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A Living Laboratory Product Function Assessment
Advanced Lighting Technology

Surface Mounted Under Counter Dimmable LED Strip - STR8

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Introduction

The product under assessment is an advanced lighting technology—a controllable, surface mounted under-counter light emitting diode (LED) strip lighting system that is designed to provide various levels of direct and indirect white light. It is an integrated system with a complete dimmable LED strip lighting fixture with embedded circuitry to enable DMX 512 control within the LED strip light. It is designed and manufactured by GVA Lighting.

This dimmable LED lighting system was assessed because of its potential widespread application in residential and commercial customer applications, its energy efficiency, and potential to be used as part of load management and demand response programs.

This lighting system contains an LED light engine (see Figure 1) and an addressable and dimmable electronic LED driver designed to illuminate a strip of LED in 1-, 2-, 3-, or 4-foot lengths (maximum 100 inches). The driver included in this system contains a standardized DMX 512 controller. One external controller can be used to control a series of LED strip lights. This controller can be connected to any other lighting control system through an RS-485 port that is compatible with DMS 512.

Figure 1: The BL Series LED Light Engine Used in the STR8 LED Light Strip

The DMX 512 control system allows the product to be digitally addressed for control over individual or groups of fixtures. This product utilizes high-efficiency dimmable LED light engines that are packaged into LED strip lighting fixtures and can be connected to a DMX 512-based lighting control panel capable of being connected to a building control system. Building control systems and DMX 512-based lighting control systems can be part of Internet-addressable demand response systems in future applications.

Objectives

The assessment goal was not to conduct a full testing program on the product, but to test its functionality regarding lighting control. The functionality testing included verification that the LED system illuminated the LEDs evenly and that control of their brightness could be achieved using the prescribed method of analog control provided by the manufacturer.

Product Description

This low profile fixture is 1.33 inches (19 mm) in height and 2.12 inches (54 mm) in depth. Cool-to-the-touch aluminum housing, specifically designed for heat dissipation, enables high powered LED operation of 50,000 hours or more. Available in two standard anodized colors, Gold Matte and Clear Matte the STR8 is an advanced lighting technology available for under-counter or under-cabinet lighting.

Table 1. Product Information

Name	Surface mounted under counter dimmable LED strip
Category	End-use (lighting – linear electronic LED strip)
Model #	STR8-1-GM-OPL-X-X-DD (example)
Manufacturer	GVA Lighting
Release date	Commercially available
Cost	Request quote
Company contact/URL	Paul Russell: http://www.gvalighting.com/pdf/led/GVA-STR8-LED-Light-Fixture.pdf

This product was designed to be lightweight and versatile for ease of installation and powered at 12 to 30 volts DC or at 100 to 240 volts AC (with selected LED light engines) voltage. Relying on the DMX 512-system for controllability, this product can respond to price signals if a demand response system interfaces to a series of DMX 512 controllers through RS-485 ports.

Control schemes can be established within the demand response system to enable price signaling to control any combination of selected LED strip light fixtures in any spatial arrangement. However, this system does not provide for daylight harvesting due to its intended application for under-counter (cabinet) lighting.

Temperature sensing is provided within the LED light engine—a standard and Underwriters' Laboratory (UL) required feature for electronic LED drivers. Temperature sensing provides safety control of the driver and LEDs to shut off the LED strip light in the event of driver or LED overheating. The standardized DMX 512 control system provides well-defined control over fixture power, LED dimming, and selection of which strips to power and dim.

The features of this product can best be described by examining the model number system (also see Figure 2) that includes:

- Low profile surface mounted strip light with linear LED light source inside

- Anodized aluminum base with clear or opal acrylic lens- only 20.5mm (H) x 54mm (W) / 0.81" (H) x 2.13" (W)
- Extruded aluminum base is designed with fins for proper heat management
- First fin works as a valance to block light from direct view
- Aluminum base available in two standard colors: Clear Matte and Gold Matte
- Standard nominal lengths of 1', 2', 3' and 4', maximum length - 100" (2540mm)
- Easy to install with screws (#4) through mounting flange
- Designed to accommodate GVA Lighting's LED Lighting Engines with high power LEDs
- Cool beam, no heat from light source, no UV generated
- Universal incoming voltage 12V - 30V DC or 100V - 240V AC (RGD light engine only)
- Continuous, flicker free dimming through switch-dim, digital or analog (0V - 10V DC) interfaces (optional)
- Each PCB is individually addressable and DMX compatible with GVA controls (optional)
- 5 Year limited warranty

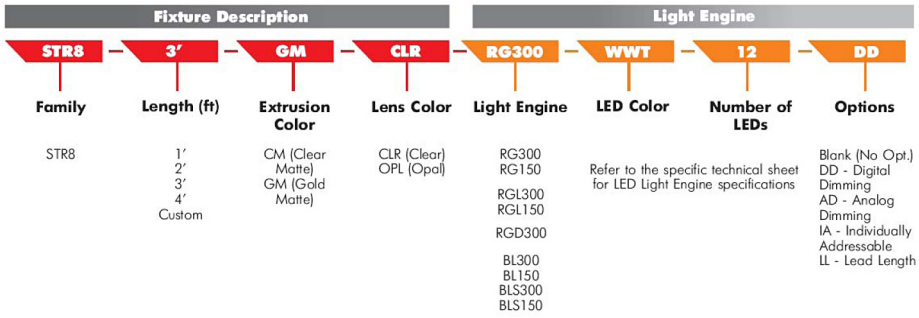

Figure 2: Model Number Breakdown for the STR8 Family of LED Light Strips

Test Environment and Method

This intelligent LED lighting system was tested for functionality including power up, power off, and dimming control. Various types of dimming control are possible with this LED system. The analog control method was chosen for the functionality testing. This and other methods could be used to integrate these systems to other lighting control platforms.

System Architecture

A DMX 512 controller is designed to control a network of GVA's dimmable LED fixtures, which include CoinLight, Ducat, and linear fixtures created with most of GVA Lighting's LED light engines (RG, BL, BLS, B83 series etc). The diagram in Figure 3 is an example of such a network.

A DMX converter is available to control the brightness of each fixture in a network in accordance with the commands supplied from an external DMX data source. A DMX controller (e.g., GVA's CL-DMX-02) converts the DMX commands to GVA's proprietary digital control protocol. CL-DMX-02 is used to set the base address and define how many GVA's addressable devices will be assigned for one DMX address. It can be set through push button control with a digital display outlining the parameters to the user. Fixtures connected to the CL-DMX-02 are automatically sequentially addressed, starting with the user selected base address.

Figure 3 shows a system in a residential or commercial facility to control and dim various LED systems including LED light fixtures (left two columns) or LED strips (right column).

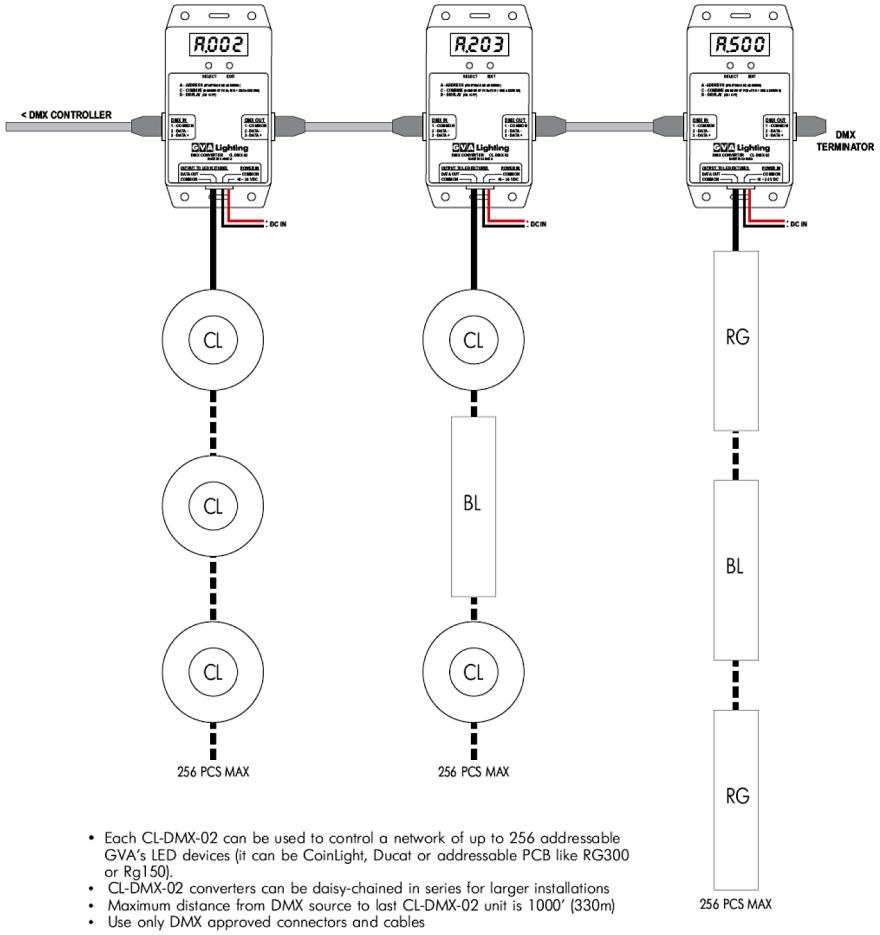

Figure 3: An Example of DMX 512 System Architecture

Functionality

EPRI tests showed the functionality of this controllable LED system:

- Continuous, flicker free dimming from 0 % to 100 % through push-dim, DMX or analog (0 to 10 volt DC) interfaces
- Smooth, eye sensitivity optimized dimming curve on the lowest light levels
- Each board individually addressable and DMX compatible with GVA control
- Can be used in conjunction with GVA's day-harvesting control

The DMX 512 lighting control system provides for individual control of any LED lighting device containing a DMX 512 chip. Each device in the DMX 512 network has its own individual digital address (not an Internet address). With this flexibility, it is possible to communicate directly with the devices. Through multi-channeling, three conductors (one power, one signal, and one ground with an interference shield) of control wires are needed with DMX 512 to control several different groups of LED devices. With the DMX 512 system, no switching of line power is needed—lighting devices can be switched off by commands initiated directly from the DMX 512 control system making the line switch unnecessary. Unlike the DALI (digital addressable lighting interface) system, no feedback commands are provided to the DMX 512 system to verify 'on' and 'off' commands, dimming commands, and condition of the driver or LED light engine. The following instructions can be transmitted to a lighting device:

- Turn 'on'
- Turn 'off'
- Lower light level
- Raise light level
- Set light level to a specific value

The wiring requirements for a DMX 512 system are simple. The cabling consists of a simple three-wire shielded cable, independent of any building topology between the devices in the system. A DMX 512 system can be easily re-configured. Once the system is installed and configured, it is very easy to change the functioning of the system. It is also easy to add (digitally) new lighting devices to an existing lighting system. When new lighting devices are added, the DMX 512 system automatically assigns them individual digital addresses not already in use. The only requirement for adding a new lighting device in a DMX 512 system is to provide the three shielded control wires from the DMX 512 system controller to each new LED lighting device(s).

Communication Protocol

This LED light strip is designed to be compatible with a DMX 512 controller. Although it contains this technology, it can be operated without control. DMX 512-A is an RS-485 based communications protocol that is most commonly used to control stage lighting and effects. DMX 512 was originally intended as a 'lowest common denominator' protocol for use between interfaces supporting proprietary

protocols. However, it soon became the primary method for not only linking controllers and dimmers, but also linking more advanced fixtures and special effects devices such as fog machines and moving lights. DMX 512 is unidirectional and does not include automatic error checking and correction, so it is not safe to use for applications involving life safety, such as controlling pyrotechnics.

A DMX 512 controller is connected to lighting fixtures or devices in a multi-drop bus topology commonly called a "daisy chain." Each device has a DMX 512 in and generally a DMX 512 out connector—sometimes marked as DMX 512 thru. The DMX 512 out on the controller is linked via a DMX 512 cable to the DMX 512 in on the first fixture. A second cable then links the DMX 512 out on the first fixture to the next device, and so on. In general, the final, empty, DMX 512 out connector should have a DMX 512 terminating plug attached into it, which is simply a resistor that matches the impedance of the cabling used (usually 120 ohms) joining pins 2 and 3 of the connector. Many modern devices negate this requirement as they are capable of auto-terminating the link.

Standards

This controllable LED lighting technology is designed to meet applicable IESNA (Illuminating Engineering Society of North America) lighting standards, NEMA (National Electrical Manufacturers Association) standards, UL product safety standards. A number of UL safety standards apply to LED-based lighting systems. However, the new UL standard UL 8750: "Outline of Investigation for Light Emitting Diode Light Sources for Use in Lighting Products" will be key in UL certifications.

The following standards will be important in identifying the performance of LED drivers, LED light engines, and LED fixtures:

- ANSI C82.XX1 Power Supply (in draft form) – This standard will address the performance of the LED diver and will include power quality and compatibility issues.
- IESNA RP-16 Nomenclature/Definitions for Illuminating Engineers (in draft form)
- IESNA LM-80 Life-testing (in draft form)
- IESNA LM-79 Electrical and Photometric Measurements (in draft form)
- ANSI C78.XX1 Specification for Chromaticity of White SSL Products (in draft form)

The original DMS 512 Standard was originally developed and published by USITT (United States Institute for Theatre Technology, Inc.) in 1990. The standard is now an ESTA (Entertainment Services and Technology Association) publication, and goes under the title of Entertainment Technology - USITT DMX512-A – "Asynchronous Serial Digital Data Transmission Standard for Controlling Lighting Equipment and Accessories." It is also known as E1.11, USITT DMX512-A, or DMX512-A. The Standard may be purchased in PDF from the ANSI (American National Standards Institute) Electronic Store. Information on the DMX 512 standard may be found at www.dmx512.com.

Scalability

Both the intelligent LED light strip system and the DMX 512 control system are designed to be scalable. Scalability in the LED light strips is limited to 100 inches of LED light engine. However, scalability in

DMX 512 control is limited to 256 LED lighting devices. Notably, the DMX 512 controller only provides control power and not LED light engine power. LED light engine power is provided via a separate DC power supply and is only passed through the DMX 512 controller. Thus, scalability is limited according to the number of individual addresses the DMX 512 controller is able to generate.

Performance

The LED light strip fixture contains the LED light engine. Thus, the performance of an LED light strip fixture is really the performance of the LED light engine. Listed below are the performance features of the LED light engine:

- Universal input voltage from 15 to 30 volts DC
- Low power consumption (1.3 to 1.4 watts per diode)
- No heat generated by light and no UV radiation
- Daisy chain connection up to 14 boards (15.4ft/4.1m) at 24V DC input voltage
- Easy mounting and electrical connection
- Thermal protection circuit regulates current through LEDs and protects LEDs from overheating
- Available in 9 LED colors, including Warm White
- Available with secondary optics (collimators) with Narrow Beam (12º), Medium (25º), Wide (50º) or Elliptical Beam (12º x 50º)
- Maintenance free, 50,000 to 100,000-hour lifetime with proper heat sink
- Built-in driver with very high efficiency up to 93%

It is not known whether the electronic driver used in this technology has embedded surge protection to reduce the likelihood of driver failure caused by voltage surges. This LED fixture system has not been tested by EPRI for compatibility with the power system and the electromagnetic environment. Such testing would also reveal if the control of the LEDs in the fixture can be affected by common electrical disturbances.

Vendor Support

Vendor support for this controllable electronic LED lighting system is provided through the manufacturer. This support includes interfacing this product with other lighting controls and energy management systems.

Conclusions

EPRI's functionality test of the specified GAV Lighting surface mounted under-counter dimmable LED strip shows that the product can be controlled and operated as indicated by the manufacturer.

This product is a good candidate for field testing as part of load management and demand response

programs. Although LED light engines (sources) are becoming more efficient (approaching higher efficacies), the ability of the utility and the customer to control them could be an important aspect of a demand response program, especially if these technologies begin to significantly penetrate the lighting device market. Areas in selected utility service territories where LED technologies are making their debut are already seeing some application of controllable high-efficiency LED systems. Controls will be the technical platform for managing power use and dimming of LED systems, An LED lighting control system can also incorporate color control of the LEDs in addition to power (on/off) control and dimmability. More sophisticated controls are required for LED color control.

Also, to understand its electrical reliability, this LED system should be tested in a real electrical (and laboratory) environment characteristic of a residential and commercial building system while connected to a DMX 512-based lighting control system with the DMX 512-system interfaced to a demand response control system. Testing the functionality of this system in the presence of other intelligent and controllable energy efficiency loads (e.g., electronic compact fluorescent lamps, adjustable speed drives, and efficient motors) would allow the investigator to determine a) if simultaneous and sustainable control could be achieved in a building environment where line, ground, and control system noise (conducted emissions) is present within the environment. Additionally, this intelligent LED lighting system should also be examined for immunity against radiated noise from such energy efficient devices. Various levels of line and ground noise can also be injected into the line, ground, and control system in efforts to assess the likelihood of upsetting the fixture control system.

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