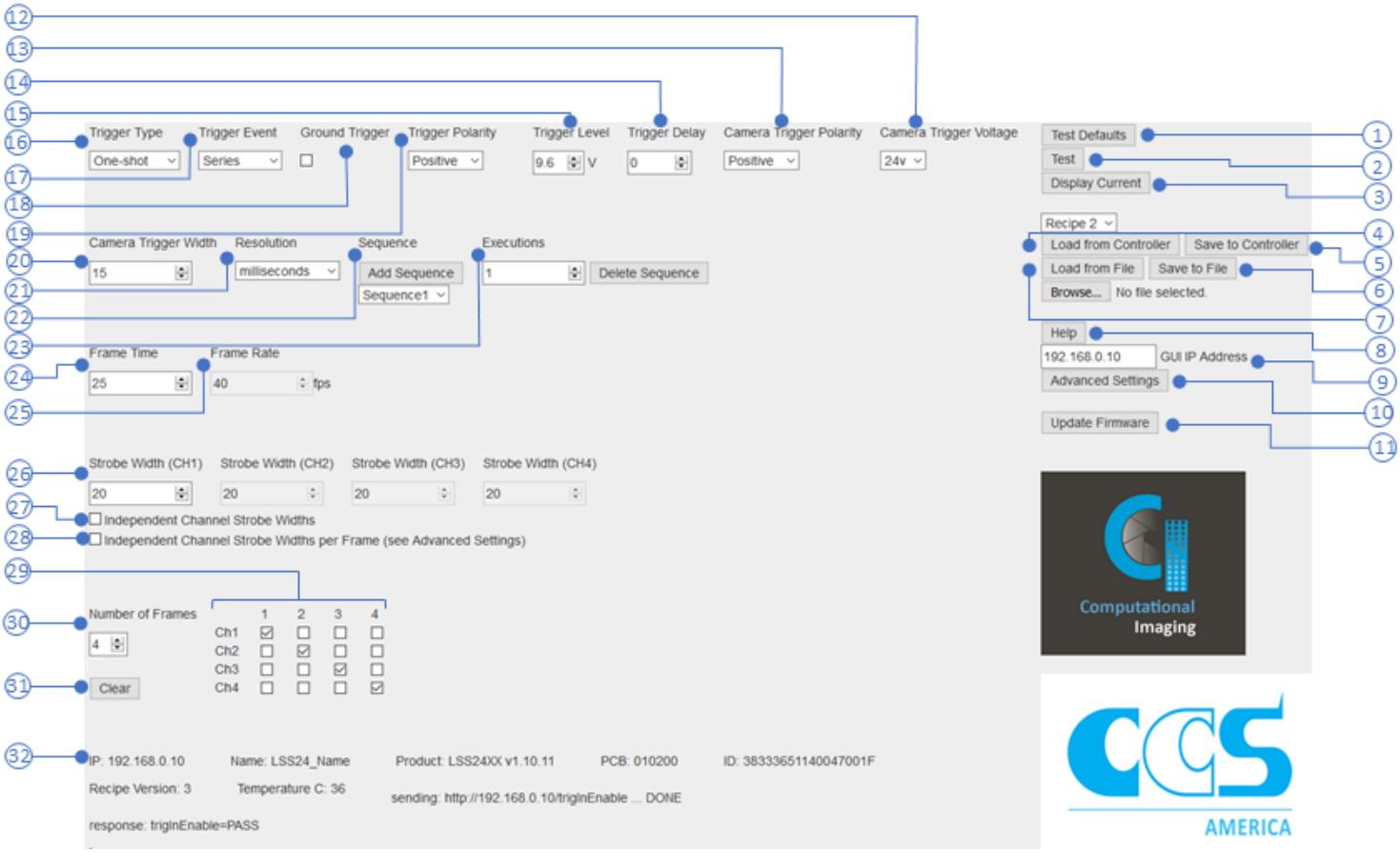


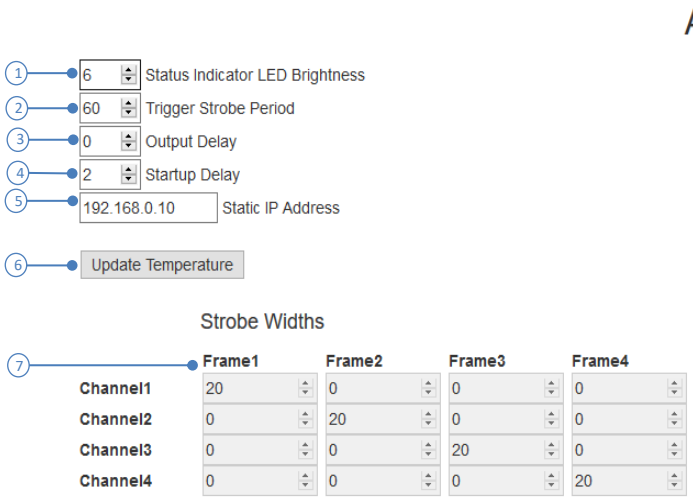
2. Change the camera software to match the new IP address
3. Change IP address on the PC to match the new host address of the LSS and camera software

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Settings Operations

The below image is a screenshot of the LSS controller software. Each setting is described for a more in-depth understanding.





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Test Defaults (1)

Used to transfer default values into RAM, also setting them to be the Current settings. The values should immediately appear in the GUI. Since default trigger type = one-shot, it waits for trigger before executing.
Note: This will change the recipe settings but not the IP address

Test (2)

Used to transfer current GUI settings into RAM, i.e. it establishes the Active settings. If trigger type = free run, the recipe runs for testing; otherwise it waits for a trigger.
Also, it stops a sequence in the middle of its execution if pressed while the sequence is running, and trigger event is set to One-Shot or Continuous

Display Current (3)

Displays the Active settings stored in RAM.

Load from Controller (4)

Loads and displays the saved settings stored in flash. It will overwrite the Active settings in RAM.

Save to Controller (5)

Saves the GUI settings to flash and overwrites the Active settings in RAM. After clicking 'Save to Controller' button, see message displayed that Save is complete.

Save to File (6)

Saves the GUI settings to named file and overwrites the Active settings in RAM. After clicking 'Save to File' button, see message displayed that Save is complete. It will not change flash settings.
Note: The file needs to be in the same directory as the LSS2404_GUI.html

Load from File (7)

Loads and displays the saved settings stored in the selected file. It will overwrite the Active settings in RAM. It will not change flash settings. Use Browse to select the file and Load from File to upload to LSS GUI.

Help (8)

Loads a document to assist with programming the GUI

GUI IP Address (9)

Used to distinguish which LSS box you are programming if using multiple LSS units in a network. Type in the IP address of the LSS box being programmed and the GUI will connect to that box.

Update Firmware (11)

Updates the LSS controller to the selected firmware. See 'Update Firmware' above for instructions on how to update.

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Recipe Settings

Trigger Type (16)

Triggered One-shot (default) – Executes one triggered recipe per rising edge on the Trigger In signal, regardless of the signal's length. The signal must return to the low state before the LSS can be triggered again.

Triggered Continuous – Executes a triggered recipe on the Trigger In signal rising edge and continues repeating the recipe as long as the signal level remains in the high state. The execution will end at the completion of the last recipe where the trigger fell to the low state.

Free-run – Recipe repeats continuously without regard to the Trigger. They start and stop when the Free-run mode is enabled and disabled.

Trigger Event (17)

Sets the trigger to initiate a recipe, sequence or frame. These can only be selected if the 'Trigger Type' is set to One-Shot.

Series – Each trigger will run through the entire programmed recipe until completion.

Sequence – Each trigger will run through one sequence. If the sequence has multiple executions all executions will be completed from one trigger. If a recipe has multiple sequences the next trigger will trigger the next sequence. Once all the sequences have run the next trigger will trigger the first sequence again.

Frame – Each trigger will initiate one frame at a time. If there is one sequence, the triggers will continue to cycle through the frames of the sequence. If there are multiple sequences, once all the frames in a sequence have been triggered the next trigger will trigger frame one in the next sequence.

Ground Trigger (18)

If checked, trigger level voltage is ignored. Use this for contact closure type trigger.

Trigger Level (15)

Sets the voltage level of the Trigger In signal at which the LSS will trigger. The default setting (9.6 V) will generally work well for 12-24 V trigger signals. Set this value lower to work with 5 V or 3.3 V logic levels. Set the value lower if the trigger signal is having problems consistently triggering the unit. Set the value higher to reject noise or if the unit false triggers.

Trigger Delay (14)

Delays sending the initial output signals for a set time once the input trigger is received. Only delays the first trigger in the recipe so it can only be set when 'Trigger Type' is 'One-shot and 'Trigger Event' is 'Series'. Maximum delay is 16,000 milliseconds or microseconds (depending on unit Resolution setting).

Camera Trigger Voltage (12)

Sets the voltage sent to the camera when it triggers

Camera and Trigger Polarity (13/19)

Inverts the logic of the trigger in the software. When set to positive it triggers on rising edge, when negative it triggers on the falling edge.

Note: the hardwire of the trigger cannot change

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Camera Trigger Width (20)
Sets the width in mS of the Trig Out signal to trigger the attached camera. It must be less than, or equal to, the lowest Strobe Width and Frame Time.

Resolution (21)
Sets the timing in milliseconds or microseconds

Sequence Settings

Executions (23)
Sets how many times the sequence is executed before moving to the next sequence in the recipe. If set to 0, the sequence will not run during testing or execution.

Add/Delete a Sequence (22)
Adds a sequence to the recipe or deletes a sequence from the recipe. Whatever sequence is shown in the drop down is the sequence being modified or deleted.

Note: If a sequence is added/deleted the sequence's number changes. What was made as sequence 4 becomes sequence 3 if sequence 1,2, or 3 is deleted. If a sequence is added all the sequences after that sequence increase in number (i.e. add after sequence 3, original sequence 4 becomes sequence 5, previous sequence 5 becomes 6, etc.).

Number of Frames (30)
Sets the number of frames in the programmed sequence; maximum 12 frames. For the LSS-2404, the default is 4 frames to correspond with flashing each of the 4 segments one time for the photometric stereo technique (PMS).

Channel Mapping (29)
Specifies which output channels turn on for each programmed frame. With the number of frames in the X-axis and number of channels (fixed by hardware configuration) in the Y-axis: Check the boxes for each light channel to be triggered per each vertical frame. Any, all, or none of the output lighting channels can be on for each frame.

Frame Settings

Frame Time (24)
Sets the time in mS for each frame in the sequence. The frame rate will automatically read out based upon the frame time set. The default is 25 mS/40 fps. It will usually be associated with the camera frame rate, exposure cycle, or a cycle time related to the machine.

Frame Rate (25)
Number of frames per second the camera displays an image. Depends on set Frame Time (Read Only).

Strobe Width (26)
Sets how long the light stays on when activated for each frame. The Strobe Width setting must be less than, or equal to, the Frame Time that is set. The default is 20 mS.

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Independent Widths (27)

Check the 'Independent Widths' box to enable the ability to set a different time for each individual channel. When unchecked the Strobe Widths for all 4 channels will be locked to each other; changing one changes them all.

Independent Channel Strobe Widths per Frame (28)

Check the box to enable the ability to set a different strobe width for every active channel per frame. Further settings are done in the 'Advanced Settings'.

Advanced (10)

Additional settings such as;

1 *Status Level* – Brightness of the status LED. Ranges from 1-100%. Requires clicking 'Save to Controller' for changes to take effect.
2 *Trigger Strobe Period* – length of time in milliseconds the Status LED blinks when a valid trigger occurs. Requires clicking 'Save to Controller' for changes to take effect.
3 *Output Delay* – Delays when the light flashes for every flash. Maximum delay is 1 millisecond.
4 *Startup Delay* – The LSS will ignore triggers coming into the LSS for the set time.
5 *Static IP* – Sets the IP address of the LSS controller and the GUI software.
6 *Update Temperature* – Displays the temperature the LSS controller is operating at. Temperature will not be updated until this button is pressed.
7 *Individual Strobe Widths* – Set the strobe width for each active channel per frame.

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GUI Settings

Clear (32)

Pressing 'Clear' removes all check boxes in the channel mapping and allows the user to set a new sequence from scratch.

Log and Titles (33)

IP – LSS static IP address

Name – LSS device name

Product – LSS product name and firmware version number

PCB – LSS PCB info number consisting of 3 parts

ID: Identifies which type of LSS (01=LSS2404, 02=reserved for future model)

REV: LSS PCB revision

MOD: Modification Number

ID – Unique processor identification number

Recipe Version – Recipe version supported by the GUI. If a different recipe version is loaded from a file, it will cause an error displayed in a pop-up window.

Temperature – Shows the temperature (in Celsius) the LSS is operating at

Log – Shows the changes that have been made to the LSS for debugging purposes

Auto Log Size Limit

Automatically checked; sets the maximum size the log can be before clearing. Uncheck if you need to manually control the size of the log.

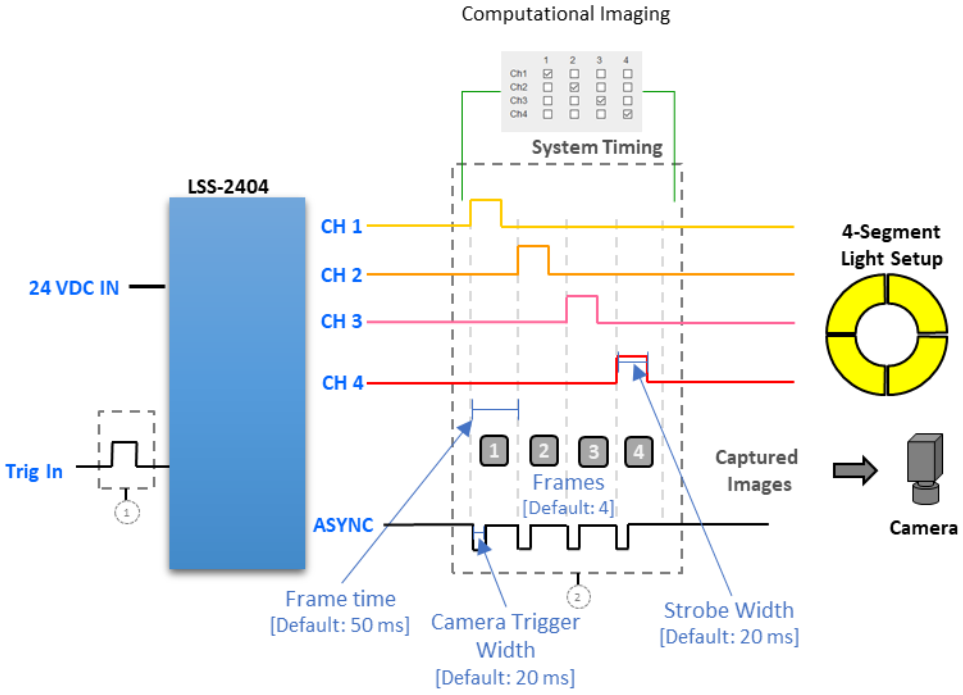
Summary

A table of the default values is below. Note: clicking 'Test Defaults' sets the Active settings to these values.

Variable	Default
Trigger Type	One-Shot
Trigger Level	9.6 V
Ground Trigger	unchecked
Executions	1
Frame Time	25 mS
Frame Rate	40 fps
Camera Trigger Width	15 mS
Camera Trigger Voltage	24 V
Strobe Width	20 mS
Independent Widths	Unchecked
Number of Frames	4
Channels	Frame 1; Channel 1 Frame 2; Channel 2 Frame 3; Channel 3 Frame 4; Channel 4

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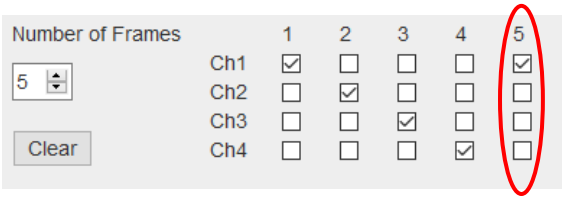
The timing diagram below illustrates the definitions described above in relation to the timing of the system.



More timing diagrams for triggering are shown in Appendix D.

Motion Correction

If the part is in motion during the multiple image capture sequence, a compensation technique called motion correction is needed. To achieve motion correction, various techniques may be used to align the images during the capture sequence. Check with your software vendor for the technique most suitable for your application. As an example, one method adds an extra frame that has the same channel mapping as the first frame.

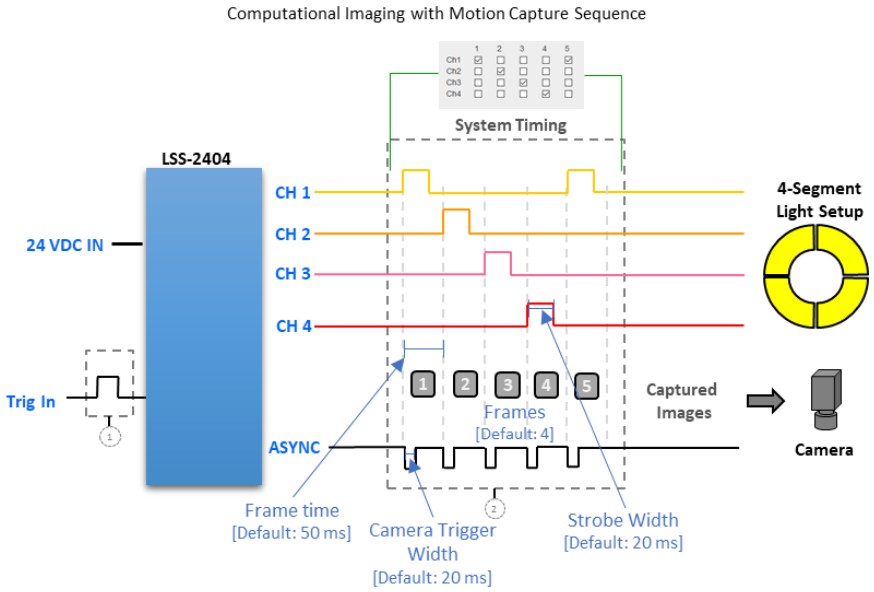


This image is considered the search image. A pattern is defined on the first image, then a search region is defined on the search image. The search region is drawn where the defined pattern will fall in the search image. Once the pattern is found, the algorithm determines how the part moved across the field of view during the capture sequence and aligns the correct pixels to produce the desired Computational Imaging technique.

Be sure to set the camera's field of view large enough so that the part stays within the field of view during the capture sequence. Also, be aware of the limitations of the motion correction technique. For instance, the part may need to move straight at constant speed without rotation and not vary in size.

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The diagram below shows the timing structure for computational imaging with the motion capture frame, using the method described above.

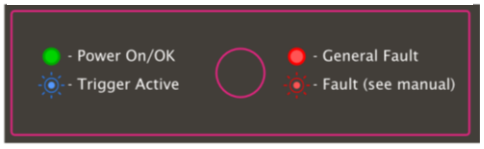


Troubleshoot

In general, if errors or unexpected behavior occur power cycle the LSS. If the issue is not solved, hard reset the LSS. The table below describes the LED light indicator:

Color	Meaning and Required Action
Green	Power on
Blue Flash	Indicate active trigger
White	Bootloader mode
Red	General fault; power cycle
Red Flash	Reserved for future use
None	Hung up; requires hard resetting the LSS to fix

LSS-2404 front panel indicators



Force on Light

To manually turn on a segment of the light open another browser tab → in the browser type

(IP address LSS is set to) 192.168.0.10/chX=1 to turn on and 192.108.0.10/chX=0 to turn it off.

Where X represents the number of the channel being forced on. X can be 1,2,3, or 4 for the LSS-2404.

Ethernet connection

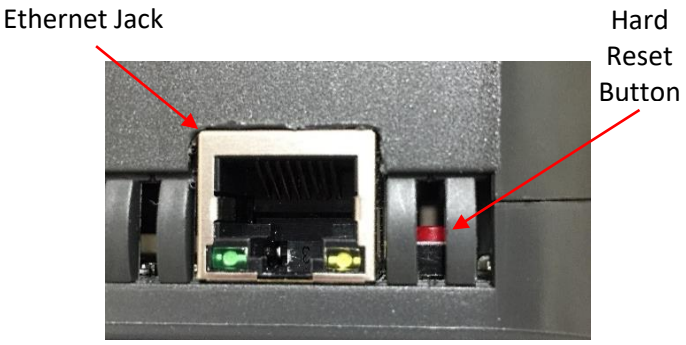
If an ethernet connection is lost, refresh the browser webpage. If a connection cannot be made, power cycle the LSS controller. If still no connection can be made the LSS is trapped in a HardFault handler. To fix hold the reset button for 10 seconds and refresh the browser page. See 'Reset Button' below for further details.

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Hard Reset button

Warning: Use with caution – user data will be erased!

Erases all the stored recipes and loads in default settings except for serial number, MAC address, authentication string, static IP address, and DHCP flag. The reset button is located next to the ethernet connection on the inside of the LSS controller to prevent accidental resets.



Power on the LSS, wait a moment, and then press/hold the Factory Reset (red) button for about 10 seconds until a Red-Green-Blue pattern on the Status LED flashes three times. This will restore the Flash memory to default settings; including the stored recipes that may be causing the LSS to crash/hang and fail to respond to ethernet commands. Then press the 'Test Default' or refresh the GUI to load the settings into the RAM.

Note: if you have the button pressed when power is turned on it will send the LSS directly into bootloader mode and the status LED will be white.

Bootloader mode

Caused by factory reset being pressed (or stuck) when powered on or the Update Firmware button got hit and only some of the firmware got loaded. If the firmware image doesn't get fully loaded (i.e. corrupted) it will always stay in bootloader mode until a complete valid firmware App is successfully loaded and stored in Flash.

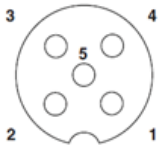
If a power cycle doesn't restore the Status back to green, click the Update Firmware button and proceed with reloading the version of firmware you were using.

If the LED indicator light remains off while trying to upgrade the firmware power off the LSS. While holding down the hard-reset button power up the LSS. The LED light will be white indicating the LSS is in bootloader mode. Either press the update firmware button on the GUI or type 192.168.0.10/ in the webpage address bar then complete the process of updating the firmware.

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Appendix

A. LSS-2404 Specifications

LSS-2404 Specifications	
Description	The LSS-2404 Light Sequencing Switch is designed to switch external +24 VDC power for up to 4-channels of lights. Upon receiving an external system trigger, the LSS-2404 executes a preprogrammed sequence of lighting on the 4-channels and outputs a correlated camera trigger, automatically timing external camera exposures to the programmed lighting sequence.
Number of Lighting Channels	4
Power Supply Requirements	24 VDC nominal at 5A (minimum)
Input Voltage	10.8 – 28.8 VDC (absolute range)
Power Consumption	5W maximum; Excluding attached lighting and dependent on configuration
Trigger Input	*Voltage mode:* Accepts 3.3 – 24 VDC logic level voltage with adjustable trigger level *Switched Ground Mode:* Supports opto-isolators or closed contacts via direct connection without external components
Trigger Input Level	Software programmable 1-24 VDC trigger level in 100 mV increments Default: 9.6 V threshold to work with 12 V or 24 V trigger logic
Trigger Out (to camera)	Selectable to 5 V, 12 V, or 24 V via software. Voltage level tolerance +/- 15%. Maximum limited to ~93% Vin
Trigger Functions	*Trigger Event* – Selectable: Series trigger all, trigger individual sequences, or trigger every frame *Trigger Delay* – Selectable 2 µS to 65 sec trigger delay for synchronization with external processes *Invert Function* – Trigger I/O logic can be inverted by software
Power + Trigger Connections	Pluggable screw terminal blocks with recessed connections. M3 set screw, 12 - 24 AWG Mating connector: Order DigiKey PN ED2781-ND
Lighting	Output connector: M12-5 female 4 lighting channels; switched ground (sinking) Pinout: Pin1 - +24 Vin Common Pin2 - CH1- Pin 3 - CH2- Pin4 - CH3- Pin5 - CH4- M12-5 Pin Assignment 

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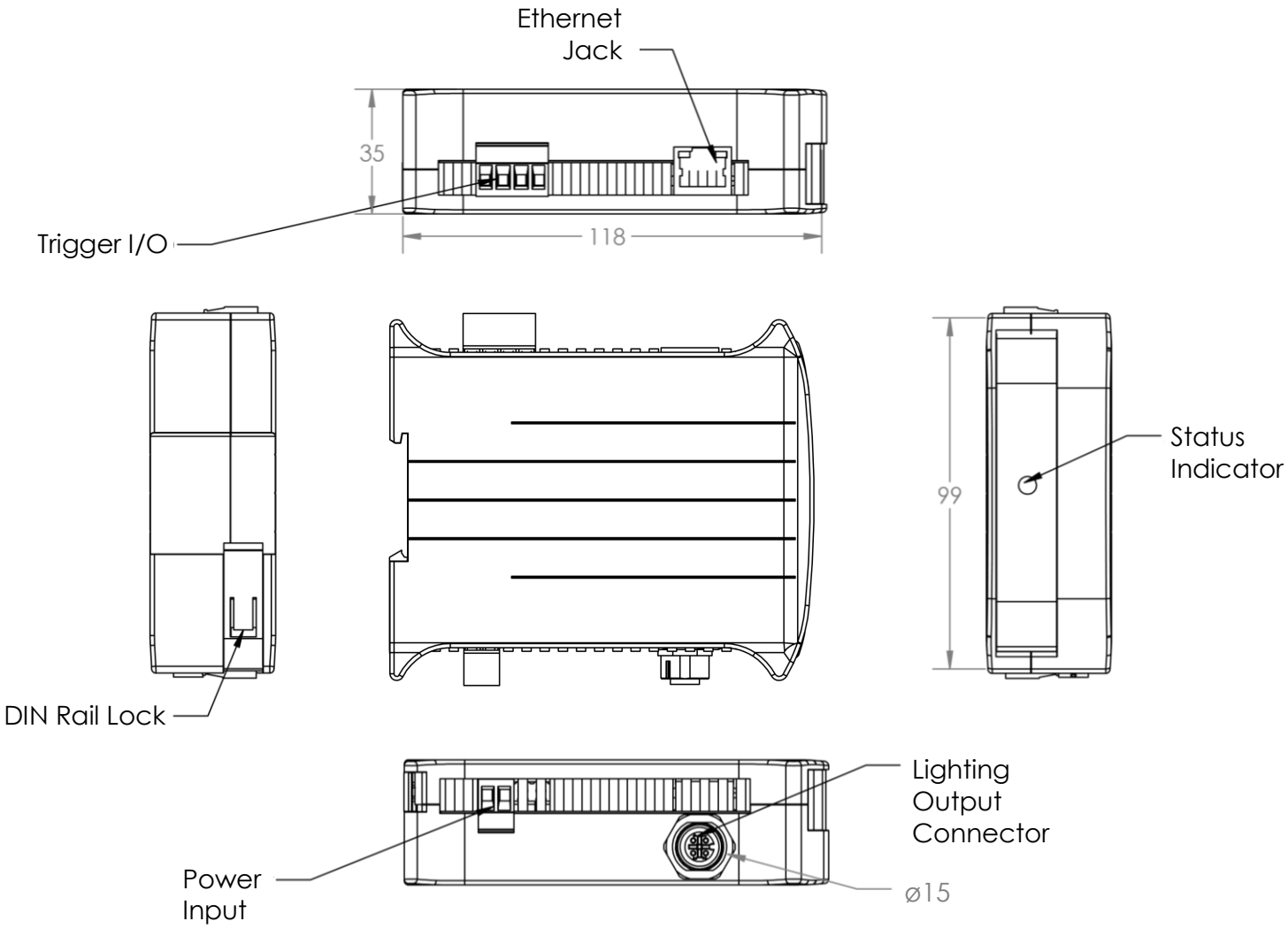
Maximum Current Rating	1.5 A/CH or 4.0 A max total all 4 lighting channels, whichever is less.
Channel Output Voltage	Unregulated; >98% of supply voltage
Channel Output Mode	Current sinking only
Communication Port	RJ45 connector. 100BaseT Ethernet. TCP/IP protocol. Control via Web-based GUI or TCP/IP command set
Indicator Functions	Power On Trigger Activity Ethernet – network connection Ethernet – network activity/fault General Fault Fault
Firmware	User upgradeable via Web-based GUI (included)
Sequence Timing	User programmable via Web-based GUI (included) and TCP/IP command set Default: Photometric Stereo (PMS) 4 frame sequence 40 fps operation, 25 mS frame, 20ms Strobe Width (exposure), 15 mS camera trigger
Timing Resolution	Maximum Trigger rate: 10,000 fps (100 µS) Minimum output signal width: 100 µS Maximum delay trigger to start first frame: 50 µS Timing resolution: 1 µS Channel skew + jitter: <= 10 µS
Frame Time	100 µS – 2000 S; Time for each frame in a sequence
Strobe Width	100 µS - 2000 S; Independently selectable CH1 - CH4. Must be < frame time
Camera trigger Width	100 µS - 2000 S; Must be < frame time
Trigger Type	Triggered One-shot (default), Triggered Continuous, Free-run (continuous non-triggered)
Trigger Event	Triggers based off Recipe, Sequence, or Frame. Note: Trigger Type must be set to One-Shot
Trigger Delay	If enabled - 2 µS - 65 mS @ 1µS resolution or 2 mS - 16 sec @ 1mS resolution (optional)

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Program Limits	6 pre-programmed recipes 10 sequences per recipe 12 frames per sequence Unlimited recipes (saved to PC)		
Additional Software Features	Program recipes via web browser Firefox (version 56 or later) or Microsoft Edge Firmware field upgradeable		
Operating Temperature Range	0° – 40° C (32° – 104° F)		
Storage Temperature Range	-10° – 50° C (14° – 122° F)		
Operating Humidity	10% - 80% (noncondensing)		
Cooling	Free air cooling		
Package Type	DIN module 1.5X (representative image below)		
Dimensions	1.4 x 4.0 x 4.7 inches / 35 x 101 x 119 mm L x W x D		
Weight	4.8 oz / 135 g		
Conformance Standard	CE, FCC, RoHS, REACH, Conflict Materials compliant		
Accessories + Options	Breakout Cables (4 branch cable to attach multiple unsegmented lights)	FCB-F-0.3-XS2	300 mm length M12-5 Connector
		FCB-F-0.3-SM3	300mm length SM Connector
		FCB-F-0.9-XS2	900 mm length M12-5 Connector
		FCB-F-0.9-SM3	300mm length SM Connector
	M12-5 Extension Cables (to increase distance from LSS to light or to lengthen branches)	FCB-1-0.5SQM12-5M5F FCB-3-0.5SQM12-5M5F FCB-5-0.5SQM12-5M5F FCB-9-0.5SQM12-5M5F	1 m 3 m 5 m 9 m
	SM Extension Cables (to lengthen branches when using SM connectors)	FCB-1 FCB-2 FCB-3 FCB-5	1 m 2 m 3 m 5 m
Compatible Products	HPR2-XXXSW-DV04M12-5 4 Segment Ring Light XXX = 50, 75,100, 150, 200, 250 mm		
	All CCS Standard Series Lights		
	BK-HPR2-CAM Integrated Light Bracket + Camera Mount		
	BK-QUADBAR-4C 4 Bar Light Bracket (fits all common bar lights)		

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B. Mechanical Drawing



Model name	LSS-2404
Output channels	4
Input voltage	10.8-28.8 VDC
Power consumption	5W Max
Weight	136 g

Scale 2:3 Units: mm

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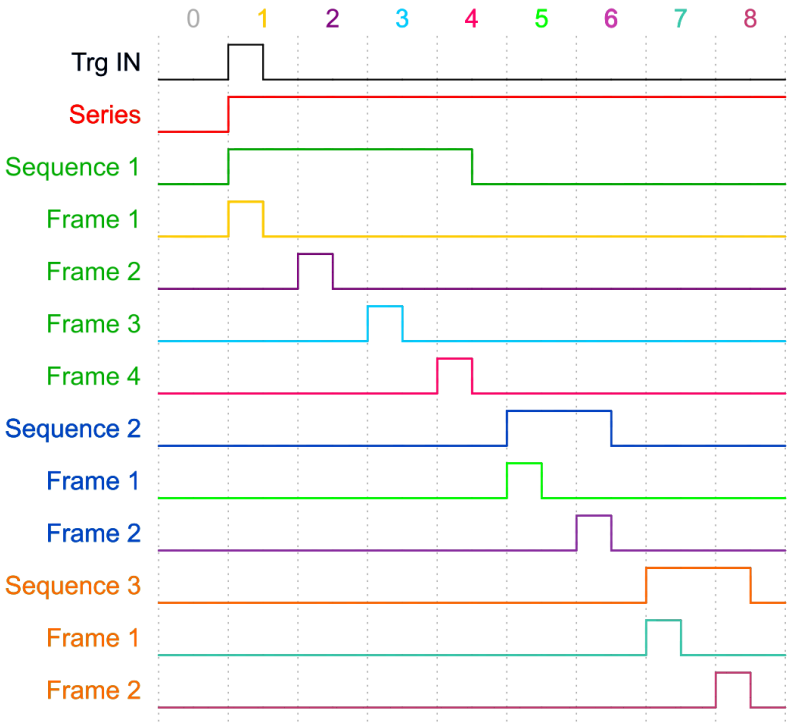
C. Timing Diagrams for Triggering

Trigger Type: One Shot (Default)

Trigger Event: Series

When a trigger is sent in, the first recipe runs until completion then waits until it receives another trigger to trigger the recipe again.

When a recipe is triggered it runs all sequences; the frames within a sequence and the number of times a sequence is programmed to execute.



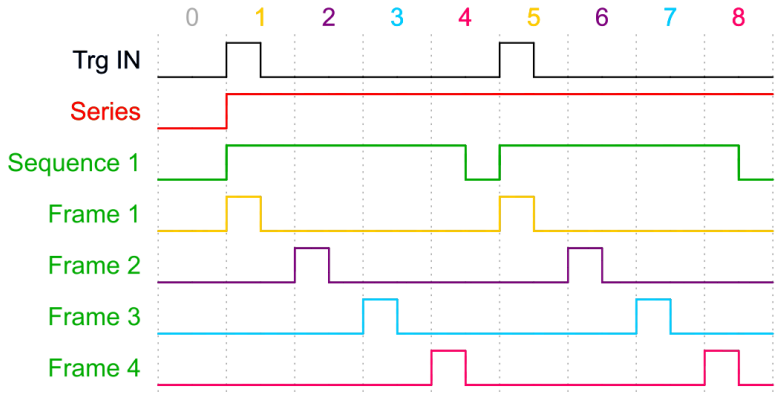
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Trigger Event: Sequence

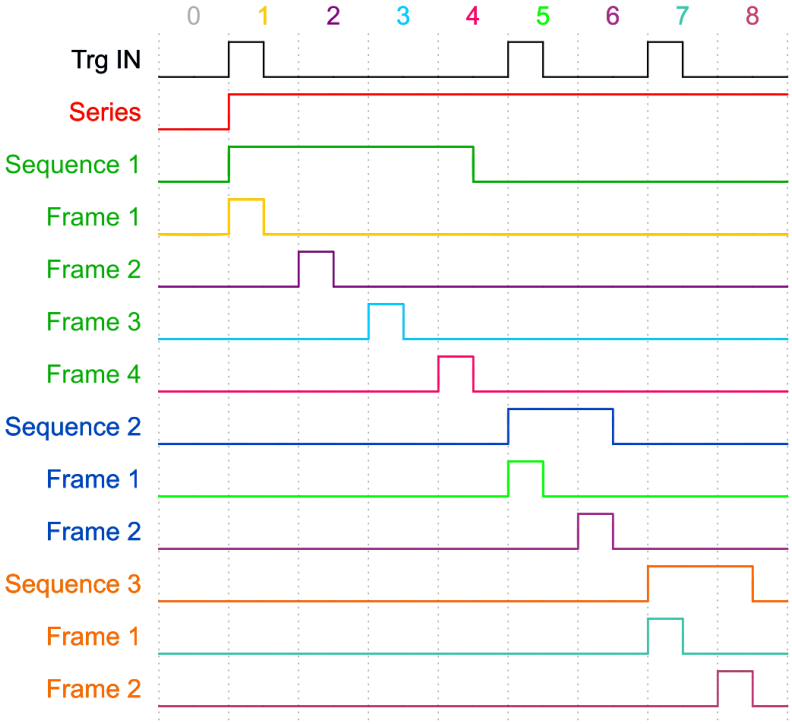
Every trigger that comes in triggers the next sequence in the recipe. When a sequence is triggered it runs through all programmed frames then stops and waits for another trigger to start the next sequence.

If the sequence is programmed to execute multiple times; one trigger will run all the executions for that sequence.

If there is only one Sequence programmed the trigger continues triggering that sequence. This is not continuous as the sequence will not run again until it receives a trigger.



If more than one sequence is programmed; each trigger will start the next sequence. Once it completes the last sequence the next trigger will trigger sequence one again and continue in consecutive order.

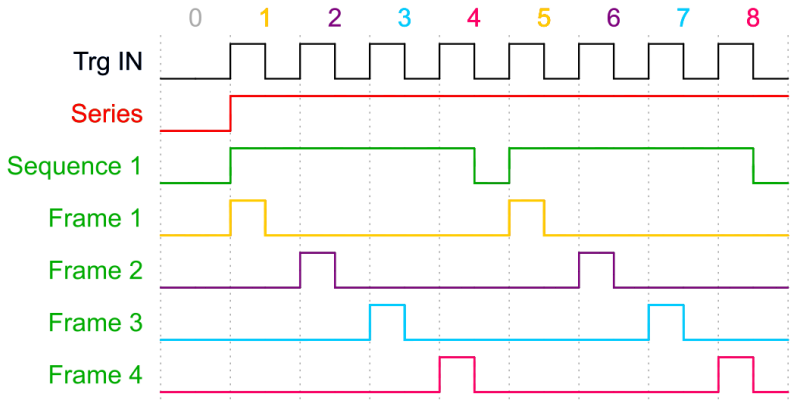


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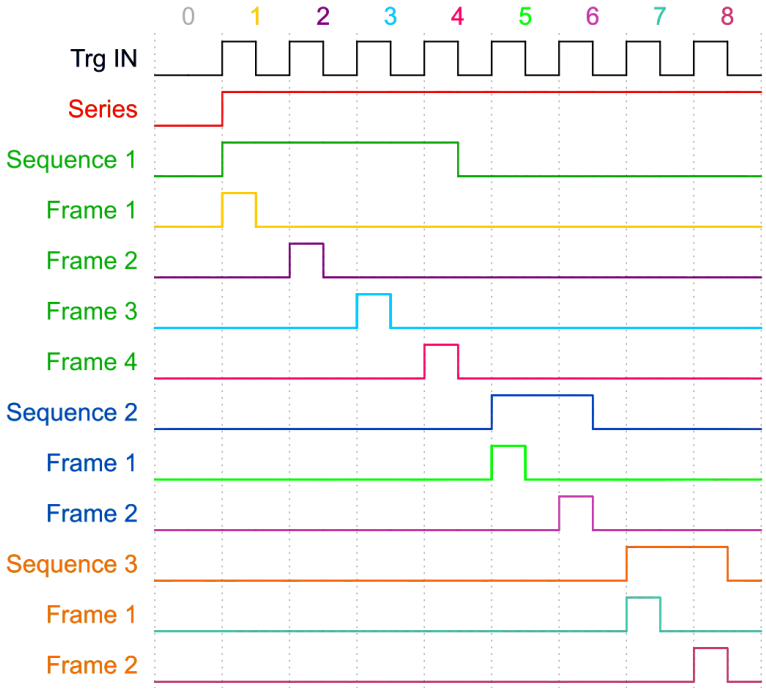
Trigger Event: Frame

Every trigger that comes in triggers the next frame in the sequence. The first trigger enables the recipe, first sequence, and first frame. The next trigger triggers the second frame in the same sequence and so on until all the frames have been triggered.

If there is only one sequence programmed the 5th trigger (in this example) will trigger the first recipe, sequence and frame again.



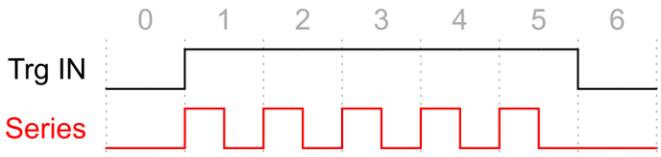
If more than one sequence is programmed the 5th trigger (in this example) will trigger the second sequence and the first frame of the second sequence.



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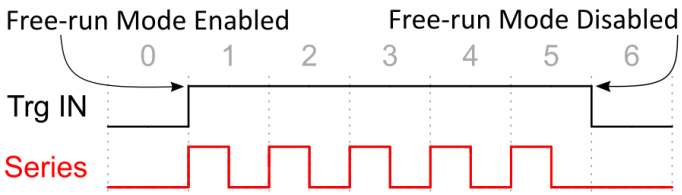
Trigger Type: Continuous

Recipe runs in a loop as long as the trigger signal remains high. When the trigger signal drops the LSS finishes the recipe that has started and ends.



Trigger Type: Free-Run

Recipe runs in a loop as long as the free-run trigger type is enabled. It does not require a trigger to begin running the sequence.

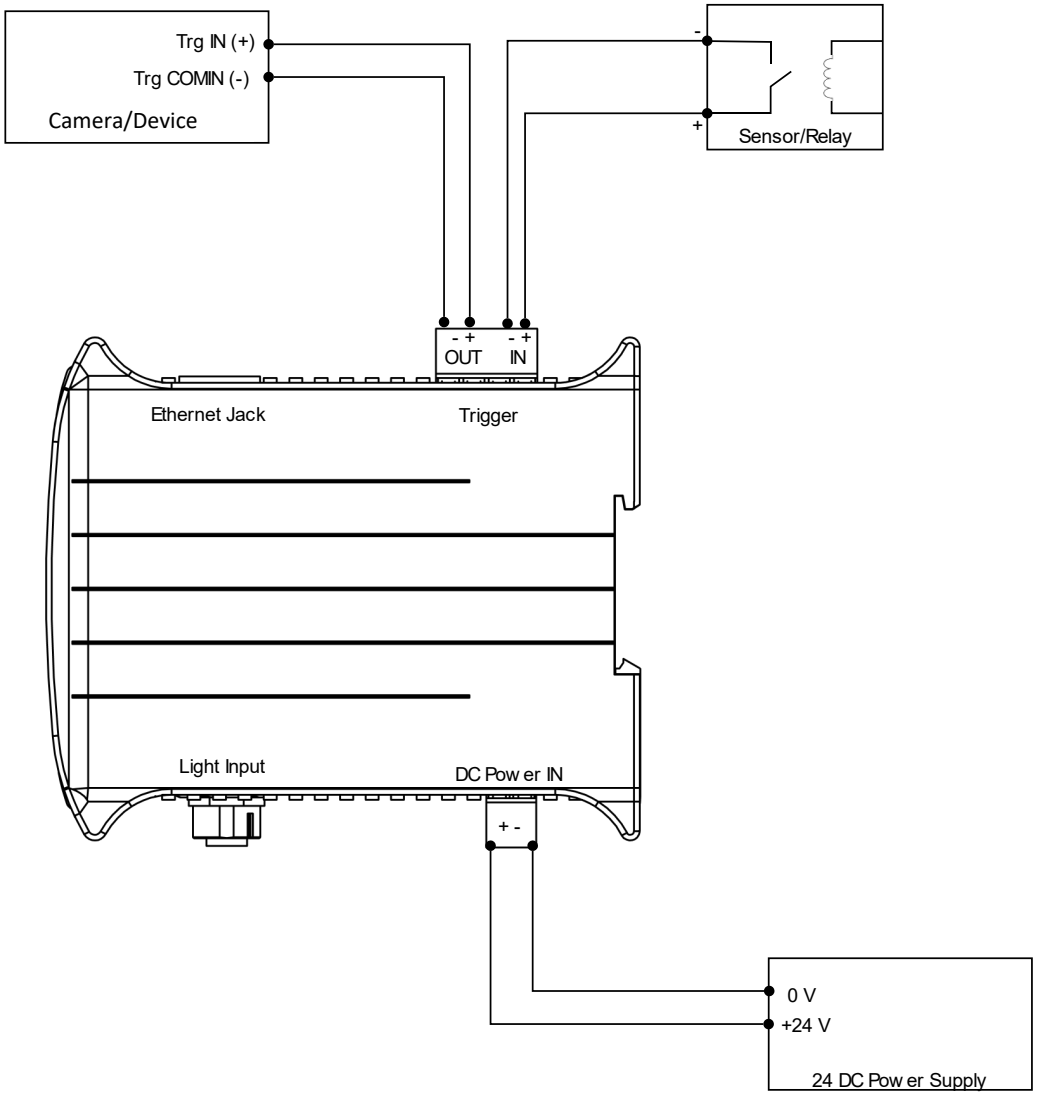


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D. Connection Diagram

LSS Master

See below for specific instructions for NPN, PNP, opto-isolator, and open collector.

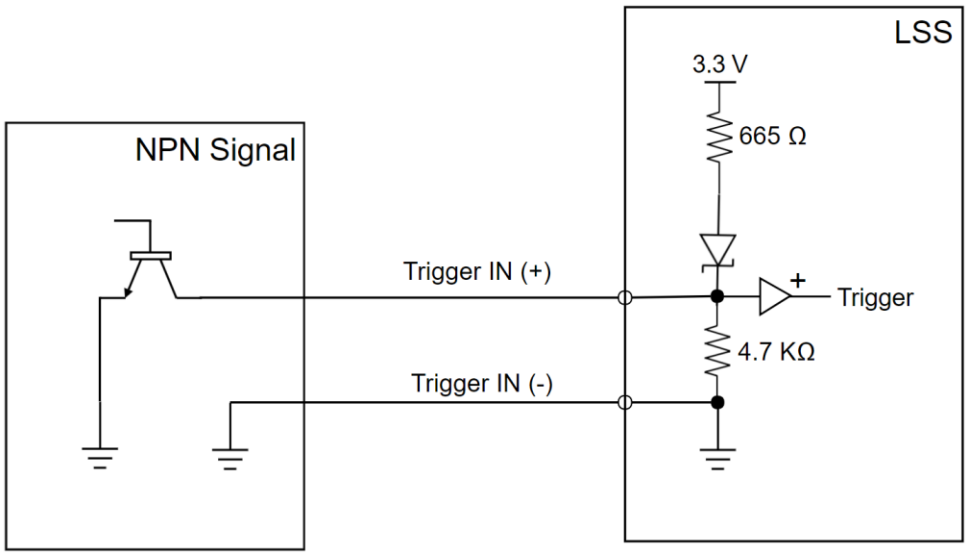


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Trigger-In Connection

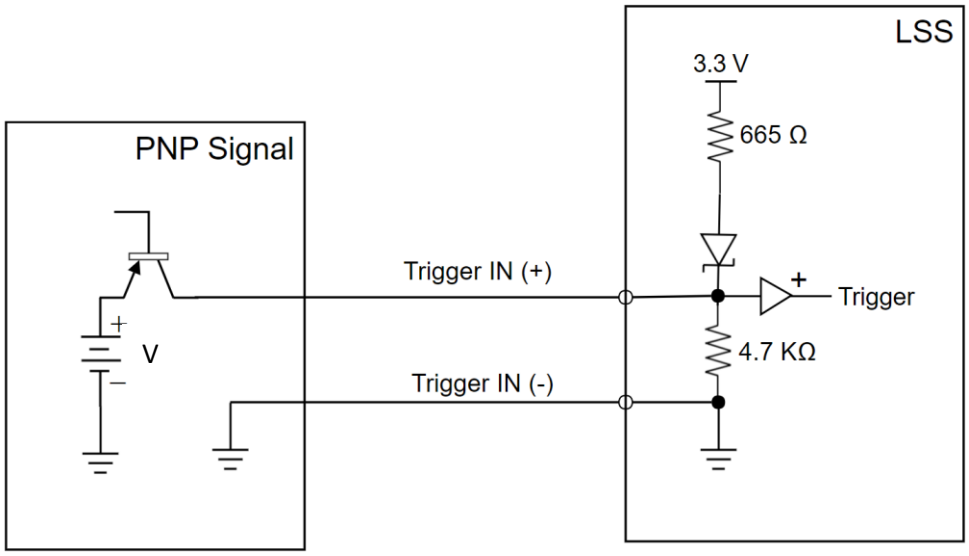
NPN/Open Collector

To connect with an NPN signal wire as shown below and be sure to check the 'Ground Trigger' button in the GUI.



PNP

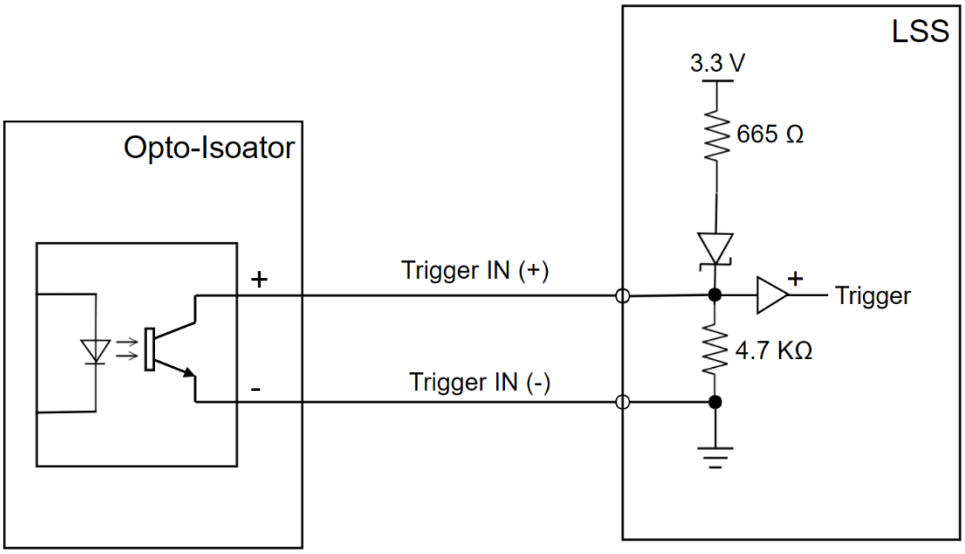
To connect with a PNP signal; wire as shown below and leave the ground trigger button unchecked in the GUI. Also, but be sure to adjust the voltage level in the GUI based on the signal voltage. PNP voltage does not need to be 24 V; can be 3.3, 5, or 12 V instead.



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Opto-Isolator (NPN)

To connect with an NPN opto-isolator signal wire as shown below and be sure to check the 'Ground Trigger' button in the GUI.



Trigger-Out Connection

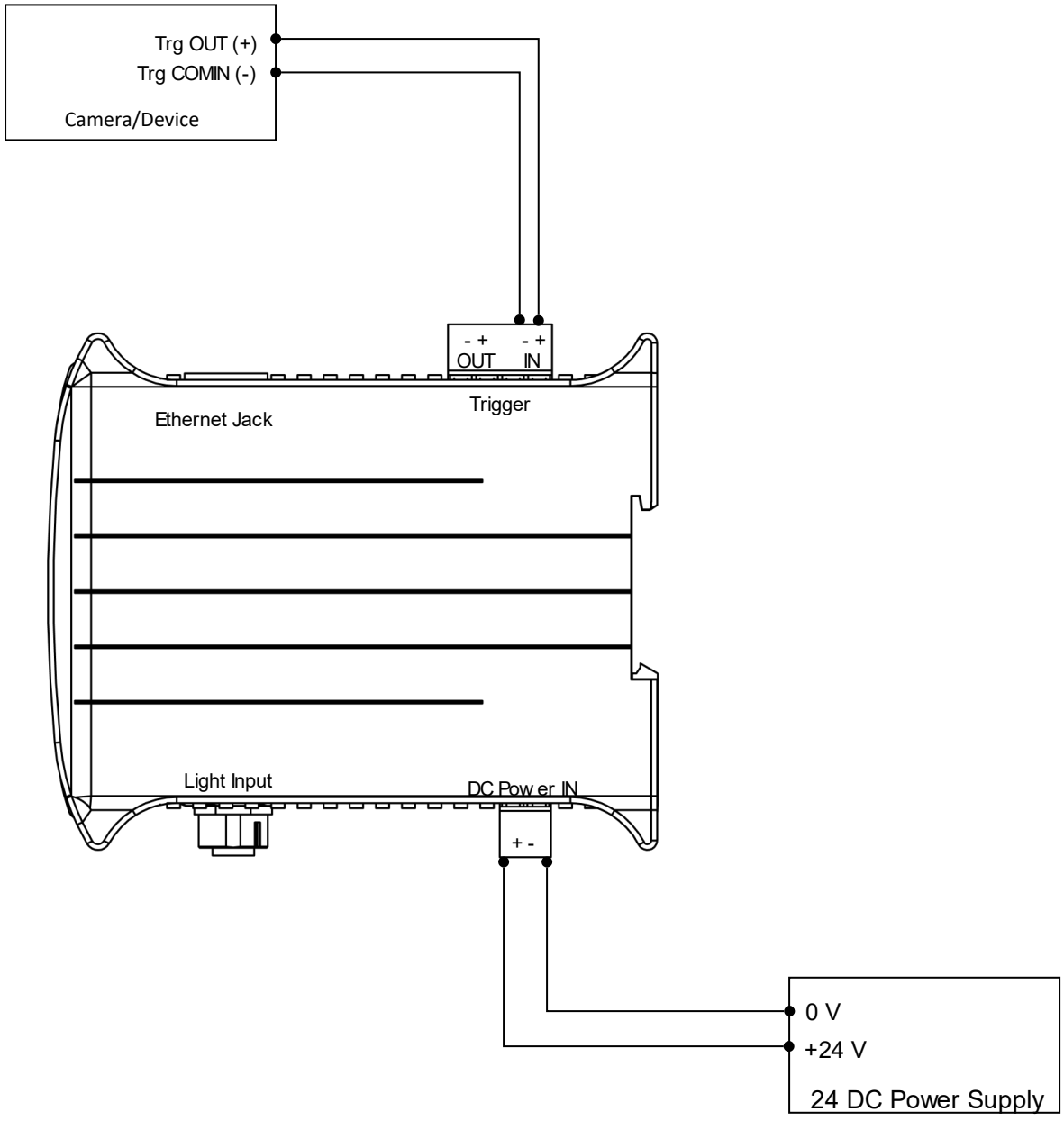
The trigger-out of LSS is voltage output. Be sure to set the output voltage level (in the GUI) to match the camera's or external trigger device's trigger voltage. The voltage level will be found in the devices manual.

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LSS Slave

To use the camera as the master and the LSS as the slave the 'Trigger Type' must be set to 'One-shot' and the 'Trigger Event' must be set to 'Frame'. See below for camera wiring for most NPN, PNP, opto-isolator, and open connector.

Be sure to set the right 'Camera Voltage' based off the camera being used as the trigger in the GUI.

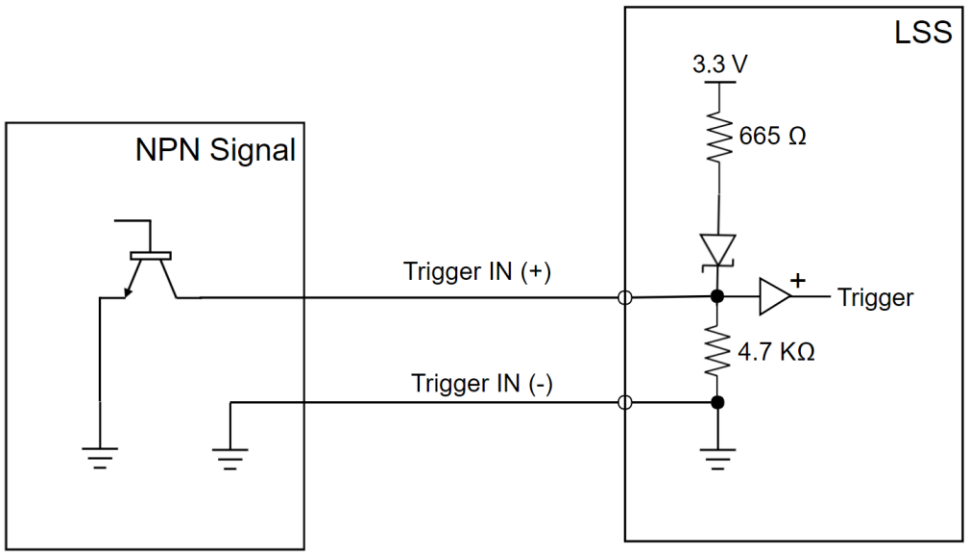


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Trigger-In Connection

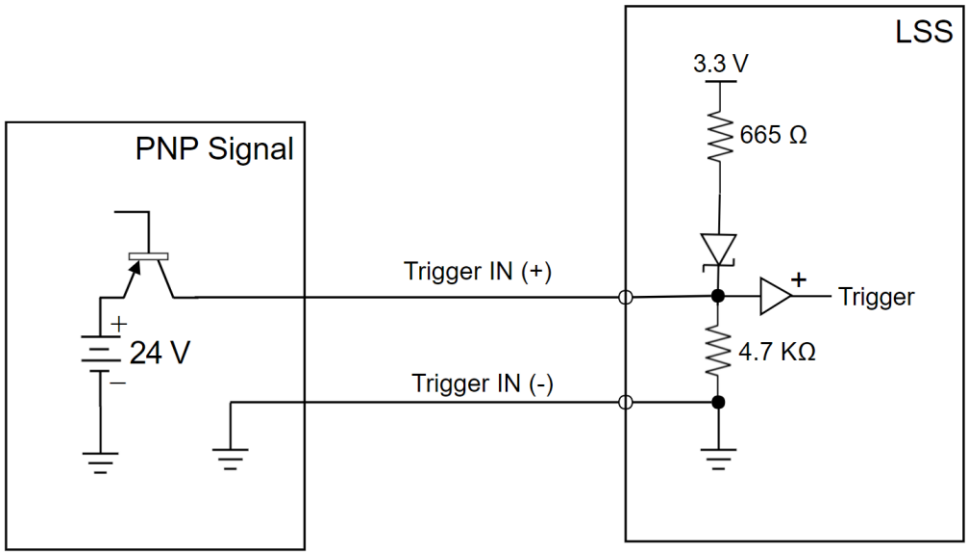
NPN/Open Connector

To connect with an NPN signal wire as shown below and be sure to check the 'Ground Trigger' button in the GUI.



PNP

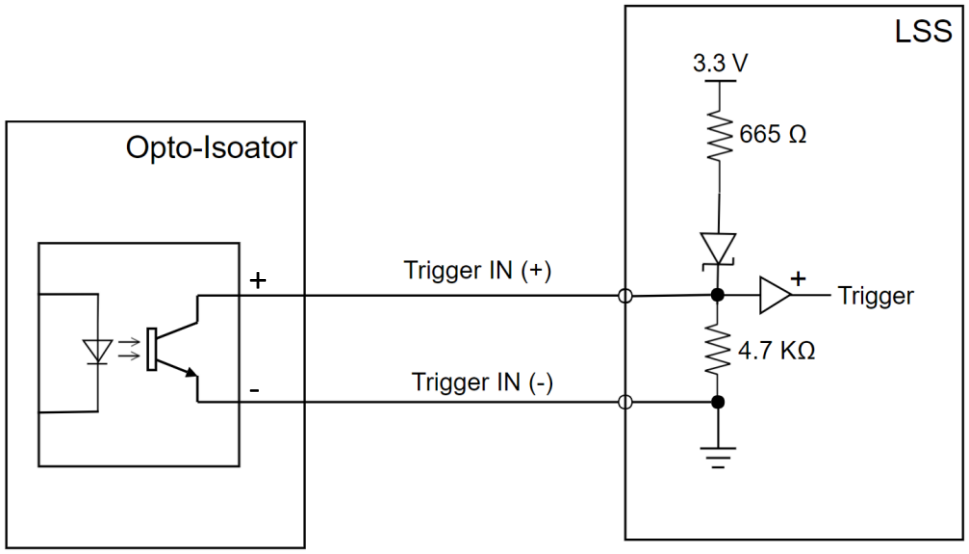
To connect with a PNP signal wire the system as shown below. In the GUI; leave the ground trigger button unchecked and be sure to adjust the 'Trigger Voltage' level based on the signal voltage.



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Opto-Isolator

Be sure to check the ground trigger button in the GUI.



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E. API Commands

HTTP RESTful APIs

APIs follow general rule of '=' indicates set and no '=' indicates get. The exception is when a get API requires a value. Set APIs generally return xxx=PASS or xxx=FAIL. Get APIs return either a single value or a JSON object.

Note that frames referenced by sequences need to be loaded first. Similarly, sequences referenced by series needed to loaded first.

Info

/info

Returns number of HTTP accesses since power up.

/version

Returns firmware name and version.

/PCB

Returns PCB info (id, rev, and mod) in 12 bit in hex format.

/id

Returns processor 96 bit unique factory programmed Device ID in hex format.

/temp

Returns floating point temperature inside processor in degrees C.

Recipe

/frame=

Sets a Frame in active Recipe (JSON format).

/frame

Returns space separated list of Frame names contained in active Recipe.

/sequence=

Sets a Sequence in active Recipe (JSON format).

/sequence

Returns space separated list of Sequence names contained in active Recipe.

/series=

Sets the Series in active Recipe (JSON format).

/series

Returns Series names contained in active Recipe.

/config=

Sets the Config in active Recipe (JSON format).

/config

Returns Series names contained in active Recipe.

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/frameGet=
Returns JSON formatted Frame in active Recipe of given name.

/sequenceGet=
Returns JSON formatted Sequence in active Recipe of given name.

/seriesGet=
Returns JSON formatted Series in active Recipe of given name.

/configGet=
Returns JSON formatted Config in active Recipe of given name.

Operational

/bootloader
Puts LSS into Bootloader Mode (to upgrade Firmware).

/trigInEnable
Enables Trigger Inputs.

/trigInDisable
Disables Trigger Inputs.

/save
Saves active Recipe (number 1) and settings to non-volatile memory.

/reset
Resets the LSS.

/start
Starts active Recipe.

/stop
Stops active Recipe.

/statusClear
Clears Status Error and Status LED indicator.

/default
Loads Recipe stored in non-volatile memory into active memory.

/clear
Clears active Recipe.

/loadDefaultParams
Loads default Recipe and settings stored in non-volatile memory into active memory.

/recipe
Returns active Recipe number (1-6).

/recipe=
Loads given Recipe number (1-6) stored in non-volatile memory into active memory.

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/recipeValid=
Returns PASS if Recipe stored in non-volatile memory at given Recipe number (1-6) is valid.

/recipeSave=
Saves active Recipe to non-volatile memory at given Recipe number (1-6).

Settings
/statusColorSet=
Sets Status LED indicator color mapping (JSON format).

{

"status":	x,	status (see below and in user manual)
"red":	x,	red intensity 1-100%
"green":	x,	green intensity 1-100%
"blue":	x	blue intensity 1-100%

}

"status":

0 - BOOTLOADER

1 - FACTORY_RESET

2 - POWER_ON

3 - TRIGGER1

4 - TRIGGER2

5 - ERROR_GENERAL

6 - ERROR_1

7 - ERROR_2

8 - ERROR_3

9 - ERROR_4

10 - ERROR_5

/statusColorGet=
Sets Status LED indicator color mapping (JSON format - see previous API).

/statusLevel=
Sets Status LED indicator brightness 1-100%.

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/statusLevel
Returns Status LED indicator brightness 1-100%.

/status=
Sets status (see /statusColorSet= API for definition of status).

/status
Returns status (see /statusColorSet= API for definition of status).

/triggerStrobe=
Sets Status LED indicator Trigger Strobe duration in milliseconds.

/triggerStrobe
Returns Status LED indicator Trigger Strobe duration in milliseconds.

/startupDelay=
Sets Startup Delay seconds.

/startupDelay
Returns Startup Delay seconds.

IP
/ip=
Sets static IP address (string format ... example 192.168.0.10).

/ip
Returns static IP address (string format ... example 192.168.0.10).

/gw=
Sets Gateway address (string format ... example 192.168.0.1).

/gw
Returns Gateway address (string format ... example 192.168.0.1).

/subnet=
Sets Subnet mask (string format ... example 255.255.255.0).

/subnet
Returns Subnet mask (string format ... example 255.255.255.0).

/dhcp=
Sets DHCP enable flag (0=disabled, 1=enabled).

/dhcp
Returns DHCP enable flag (0=disabled, 1=enabled).

/name=
Sets LSS device name (string format 24 characters max).

/name
Returns LSS device name (string format 24 characters max).

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Diagnostics

/ch1= ... /ch12=
Sets channel output (0=off, 1=on).

/ch=
Sets all channel outputs (bitmapped hex format - D0=ch1 ... D11=ch12).

/triggerOut1= /triggerOut2=
Sets Trigger Output (0=off, 1=on).

/Vtrigger=
Sets Trigger Output voltage (5,12, or 24).

/triggerIn1 /triggerIn2
Returns Trigger Input ADC voltage reading in float format (scaled by 1/9.069 of voltage at Trigger Input connector pin).

/RGBRed=
Set red color intensity of Status LED indicator 1-100%.

/RGBGreen=
Set green color intensity of Status LED indicator 1-100%.

/RGBBlue=
Set blue color intensity of Status LED indicator 1-100%.

/ethernetOff
Turns off Ethernet subsystem.

/FactoryReset
Returns state of Factory Reset button (1=pressed, 0=not pressed).

Factory

/password=
Returns TRUE only if password is correct ... otherwise returns HTTP error for security (not password=FAIL).

/mac
Returns MAC address (string format ... example 11-22-33-44-55-66).

/authorizationPassword=
Returns TRUE only if authorization password is correct ... otherwise returns HTTP error for security (not authorizationPassword=FAIL).

/authorization
Returns authorization string.

/sncm=
Sets CM serial number (string format 64 characters max).

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/sncm
Returns CM serial number (string format 64 characters max).

/snCCS=
Sets CCS America serial number (string format 64 characters max).

/snCCS
Returns CCS America serial number (string format 64 characters max).

JSON Object Format Examples
All JSON objects are fixed size and must contain all parameters.

Frame
All times are 0-2,000,000,000us unless noted. EndDelay is equal to Period minus longest trigger or channel output plus output delay.

```
frame=

{
  "type"                    :"frame",     // type - frame
  "name"                    :"FrSeqFr1", // frame name
  "period"                  :400000,      // period time
  "endDelay"                :200000,      // end delay time
  "independentWidthsFlag":1,              // 1=independent
                                          // channel widths
  "endDelay"                :"200000",   // end delay time
  "trigOut1":
  [
    "0",                 // start time
    "0"                  // end time
  ],
  "trigOut2":
  [
    "0",
    "0"
  ],
```


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```
  "channels":
  [
    0,200000,  // channel 1 start/end time
    0,0,   // channel 2 start/end time
    0,0,
    0,0,
    0,0,
    0,0,
    0,0,
    0,0,
    0,0,
    0,0,
    0,0,
    0,0    // channel 12 start/end time
  ]
}
```

Sequence

```
sequence=
{
  "type"              :"sequence",// obj type - sequence
  "name"              :"Seq1",    // sequence name
  "framingModeFlag" :0,       // 1= framing mode
  "frameNames"        :           // list of 14 frame names
                                   // 0 if not used
  [
    "FrSeq1Fr1",
    "FrSeq1Fr2",
    "FrSeq1Fr3",
```


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```
    "FrSeq1Fr4",
    "0","0","0","0","0","0","0","0","0","0" // blank must
                                // be "0"
  ],
  "repeats":            // list of repeats for each frame
  [
    1,
    1,
    1,
    1,
    0,0,0,0,0,0,0,0,0,0
  ]
}
```

Series

```
series=
{
  "type"           :"series",  // object type - series
  "name"          :"Ser1", // series name
  "sequenceNames" :             // list of 10 sequence names
  [
    "Seq1",
    "Seq2",
    "0","0","0","0","0","0","0" // blank must be "0"
  ],
  "repeats":             // list of repeats for each sequence
  [
    0,0,0,0,0,0,0,0,0,0
  ],
  "seriesRepeats":"0"  // series repeat
```


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```
}
```

Config

```
config=

{
  "type"              :"config",       // object type - config
  "name"              :"Cfg1",         // config name
  "version"           :2,              // Recipe version
  "triggerInputs":
  [
    {
      "level"                 :0.15,// 0.0 - 24.0 volts
      "polarityHighFlag"      :0,       // 1=high, 0=low
      "type"                     :1,    // 1=oneShot
                                        // 2=activeRun
                                        // 3=freeRun
      "groundTriggerFlag"     :0,       // 1=ground trigger
      "delay"                 :0,    // trigger delay
      "event"                 :0,       // 0=frame,
                                        // 1=sequence,
                                        // 2=series
      "function"              : 0,   // 0=reset,
                                        // 1=pause,
                                        // 2=alternate ...
                        // unused/TriggerInput1
    },
    {
      "level"                 :0.15,
      "polarityHighFlag"      :0,
      "type"                     :1,
```


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```
      "groundTriggerFlag"     :0,
      "delay"                 :0,
      "event"                 :0,
      "function"              :0
    }
  ],
  "triggerOutputs":
  [
    {
      "level"           :5,// 5,12,24 volts
      "polarityHighFlag":0,// 1=high, 0=low
      "width"           :100  // global width
    },
    {
      "level"           :5,
      "polarityHighFlag":0,
      "width"           :100
    }
  ],
  "resolutionUSFlag"    :0, // 0=ms, 1=us (GUI only)
  "outputDelay"         :0  // output delay from camera
}
```


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Use Case: Storing a Recipe to the LSS

The following API stopping/disabling current Recipe and loads/enables a new Recipe:

/stop	stop current Recipe
/trigInDisable	prevent trigger of current Recipe
/config={...}	send Config (MUST before Frame/Sequence/Series)
/frame={...}	send Frames (MUST bebefore Sequences/Series)
...	
/sequence={...}	send Sequences (MUST be before Series)
...	
/series={...}	send Series (MUST be last)
/trigInEnable	enable new Recipe trigger

NOTE: Verify Config/Frame/Sequence/Series APIs return PASS (FAIL indicates a JSON format error or missing parameter).

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F. Multi Shot Imaging Examples

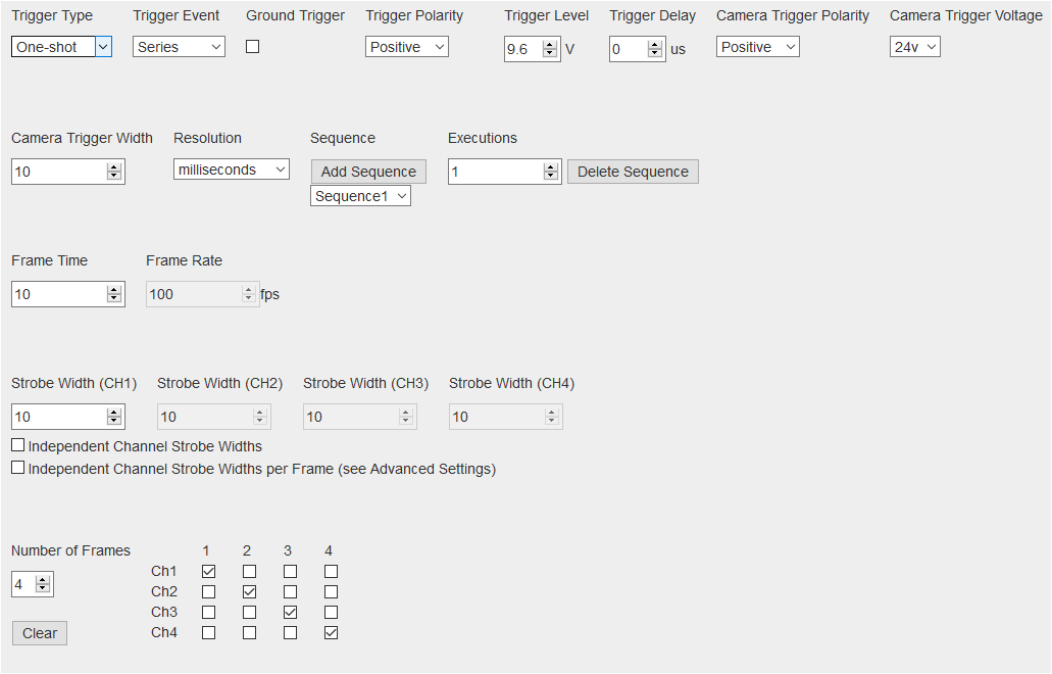
Example 1

How to set up a program that has: one PMS image, 3 normal ring light images, and one image that only illuminates the left quadrant of the light (lighting block 2). During execution only one trigger is needed to run the entire recipe. The inspection is stationary but requires the recipe to have a capture time of 110 ms.

Recipe Settings

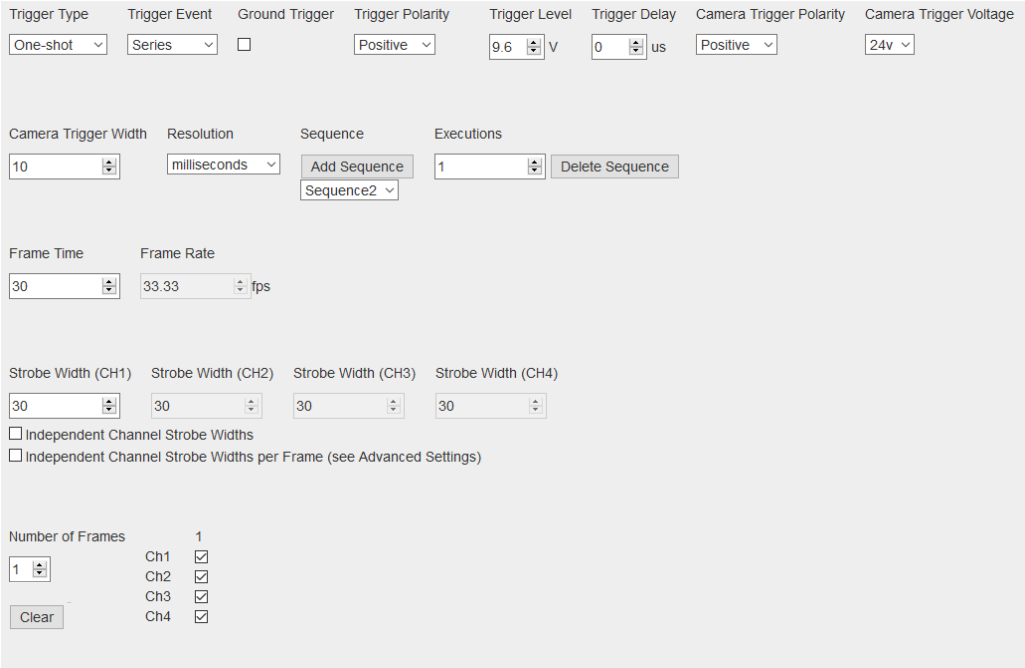
Trigger Type: One Shot Trigger Event: Series

Sequence 1: will have a total capture time of 40 ms, 10 ms for each frame.

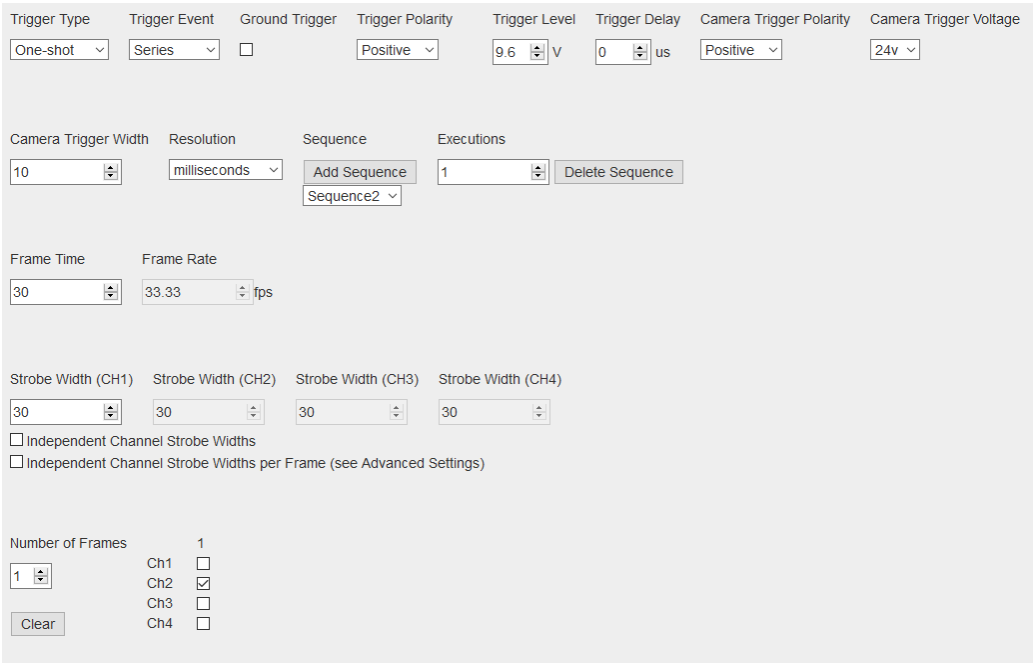


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Sequence 2: The next images require a longer strobe width to create a brighter image. The frame time and strobe width have been increased. The capture time is 30 ms.



Sequence 3: The frame time and strobe width are increased. The capture time is 30 ms.



The total capture time for the recipe (all 3 sequences) is 100 ms.

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