Wireless LED Fixture Controller

User Manual

Giulio Lighting

Important Infomation

Please read through these notes and the remaining instructions before installing this device.

1. Refer to local and state codes to ensure compliance when installing this device. Consult an Electrical Inspector if you have any questions.
2. Use only with a listed Class 2 or Limited Power Source external power supply.
3. The external power supply must be located outside any cabinet and not concealed.
4. LEDdrive cables should be rated CL2 or better with 24 AWG conductors.
5. Do not interconnect ethernet and LEDdrive devices even though they use the same RJ45 connector. Damage may result.
6. Do not exceed the maximum number of attached LEDdrive devices as specified by the device User Manual.
7. Do not exceed the maximum LEDdrive cable length.
8. Use only insulated staples or plastic ties to secure cords.
9. Make sure that power is disconnected before connecting or disconnecting any LEDdrive devices.
10. Make sure this device and its power supply are located in a dry environment.
11. Be sure to plan the installation before beginning.

Wireless LED Fixture Controller

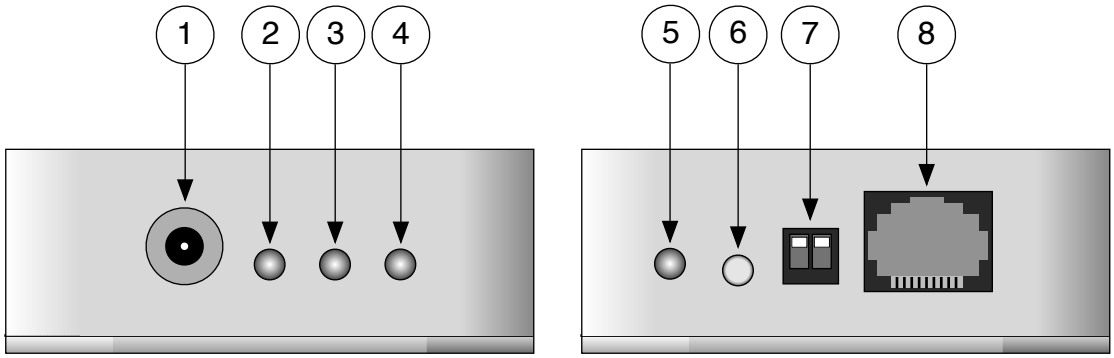
Model LC-001

The Model LC-001 Wireless LED Fixture Controller is part of the QualColor™ family and controls one or more Giulio Lighting LED-based light fixtures connected using LEDdrive. Integrating a wireless receiver with the sophisticated Giulio Lighting LEDsmarts system, the LC-001 allows full control over a lighting system's color and intensity. The LC-001 can be operated by any Giulio Lighting controller using the LEDlink wireless interface.

Feature	Benefit
LEDlink digital radio interface	Allows easy installation of lighting system components.
LEDdrive fixture interface	Easy connection to fixtures and OEM drivers using commonly available tools and cabling.
Supports multiple LED Configurations	Simplifies multi-controller installations of mixed fixture types without worrying about how individual channels are mapped to specific controls. The LC-001 controller can operate fixtures with a different LED configurations (for example RGB, RGBW, RGBA).
LEDsmarts fader	Allows any number of fixtures to be operated by one control by distributing the fading operation to the fixture controllers.
LEDsmarts automatic programs	Allows fixtures to operate independently of the remote controlling device.
Configurable Link attributes	Allows multiple controllers to co-exist and to handle radio interference from external sources.

Feature	Benefit
Configurable address	Allows sophisticated installations with independently operating fixtures.
Configurable calibration	Allows tuning of the white light generated by fixtures generating using RGB or RGBA LED configurations.
Small size	Easily hidden under or over cabinets and in coves.

Device Description



Side Views

Item	Description
1	Power Input Jack. Provides power for the LC-001 device and fixtures that require power from LEDdrive. Connect to a 24 volt DC Class 2 or Limited Power Source.
2	Power Indicator. Green indicator that is lit when the LC-001 is receiving power.
3	RF Activity Indicator. Green indicator that blinks each time the LC-001 receives a packet over the LEDlink RF interface.
4	RF Error Indicator. Red indicator that blinks when the LC-001 detects a missed packet. Excessive blinking of this indicator indicates poor reception by the LC-001.

Item	Description
5	Prog Indicator. Red indicator that is lit when the LC-001 is put into Provisioning Mode (the Prog Button is pressed). Remains lit until an external device successfully provisions the LC-001, the Prog Button is pressed a second time or a one hour period expires.
6	Prog Button. Recessed button used to put the LC-001 into and out of Provisioning Mode. See section "Provisioning" for a more detailed description of the provisioning process.
7	LED Fixture Configuration. Two recessed DIP switches used to configure the LC-001 appropriately for the fixture(s) it will control. These switches should be set to match the requirements of the fixture(s) being controlled. These requirements are indicated on the fixture label. The two switches allow for four combinations of LED colors. Looking at the switches head on, the following assignments are made. 1. up - up : White-only. The LC-001 is configured to control a fixture containing only white LEDs. The LC-001 controls the intensity of the fixture. It ignores all color data. It also ignores commands to enter an automatic program mode. 2. up - down : RGBW. The LC-001 is configured to control a fixture with red, green, blue and white LEDs. The LC-001 will utilize the color LEDs to generate color and the white LEDs to generate white light. It automatically and evenly switches between the two groups as necessary. 3. down - up : RGBA. The LC-001 is configured to control a fixture with red, green, blue and either amber or yellow LEDs. The LC-001 will utilize all LEDs to generate all colors and white. This configuration is for advanced uses and may require additional provisioning of the LC-001 with calibration information specific to the fixture(s) it will control. 4. down - down : RGB. The LC-001 is configured to control a fixture with red, green and blue LEDs. The LC-001 will utilize the three LED colors to generate all colors and white. The LC-001 may be provisioned with additional calibration information to optimize the white generated by the fixture(s) it will control.

Item	Description
8	LEDdrive connector. Connects the LC-001 to the first fixture using an 8-conductor RJ45 cable carrying power and LED modulation signals. See section "LEDdrive Pinout" for more information about the LEDdrive connection. The LC-001 can drive any LEDdrive capable fixture. The User Manual for the fixture will describe which of the following three methods is used to distribute power. 1. LC-001 sources power: The power supply connected to the LC-001 will provide power for the LC-001 and attached fixture(s). The User Manual for the fixture will specify the maximum number of allowed fixtures. In all cases the maximum current is 1.25 Amps. 2. LC-001 receives power: The attached self-powered fixture provides power for the LC-001 via the LEDdrive cable. The LC-001 does not require an external power supply for use with this kind of fixture. 3. LC-001 self power: The power supply connected to the LC-001 provides power for the LC-001 only. All attached fixtures contain their own power supply.

LEDsmarts

The LC-001 contains a sophisticated controller called LEDsmarts that manages the LED fixtures locally. The LEDsmarts controller allows installations of LED lighting systems that do not depend on any one central controller to manage all lighting effects. Installations may be controlled by multiple control devices and may even operate independently of any controller. The LC-001 LEDsmarts controller includes the following capabilities.

- Color fader: The LC-001 manages transitions from one color and intensity to another one automatically and independently.
- Automatic programs: The LC-001 can automatically animate a color-capable fixture with one of two programs. Each program change the fixture color at one of four speed settings.
  - Random : The LC-001 fades the fixture(s) smoothly between randomly chosen colors for a ever-changing light show.
    - Slow : 30 - 180 seconds for each color change.
    - Medium/Slow : 10 - 60 seconds for each color change.
    - Medium/Fast : 5 - 30 seconds for each color change.
    - Fast : 1 - 6 seconds for each color change.

    - Sequential : The LC-001 fades the fixture(s) smoothly between all the hues in the rainbow.
        - Slow : 30 minutes for the complete sequence of colors.
        - Medium/Slow : 10 minutes for the complete sequence of colors.
        - Medium/Fast : 3 minutes for the complete sequence of colors.
        - Fast : 15 seconds for the complete sequence of colors.
- Color space mapping : The LC-001 automatically controls multiple configurations of LEDs to properly generate colors without requiring any central controllers to have specific knowledge of the fixture.

Addressing

The LC-001 controller supports Zone/Unit addressing with Group support.

- Zone Address: 0-65535. Factory default value of 1.
- Unit address: 0-65535. Factory default value of 1.
- Four Group Addresses: 0-255. Factory default value of 0 for each group address.

Zone addresses are used to associate related fixtures and fixture controllers. For example all fixtures and fixture controllers in one physical location such as a room may be given the same Zone address so that they may be controlled together.

Unit addresses are used to control individual lights within a Zone. Each separate fixture or fixture controller is given a unique Unit address allowing it to be controlled alone.

Group addresses are used to control groups of related fixtures or fixture controllers within a Zone. All fixtures with the same Group address will respond identically to commands addressing that group.

LEDlink Radio Interface

A LC-001 and one or more other devices communicate using the proprietary LEDlink radio protocol sharing certain characteristics called a Link. A LC-001 is considered linked to another device when it and the other device share the same Link attributes. These attributes define the Link characteristics.

1. Radio channel : Specifies the common frequency the radio transceiver in the LC-001 and other device(s) are tuned to.
2. Network ID : The Network ID is designed to allow multiple, overlapping installations of fixtures and other controllers to work without interference. The primary use of the Network ID is to prevent an installation of devices in one

apartment or home from affecting devices in another apartment or home where the radio signals may overlap. Devices with different Network IDs ignore each other.

3. Device address : Each fixture or fixture controller may be configured with a unique device address. The LC-001 is configured with the device address for the fixture(s) it controls.

The factory default configuration for the LC-001 and all LEDlink capable Giulio Lighting control devices contains the same linking attributes allowing a LC-001 fixture controller to immediately work with these devices.

Certain conditions may require that one of the Link attributes be changed. Example conditions include the following.

1. The user desires to have multiple LC-001 fixture controllers, each with a different address in order to be operated independently.
2. The user desires to change the Radio channel to avoid radio interference from a device like a microwave oven.
3. The user desires to change the Network ID to avoid interference from a lighting system in another apartment or home.

Link attributes are changed using a process called provisioning described in the next section.

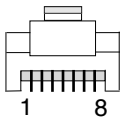
Provisioning

Link attributes and other operating parameters of the LC-001, such as address, are changed by a process called provisioning. During provisioning an external device communicates the new Link attributes to the LC-001 over the LEDlink wireless interface. The external device may be a handheld remote control or some sort of computer interface under the control of software running on a personal computer. The LC-001 is put into a special mode, called the Provisioning or Link mode, by pressing the Prog button and and verifying the Prog Indicator is lit. Typically this is a step described in the User Manual for the device or software being used to provision the LC-001. The LC-001 will remain in Provisioning mode for up to one hour before reverting automatically to normal operation. In Provisioning mode the Link characteristics of LEDlink are set to a known condition so that another device may communicate with it successfully over the LEDlink.

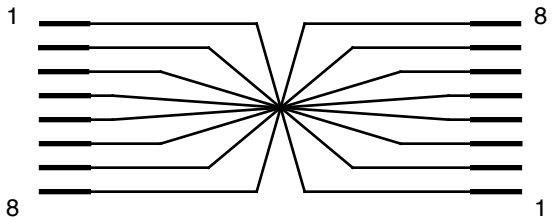
LEDdrive Pinout

LEDdrive cables are based around ethernet cabling technology to simplify building custom cables in the field. LEDdrive cables have the following requirements.

1. Minimum conductor size of 24 AWG.
2. Cable type of CL2 or better. A higher rated cable may be substituted (CMP, CL3P, CL2P, CMR, CL3R, CL2R, CMG, CM, PLTC, CL3).
3. Cable wiring is identical to ethernet "straight-through" wiring as shown by the following illustrations.



RJ45 connector pinout (front view)



Wiring Diagram

Pin	Color (both sides identical)
1	White with orange
2	Orange
3	White with green
4	Blue
5	White with blue
6	Green
7	White with brown
8	Brown

Cable wire assignment

Advanced Features

The LC-001 supports custom calibration parameters to enhance operation of certain fixture types.

1. White balance calibration : Adjust the amount of red, green, blue and optionally amber used when generating white light for RGB and RGBA fixture types. These calibration parameters allow the user to specify the precise white generated by a fixture that uses separate color components.
2. Amber/Yellow Channel calibration : Specify the precise color of the Amber channel in relation to the green and red channels for fixtures using RGBA or RGBY LED arrays.

Use of these calibration parameters is beyond the scope of this document. Please refer to the User Manual for the calibration software available on the Giulio Lighting website.

Pre-installation

It can be helpful to plan an installation prior to starting to physically install components.

The following items should be considered when creating the plan.

Provisioning

Provisioning of the LC-001 is required if any link attributes or other operating parameters must be changed. It may be helpful to provision the LC-001 before installation in order to place the LC-001 and provisioning device in close proximity (although the LC-001 can be provisioned or re-provisioned once installed). It is not necessary to attach any fixture(s) to the LC-001 unless required by the provisioning process. Locate the LC-001 near the provisioning device (within five feet / 2 m). Attach the external power supply to the LC-001 and plug the PSU into an outlet. Press the Prog button to put the LC-001 into Provisioning Mode. Finally follow the procedures described in the User Manual for the provisioning device or software.

LED Fixture Configuration

Configure the DIP switches on the LC-001 to match the requirements of the LED fixture(s) it will be controlling. Fixtures supplied by Giulio Lighting indicate the required configuration on the fixture label.

LC-001 and Power Supply Location and Orientation

Determine the installation location for the LC-001. The location generally depends on the following factors.

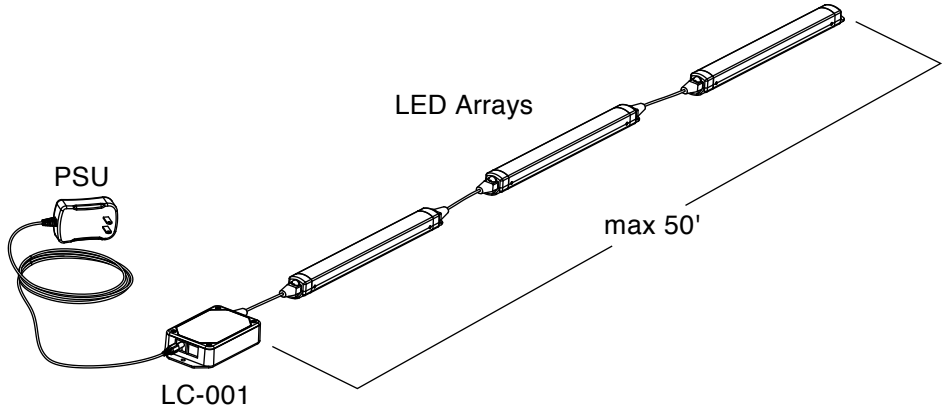
- Location of power outlet. The power supply cable length dictates the maximum distance from a power outlet to the LC-001 location.
- Access for fixture cabling. The LEDdrive cable connection to the first fixture should be routed in an unobtrusive manner.
- LC-001 position and orientation for best radio reception. The LC-001 should be located so that there is a clear path for the radio signal from the device that will control it. Examples locations include on the underside or top of a cabinet or in a cove. The LC-001 may be located inside a wood cabinet. However it should never be located inside a metal enclosure or against a metal surface. Note the orientation arrow on the LC-001 label. The indicated side should be mounted closest to nearest wall.

The LC-001 will typically work up to 100 feet (30 m) from the controlling device outdoors and 50 feet (15 m) indoors. Actual range may vary substantially based on the position and orientation of the fixture and objects, such as walls, between the LC-001 and the controlling device.

The LEDlink radio communication between the LC-001 and controlling device is very robust. However some other devices, including microwave ovens, cordless phones and Wifi devices, may cause interference. Often changing the radio channel used by the LC-001 can alleviate the interference. See the User Manual for the controlling device or provisioning software for further instructions on changing the channel.

Fixture Cabling

A LEDdrive cable is routed from the LC-001 to the first fixture and from there, in a daisy chain method, to additional fixtures. The maximum length of the LEDdrive cabling from the LC-001 to the final fixture is 50 feet (15 m) as shown in the following illustration.



Calculate each LEDdrive segment cable length and either select an off-the-shelf cable from Giulio Lighting or make your own. Be sure to follow the wiring directions in the section "LEDdrive pinout".

Installation

The installation process consists of the following steps.

1. Mount. The LC-001 is designed to be mounted using the supplied screws.
2. Connect fixture via LEDdrive. Connect all fixtures using the LEDdrive cables determined during the pre-installation phase.
3. Attach power supply. Connect the power supply to the LC-001.
4. Plug power supply into power. Verify the the power indicator is lit.
5. Test installation. Verify correct operation of the installation. The RF Activity LED should blink as commands are transmitted to the LC-001.

Troubleshooting

Please refer to the following table for help troubleshooting an installation.

Problem	Possible Cause
Power LED does not light	No power to outlet.
	Power Supply not completely plugged into the LC-001.
	A custom LEDdrive cable was wired incorrectly causing the power supply to automatically shut itself down.
RF indicator does not flash	Controlling device is too far from the LC-001.
	Radio signals are being blocked by materials surrounding the LC-001.
	The LC-001 and the controlling device are not properly linked (e.g. different radio channel or Network ID).
RF Error indicator flashes excessively	Controlling device is too far from the LC-001.
	Radio signals are being blocked by materials surrounding the LC-001.
Fixture colors are not as expected	A custom LEDdrive cable was wired incorrectly.
	The LED Fixture Configuration switches are set to an incorrect value for the fixture.

Specifications

Functions	Fixture Controller	Controls any LEDdrive capable fixture.
	LED Fixture Support	White-only RGB RGBA (RGBY) RGBW
	Automatic Functions	Pseudo-random color selection with four selections for rate of change. Sequential color selection with four selections for rate of change.
	Fixture Calibration	RGB White calibration RGBA Amber/Yellow calibration
Interface	Type	Giulio Lighting LEDdrive proprietary interface.
	Connector	RJ45 8-pin female connector 8 conductor cable Power + 4 channels LED modulation
	LED Modulation	Modified Bit Amplitude Modulation ~122 - 3370 Hz
Radio	Type	Giulio Lighting LEDlink proprietary digital bi-directional protocol. Interoperates with all Giulio Lighting LEDlink capable fixtures.
	Modulation Type	GFSK
	Frequency Range	2.4 GHz Instrument, Scientific and Medical band (ISM) 2.402 GHz - 2.480 GHz
	Power Output	0 dBm typical at antenna input
Power	DC Input	24 volts DC, 1.5 A maximum 2.1x5.5mm Center Positive Connector

Dimensions	Width	7.23 cm / 2.845″
	Length	13.03 cm / 5.130″
Dimensions	Height	2.81 cm / 1.107″
Environmental	Operating	0 - 50º C / 32 - 122º F 20 - 90% relative humidity, non-condensing
	Storage	-20 - 60º C / -4 - 140º F 10 - 95% relative humidity, non-condensing
Regulatory	FCC	FCC Class B Contains FCC ID: XO6-DJ2MOD1 IC: 8558A-DJ2MOD1
	UL	UL2108 and UL8750

Warranty Information

Manufacturer warrants this product to be free from defects in material and workmanship under normal use and conditions ("manufacturing defect") for a period of one (1) year from date of original purchase (the invoice date). This warranty extends to the original buyer (Purchaser) or end-user customer of Manufacturer authorized reseller, and does not apply to fuses, batteries, equipment attached to product or any product, which, in Manufacturer's opinion, has been misused, altered, neglected or damaged by accident or abnormal conditions of operation or handling. Manufacturer will, at its option, repair or replace the Product, or reimburse Purchaser or end user for the full purchase price.

To obtain service, obtain a return authorization (RMA) from the Manufacturer website and then follow the instructions for return of the unit you receive with the RMA.

THIS WARRANTY IS PURCHASER'S SOLE AND EXCLUSIVE REMEDY AND IN IS IN LIEU OF ALL OTHER WARRANTIES, EXPRESSED OR IMPLIED, INCLUDING, BUT NOT LIMITED TO, ANY IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE. MANUFACTURER SHALL NOT BE LIABLE FOR ANY SPECIAL, INDIRECT, INCIDENTAL OR CONSEQUENTIAL DAMAGES OR LOSSES, INCLUDING LOSS OF DATA, WHETHER ARISING FROM BREACH OF WARRANTY OR BASED ON CONTRACT, TORT, RELIANCE OR ANY OTHER THEORY.

Since some countries and states do not allow limitation of the term of an implied warranty, or exclusion or limitation of incidental or consequential damages, the limitations and exclusions of this warranty may not apply to every buyer. If any provision of this warranty is held invalid or unenforceable by a court of competent jurisdiction, such holding will not affect the validity or enforceability of any other provision of this warranty.

INFORMATION TO USER

This device complies with Part 15 of the FCC Rules. Operation is subject to the following two conditions: (1) This device may not cause harmful interference, and (2) This device must accept any interference received, including interference that may cause undesired operation.

This equipment has been tested and found to comply with the limits for Class B Digital Device, pursuant to Part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures.

- Reorient or relocate the receiving antenna
- Increase the separation between the equipment and receiver
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected
- Consult the dealer or an experienced radio/TV technician for help

Any changes or modifications not expressly approved by the party responsible for compliance could void the user's authority to operate the equipment.

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Contact
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This document and the functionality of the product may be subject to change without notice.

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