



THE LIGHTGUARD SYSTEMS INSTALLATION & USER MANUAL and FACTORY RECOMMENDED GUIDELINES

September 2022

LightGuard Systems, Inc.

2292 Airport Blvd.

Santa Rosa, CA 95403-1003

Ph: 707-542-4547 | Fax: 707-525-6333

www.lightguardsystems.com

www.crosswalks.com

©2019 LightGuard Systems®, Inc. (LGS). All Rights Reserved. Printed in the United States of America. Except as permitted under the Copyright Act of 1976, no part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written permission of LGS. This document is provided for informational purposes only. LGS disclaims all warranties whether expressed or implied, and specifically all implied warranties of merchantability and fitness for a particular purpose. Failure to comply with the recommendations and guidelines contained here within may result in a void of product warranty. LightGuard Systems is a registered trademark of LightGuard Systems Inc. Smart Crosswalk, LightStar & DuraFlash & SmartSense are trademarks of LightGuard Systems Inc. All Rights Reserved. US Patent # 6,384,742

TABLE OF CONTENTS

1	THE LIGHTGUARD CROSSWALK SYSTEM AND COMPONENTS	2
1.1	THE LIGHTGUARD CROSSWALK SYSTEM	2
1.2	POWER SYSTEM – Flashing Controller Interface.....	2
1.3	OUTPUT: IN-ROADWAY WARNING LIGHT (IRWL) FIXTURE.....	3
1.4	OUTPUT: LED “ENHANCED” PEDESTRIAN CROSSING SIGN.....	3
1.5.	OUTPUT: RECTACNGULAR RAPIDLY FLASHING BEACON (RRFB)	3
1.6	SYSTEM ACTIVATION; AUTOMATIC/MANUAL/CONTINUOUS/PROGRAM	3
1.7	LGS COMPONENTS NEEDED FOR A TYPICAL SMART CROSSWALK™	4
1.8	SUGGESTED INSTALLATION EQUIPMENT, MATERIALS AND TOOLS	5
2	POWER SYSTEM AND COMPONENTS	6
2.1	POWER SYSTEM DESCRIPTION	6
2.2	GENERIC LIGHTGUARD CROSSWALK SYSTEM WIRING DIAGRAM.....	6
2.3	UC ENCLOSURE POLE MOUNT EXAMPLE.....	7
2.4	UC BACK PANEL ELECTRICAL I/O CONNECTIONS	7
2.5	UC-AC DESCRIPTION.....	8
2.6	UC-SOLAR DESCRIPTION	10
2.7	UC USER INTERFACE SETTINGS/PARAMETERS	12
2.8	UC UI (KEYPAD/LCD) DETAILED INSTRUCTIONS	12
3	IN-ROADWAY WARNING LIGHT (IRWL)	15
3.1	GENERAL DESCRIPTION.....	15
3.2	IRWL FIXTURE AND BASE PLATE INSTALLATION OVERVIEW	15
3.3	MAJOR CONSIDERATIONS FOR IRWL INSTALLATION	16
3.5	CONCRETE INSTALLATION PROCEDURE	24
4	AUTOMATIC ACTIVATION SYSTEM - SMART CROSSWALK™	25
4.1	BOLLARD PEDESTRIAN DETECTION SYSTEM DESCRIPTION	25
4.2	BOLLARD PAIR LAYOUT AND WIRING DIAGRAM (EXAMPLE).....	25
4.3.	BOLLARD INSTALLATION GUIDELINES.....	26
4.4.	BOLLARD DETECTION ZONE OPERATION VERIFICATION.....	28
4.5	BOLLARD ALIGNMENT.....	28
5	MANUAL ACTIVATION – PUSH BUTTON	32
5.1	PUSH BUTTON ACTIVATION DESCRIPTION	32
5.2	TOUCHLESS ACTIVATION DESCRIPTION - SMARTSENSE	34
6	FLASHING OUTPUT LIGHT FIXTURES (POLE MOUNTED, NOT IRWL)	36
6.1	LED “ENHANCED” SIGN GENERAL DESCRIPTION.....	36
6.2	RRFB GENERAL DESCRIPTION.....	37
7	SOLAR POWERED SYSTEMS CONSIDERATIONS	39
7.1	SOLAR SYSTEM INSTALLATION STEPS	39
7.2	SOLAR PANEL	39
7.3	BATTERIES	41
7.4	CHARGE CONTROLER	42
8	TROUBLE SHOOTING / MAINTENANCE / AFTER INSTALLATION	43
8.1	TROUBLE SHOOTING GUIDE & TIPS	43
8.2	FIELD RELATED TOTAL PREVENTATIVE MAINTENANCE	44
8.3	RECOMMENDED MAINTENANCE	44
8.4	EQUIPMENT LIST.....	46
9	ADDENDUMS.....	46

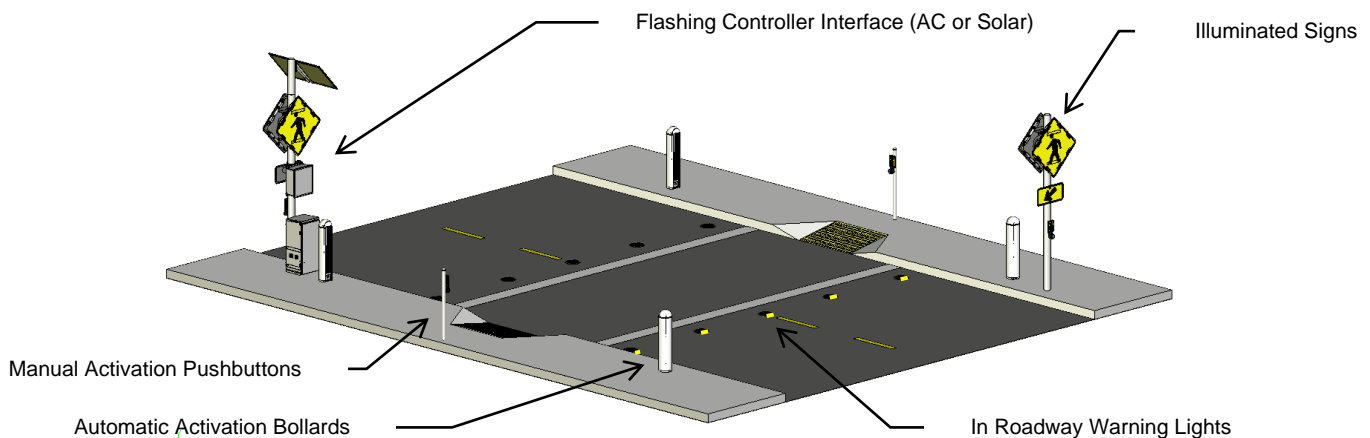
1 THE LIGHTGUARD CROSSWALK SYSTEM AND COMPONENTS

1.1 THE LIGHTGUARD CROSSWALK SYSTEM

The LightGuard crosswalk system (The System) is designed for applications at mid-block or uncontrolled intersection crosswalks and other roadway crossings. It is entirely compliant with the MUTCD and in many cases, the MUTCD text regarding In Roadway Warning Lights (IRWL) was composed with the LightGuard product development and testing in mind.

The System utilizes a series of light emitting diodes (LED's) in a durable housing embedded in the roadway which flashes, in a unidirectional manner, a warning to approaching motorists that a pedestrian is in or entering the crosswalk. The IRWL fixtures are aimed down the motorist-viewing path of the approaching driver to allow the flashing lights to be easily seen by motorists along the full length of the un-obscured viewing approach path. Per the MUTCD, the lights flash for a pre-set duration before automatically turning off. The System can be activated by a pedestrian pushing a button, or automatically when a pedestrian passes through an activation zone breaking an optical beam. It can be a stand-alone solar-powered System, or a conventional AC powered system with battery back up.

The System is comprised of the following components. All components must work in unison.



1.2 POWER SYSTEM – Flashing Controller Interface

A roadside, or pole mounted, cabinet contains all of the LED drive electronics and field wiring electrical interfaces. UC-AC systems branch circuits operate using 12 VDC via a power supply energized from an AC line. The AC system can be energized from either 110VAC or 220VAC nominal. UC Solar Systems operate using 12 VDC nominal battery power and are recharged during daylight hours from a Photo-Voltaic (PV) Solar panel.

Typical power usage is ranges from 20 to 100 watts depending on the type of electrical loads (flashing lights) connected to the system & activation mechanism. Total energy consumed (in KWH) is dependent upon the number of light fixtures, the CROSSTIME duration, and the number of activations. Circuit breakers protect internal circuitry and field wiring. The flashing controller high speed embedded microcontroller. LGS proprietary software program provides effective, reliable operation allowing the user simple operation adjustments with a simple user interface and display (LCD).

1.3 OUTPUT: IN-ROADWAY WARNING LIGHT (IRWL) FIXTURE

LightGuard Systems IRWL fixtures are manufactured of high strength impact resistant materials. They are designed to be mounted onto a metal or composite base plate assembly that is permanently attached to the roadway. This allows for easy replacement of any IRWL that may become damaged, or inoperable, for any reason.

For IRWL models that also include Surface Mount Pedestrian Luminaire (SMPL), the white LED SMPL™ portion of the light fixture simultaneously energizes (only at nighttime).

1.4 OUTPUT: LED “ENHANCED” PEDESTRIAN CROSSING SIGN

Fluorescent-yellow-green color (FYG), diamond-shaped pedestrian crossing sign (W11-2) with LED warning light modules at the “enhanced” flash rate is recommended with each System (FYG S1-1 school sign also available). The LED warning lights are designed to flash in conjunction with activation of the System. This active LED pedestrian crossing sign enhances driver recognition of the System’s presence, especially in adverse weather conditions, and contributes to educating the motorist as to the meaning of the flashing array of IRWL. Illuminated signs are replacements for the standard static W11-2 (or S1-1) sign typically placed at the crosswalk site.

1.5. OUTPUT: RECTANGULAR RAPIDLY FLASHING BEACON (RRFB)

The RRFB produces a flashing output in accordance with “MUTCD Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons (IA-11)” when 12 VDC (nom) is supplied to the RRFB from the UC.

1.6 SYSTEM ACTIVATION; AUTOMATIC/MANUAL/CONTINUOUS/PROGRAM

1.6.1 AUTOMATIC ACTIVATION- Bollards

The Smart Crosswalk™ automatic pedestrian detection system is a dual break-beam topology utilizing modulated infrared sensors housed in a pair of decorative posts (Bollards) at each entrance to the crosswalk. Direction of pedestrian travel is detected and activates the System only upon entry, not when exiting. Custom designed Bollards house the drive electronics for automatic activation. Separation distance between Bollard within a pair is based on sensor manufacturers specifications. Range for Bollard model LGS-T6 is 40 feet, model T6L is 100 feet

1.6.2 MANUAL ACTIVATION – Push button, Key Switch, Touchless operation

A standard (ADA) push button assembly may be installed to MANUALLY activate the System. When the pedestrian momentarily pushes the button, an “ON” response from the System is immediately visible via flashing LED lights above the words “CROSS WITH CAUTION”.

On optional Key Switch can be installed/used to manually activate & deactivate the system.

The SmartSense™ touchless crosswalk activation mechanism is a short-range infrared proximity sensor that connects in parallel with pedestrian detector push button mechanisms (via a relay) to send a call signal to the crosswalk controller before pedestrian makes contact with the button. It mounts in a compatible push button station.

1.6.3 CONTINUOUS – CONSTANT ON

The Illuminated crosswalk system can be set for continuous flashing 24/7 by positioning the latching TEST switch to the up position. This is NOT recommended for solar powered systems due to the continuous power drain affecting battery recharge.

1.6.4 PROGRAMMABLE – Pre-set on/off timer

The Illuminated crosswalk system can be programmed to activate for predetermined durations with 3 different start/stop times up to 7 days per week (using the internal calendar features). Refer to section 2.7 for instructions.

1.7 LGS COMPONENTS NEEDED FOR A TYPICAL SMART CROSSWALK™

Typical Required Equipment (Quantities based on 4 lane crossing)		
Item	Qty	Description
1	1	Flashing Unit Interface Controller (UC AC or SOLAR). High speed embedded microcontroller including User Interface, timer duration mechanism & LGS's proprietary software program.
2	1	Electronics Enclosure The enclosure is sized to allow mounting of all components necessary to control the System. The enclosure's water-resistant design is based upon the NEMA specifications.
3	14	In-Roadway Warning Lights The IRWL assemblies are street-mounted to withstand normal vehicle traffic. The patent protected assemblies, including base plates, are a LGS proprietary design
4	4	Automatic Activation Bollards Pedestrian detection Bollards are located at each crosswalk entrance. Optical beam interruption sensors are designed to automatically activate the Smart Crosswalk™ System
5	2	LED Enhanced Pedestrian Warning Sign The fluorescent-yellow-green (FYG) color, diamond shaped pedestrian warning sign (W11-2) contains LED warning light modules designed to flash at the same flash rate & in conjunction with activation of the IRWL
6	LOT	Mount Assemblies LGS approved standard mount assemblies are sized and configured appropriately to allow mounting of the enclosure, automatic activation sensors, LED enhanced signs,. Tamper resistant hardware is recommended but not included
7	LOT	Light fixture Spare Parts Gel-plugs & mount screws
8	LOT	Cable/wiring LGS approved multi-strand 8 conductor wiring (BELDEN 28601A), 18 AWG, to connect the activation assemblies to the controller. Stranded wire, 14 AWG, type RHW-2/USE-2/XLP (3 individual conductor colors – BLK, YEL, & RED), maximum OD 0.17" (4.3 mm) can be provided to connect to IRWL
9	LOT	Epoxy LGS approved 2 part Epoxy (either BOND0 7084 or DSB). Epoxy mixing & dispensing equipment not provided - refer to section 3.2.7 .
10	LOT	Loop sealant LGS approved loop sealant (DSB 900) mixing & dispensing equipment not provided.
11	LOT	Backer Rod LGS approved Backer Rod
Optional or Alternate Equipment		
12		Solar Power Assembly and Enclosure Includes crosswalk flashing controller, Solar Panel + pole mount, battery charge controller (amp/load), sealed solar cell batteries, battery & solar panel cables, branch circuit protection.
13		UC-AC Assembly and Enclosure. UC-AC Assemblies includes flashing unit controller for 110 to 200 VAC input (5A max)
14		AC Beacon Interface Modified PCU & DIN Rail connections for 2 separate 115VAC relays operating in either wig-wag or continuous mode
15		DC Beacon Interface Modified software for separate 12VDC beacons operating in either wig-wag or continuous mode (10A max)
16		Audible crosswalk Interface plug & play connections for some audible systems (voice, chirp, tweet, etc.)
17		Dual Zone Upgrade Kit custom upgrade for 2 independent cross walk zones (activates flashing at 2 separate crosswalks)
18		RRFB Rectangular Rapid Flashing Beacons
19		RAD Remote Activation Device (compact form Automatic Directional Detectors)

1.8 SUGGESTED INSTALLATION EQUIPMENT, MATERIALS AND TOOLS

The general list below may include all equipment, materials, or tools required for installation.

Typical electrical tools used in street lighting and signal work

- | | |
|----------------------------------|---|
| • Inch pound torque wrench | • Taps & dies |
| • End wrenches & sockets | • 2 putty knives x 4" (100mm) wide |
| • Crescent wrenches | • Cordless drill with assorted bits 0.250" (6.3mm) to 1" & hole saws 1" & 1½" (25mm & 38mm) |
| • Allen wrenches | • Rotor hammer – 1" bit & 1½" bit |
| • Hammers - 3 lb. (1.5kg) & claw | • Skill saw & blades |
| • Hack saw, file, & knife | • Small hand held grinder |
| • Wire strippers | • Latex gloves – disposable |
| • Slip joint channel lock pliers | • Dc meter |
| • Chisel | • Container and mixing tool for 2-part adhesive |
| • 1/8" hex socket | |
-

- | | |
|---|-------------|
| • 100 ft (30m) measuring tape | • Duct seal |
| • Black & red electrical tape | • Fish tape |
| • Grinding core drill: best practice custom "flat bottom" core drill: best practice custom "flat bottom" core drill to eliminate the need for removing excess material from cored depression cut. <i>contact Lightguard Systems for more information about availability.</i> | |
-

- | | |
|--|---------------------------------------|
| • Air-blower (compressor) | • Wheelbarrow |
| • Broom & dust pan | • Shovel – square point & round point |
| • 1 Hose -garden type & fire hydrant adaptor | • Rope |
-

- | | |
|--|---|
| • Cut-off, mixed fuel, & spare blades | • 6 sack mortar mix (base of poles & boxes) |
| • Conduit sealer | • 90lb (40kg) sack of sand |
| • 5-gallon (20L) pail of ¾" (19mm) rock for under traffic valve boxes | |
| • Generator, with extension cord, for auxiliary power | |
| • Cut-off, mixed fuel, & spare blades | |
| • Power driven asphalt (saw) cutter capable of cutting ½" (12mm) wide x 2" (50mm) deep | |
-

- | |
|--|
| • 1¼" (32mm) <i>minimum</i> conduit as required by local agency (sizes can be determined by site engineer) |
| • Reel wire holder ½" (12mm) diameter x 36" (1m) long on stand (optional) |
-

- **ALL NECESSARY EQUIPMENT FOR IMPLEMENTING AN APPROVED TRAFFIC CONTROL PLAN**
-

2 POWER SYSTEM AND COMPONENTS

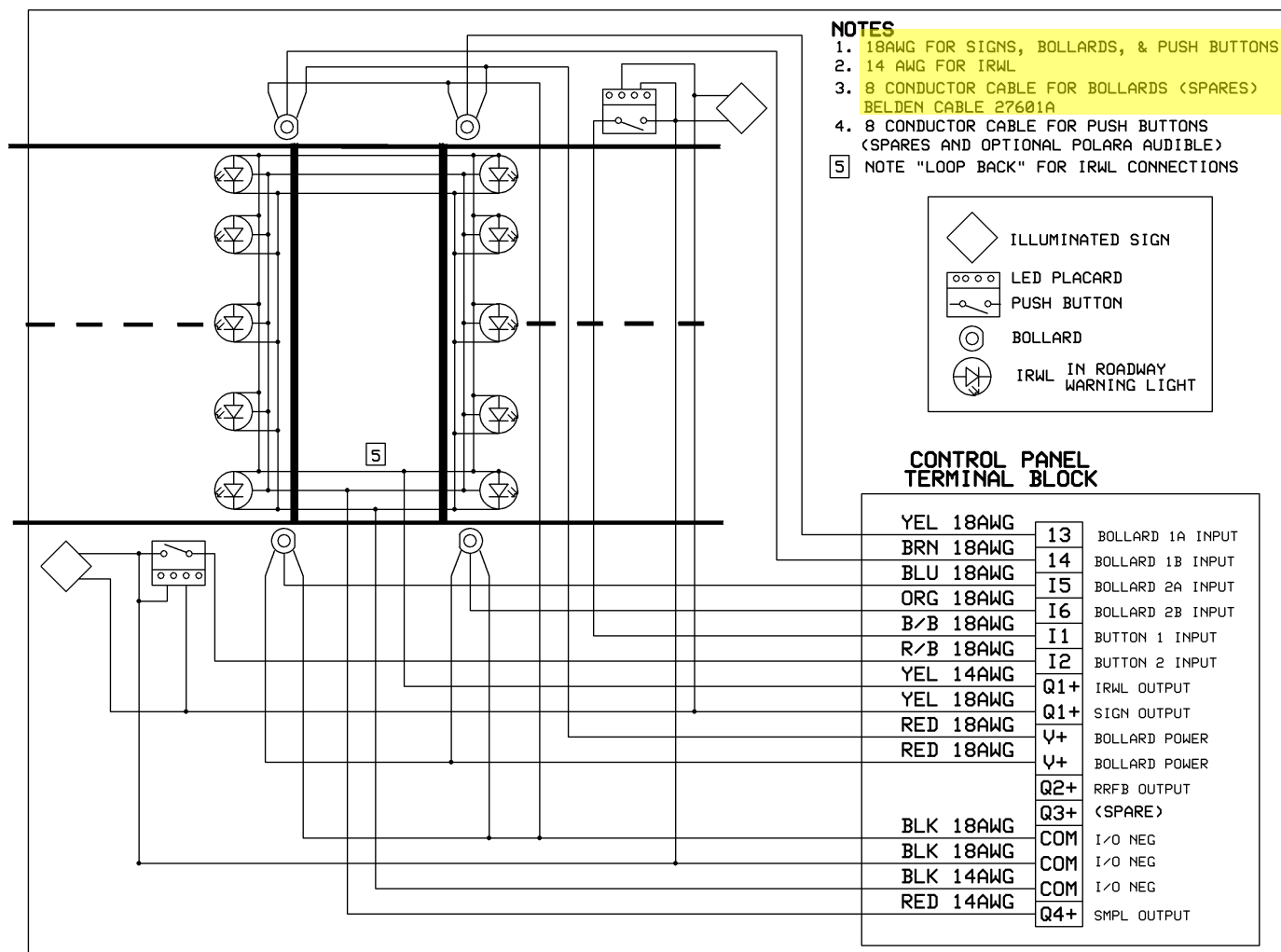
2.1 POWER SYSTEM DESCRIPTION

An AC powered system uses either 115VAC nominal or optional 230VAC nominal as an energy source. A DPST 5A circuit breaker protects both the *Line and Neutral* for single line OR *both Lines* for line-line input. The AC power is transformed to 12VDC nominal via a 150W power supply. The 5A DPST circuit breaker is marked by the factory for both *Line & Neutral*, with one pole of the 5A DPST circuit breaker labeled “hot black” and the other labeled “neutral white”. For line-line operation, the label marked “neutral white” must be removed or otherwise placard over & the power supply switch must be reset to 230V prior to energizing the main 5A DPST circuit breaker on the back panel. The switch setting is normally factory configured for 115VAC & **MUST BE RESET** at time of installation for 230VAC source. Refer to section [2.5.2](#) for switch location.

A Solar powered system uses a minimum 75W Photovoltaic array providing DC power to the internal batteries. All branch circuits have their own independent circuit protection in the Electronics Enclosure.

UC-AC system uses 115VAC as an energy source. A DPST 5A circuit breaker protects both the Line and Neutral. The AC power is transformed to 12VDC nominal via a 100W class 2 power supply.

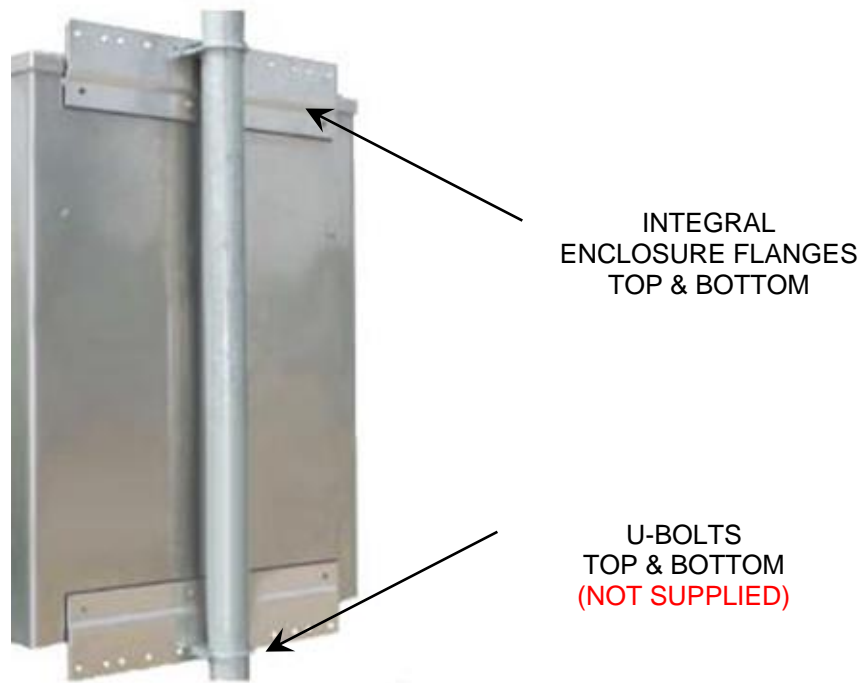
2.2 GENERIC LIGHTGUARD CROSSWALK SYSTEM WIRING DIAGRAM



NOTE: This is a reference diagram only, connections shown are not applicable to all installations.

2.3 UC ENCLOSURE POLE MOUNT EXAMPLE

UC enclosures can be pole or wall mounted. Example below shows pole mount.



2.4 UC BACK PANEL ELECTRICAL I/O CONNECTIONS

External electrical connections include power source (AC or solar), outputs (IRWL, illuminated Signs, RRFB, overhead beacons, etc.), & inputs (push buttons, bollards, etc.)

2.4.1. UC INPUT/OUTPUT (I/O) Connections

All I/O ports are software controlled. I/O responses can be reprogrammed/customized & should only be attempted by those familiar with PLC ladder logic. **This section describes I/O functions based on Software UC1 v 1-3.**

Electrical connections to I/O terminal blocks should be limited 14AWG or smaller.

INPUTS

I1 & I2 reserved for non-directional momentary push button call signals (50mA max)
I3/I4 & I5/I6 pairs reserved for directional momentary bollard input call signals (50mA max).

COMMON (DC Ground)

COM 0VDC reference, return for all I/O & branch circuits (10A max)

OUTPUTS

V+ unswitched 12VDC for **BOLLARDS & APS** supply (1.6A fused)
Q1+ switched Enlighten1™ flash rate reserved for **IRWL & SIGNS** (6A or 10A fused)
Q2+ switched 12VDC for the CROSSTIME duration, typically used for **RRFB** (6A or 10A fused)
Q3+ short pulse for CROSSTIME duration for **LOWER ENERGY CONSUMPTION** (6A or 10A fused)
Q4+ switched/scheduled 12VDC for CROSSTIME duration for IRWL **SMPL** (6A or 10A fused)

2.5 UC-AC DESCRIPTION

All user INPUT connections are made directly to the Flashing Unit Controller Subassembly. This system is field programmable, and directly supports IRWL with SMPL (no upgrade kit required). Refer to section 2.11 for additional information.

Model UC-AC output is limited to 5A total.

Model UC-AC MP output is rated for 10A total.

Except for the power source, all other features (installation, operation, and electrical I/O connections) are identical for all UC models. The UC-AC back panel incorporates the Timer/Controller flash unit, circuit breakers, surge suppressor, and DC power supply.

2.5.1 UC-AC ENCLOSURE

The vented Aluminum enclosure is rated NEMA3R & is designed for wall or pole mounting only. The non-removable hinged door is secured using a pad lockable latch (left side). The enclosure is supplied with flange mount tabs on both the top/bottom of the enclosure backside. U bolts + saddle clamp (shown in graphic) or standard Unistrut compatible hardware (NOT SUPPLIED) can be used to secure the enclosure to industry standard sign supports/poles. Electrical conduit access can be made by drilling holes either on the bottom (2x ½" NPT KO available) or on the rear of the enclosure CLEAR OF ALL ELECTRONICS. The enclosure has sufficient clearance to support 1½" NPT connectors on the rear, and several ½" NPT connectors on the bottom. The standard enclosure color is unpainted Aluminum.

External dimensions
20"H x 17.5"W x 12"D



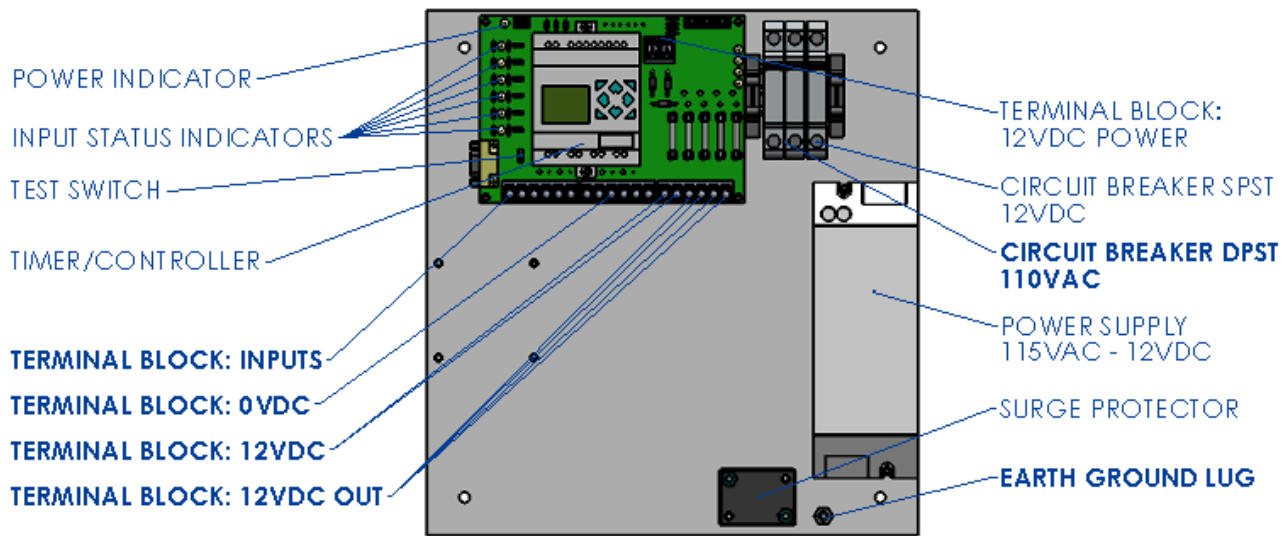
2.5.2 UC AC I/O Electrical Connections

REFER TO SECTION 2.4 FOR ALL I/O CONNECTIONS

2.5.2.1 UC AC Power Connections

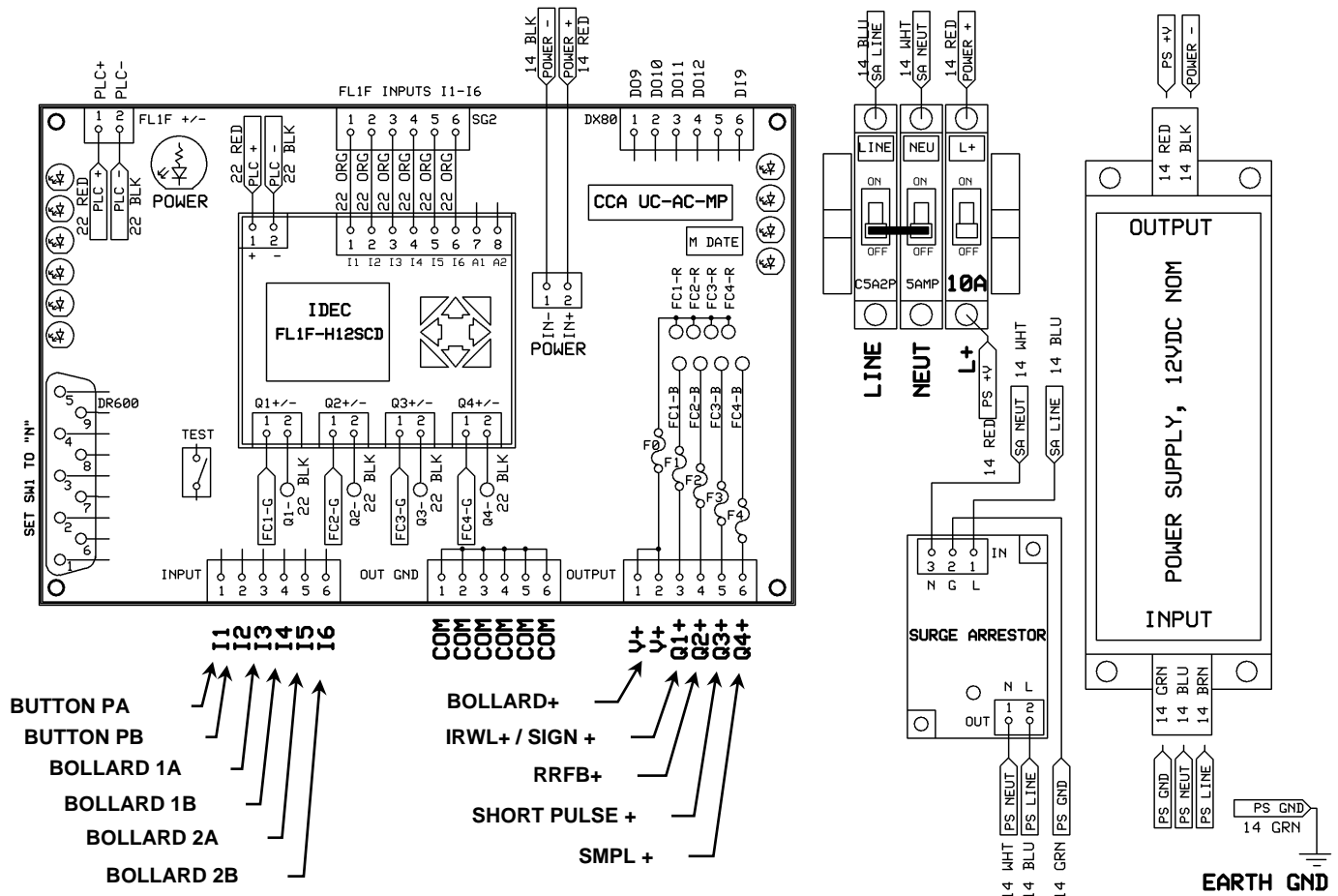
110 VAC Line & Neutral terminate	to the input side (bottom) of the 2 pole 5 A circuit breaker.
Earth Ground terminates	to ground lug located in the bottom right of the back panel.

2.5.3 UC-AC BACK PANEL LAYOUT



Note: Bold font indicates locations for external electrical connections (power, inputs, & outputs).

2.5.4 UC-AC BACK PANEL SCHEMATIC



2.6 UC-SOLAR DESCRIPTION

The UC-SOLAR system differs from the UC AC only by the power source. All operations for both the UC-AC & UC-SOLAR are identical. All user INPUT connections are made directly to the Flashing Unit Controller Subassembly. This system is field programmable, and directly supports IRWL with SMPL (no upgrade kit required). Refer to section 2.11 for additional information.

Model UC-SOLAR is rated for 10A total.

Except for the power source, all other features (installation, operation, and electrical I/O connections) are identical for all UC models. The UC-AC back panel incorporates the Timer/Controller flash unit, circuit breakers, surge suppressor, and DC power supply.

2.6.1 UC-SOLAR ENCLOSURE

The vented Aluminum enclosure is rated NEMA3R & is designed for wall or pole mounting only. It is identical in construction to the UC-AC Enclosure, except that it is large enough to accommodate up to 2 class 27 or class 31 batteries. The non-removable hinged door is secured using a pad lockable side latch. The enclosure is supplied with flange mount tabs on both the top/bottom of the enclosure backside. U bolts + saddle clamp or standard Unistrut compatible hardware (NOT SUPPLIED) can be used to secure the enclosure to industry standard sign supports/poles. Electrical conduit access can be made by drilling holes either on the bottom (2x ½" NPT KO available) or on the rear of the enclosure CLEAR OF ALL ELECTRONICS. The enclosure has sufficient clearance to support 1½" NPT connector on the rear, and several ½" NPT connectors on the bottom. The standard enclosure color is unpainted Aluminum.

External dimensions

22.625"H x 19.25" W x 19.625" D



2.6.2 UC-SOLAR I/O CONNECTIONS

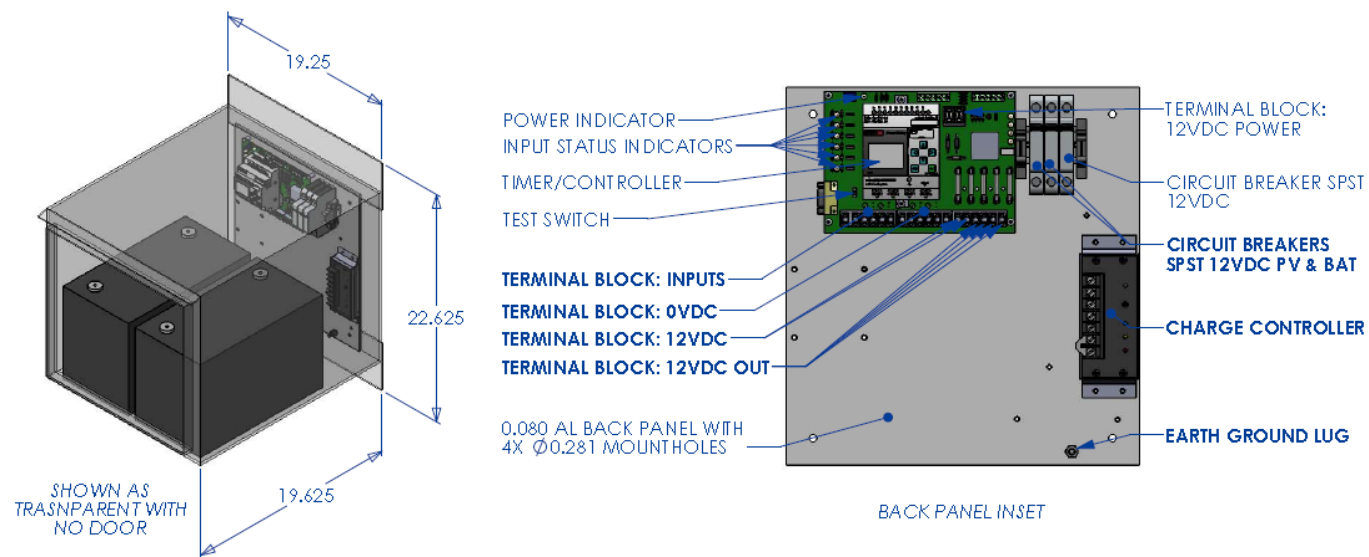
REFER TO SECTION 2.4 FOR ALL I/O CONNECTIONS

2.6.3 UC-SOLAR POWER CONNECTIONS

Solar Panel Positive	to circuit breaker labeled PV+ (Photo Voltaic)
Solar Panel Negative	to charge controller terminal labeled SOLAR –
Battery Positive	to circuit breaker labeled BA+
Battery Negative	to charge controller terminal labeled BATTERY –
Earth Ground	to Ground lug bottom right corner of the back panel

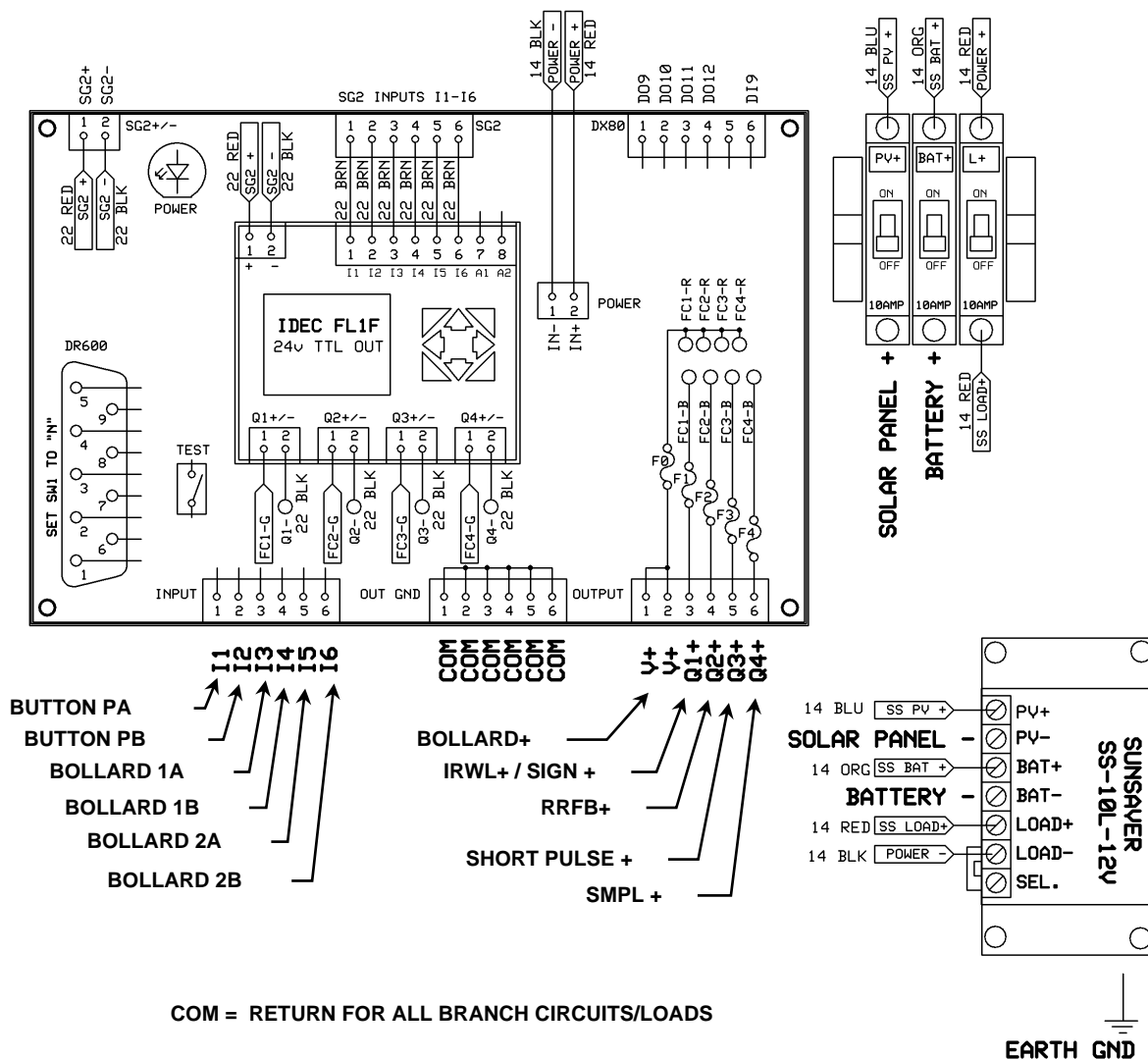
REFER TO SECTION 7 OF THIS MANUAL FOR SOLAR POWERED CONSIDERATIONS

2.6.4 UC-SOLAR BACK PANEL LAYOUT



Note: Bold font indicates locations for external electrical connections (power, inputs, & outputs).

2.6.5 UC-SOLAR SCHEMATIC



2.7 UC USER INTERFACE SETTINGS/PARAMETERS

2.7.1 UC PARAMETER ADJUSTMENTS DESCRIPTION

The UC-employs an LCD & keypad for field adjustments, including setting the CROSSTIME flash duration, setting real time clock & calendar, scheduling output activations, and scheduling time window where SMPL can be active. Refer to instructions in this section for field adjustments. The UC will operate with Bollards &/or Push buttons. Status indicators on the Flashing Unit Controller Subassembly illuminate for each input when detected & each output when activated. There is also a power status indicator showing that the system is energized. Lastly, there is a test switch which can be used for in-cabinet testing of the UC-AC System.

The UC supports 2 independently scheduled CROSSTIME duration outputs, triggered from the real time clock/calendar. This system is customizable but with limitations. Contact LightGuard Systems for specific custom software configurations (ie: 2x DC beacons with alternating flash patterns).

2.7.2 TEST MODE

This mode is not a software feature & does not require keypad/LCD for use. The PLC controller outputs can be tested using the slide switch labeled TEST. The slide switch is located adjacent to the PLC on the main control circuit card. Slide the switch up to engage test mode, slide down to return to standby. After the system is returned to standby, the output will remain active for the CROSSTIME duration. While the TEST switch is in the UP position, the output will engage indefinitely.

2.7.3 UC LCD DESCRIPTIONS

- When controller is in standby, no outputs are active.
 - The controller displays the default screen text LightGuard Systems, service contact phone, software version, & XTIME setting.
- When the controller has received a call signal from an input, the outputs are active.
 - The PLC displays the CROSSTIME setting value (duration in sec) & the remaining CROSSTIME (duration in sec) counting down
 - pressing the UP ARROW will not change the display & pressing DOWN ARROW will show date/time
- While scheduled Auto-time is active, the LCD will display the schedule

2.8 UC UI (KEYPAD/LCD) DETAILED INSTRUCTIONS

Most parameter adjustments can be made while the main program is running on the FL1F PLC controller. Some adjustments require stopping the program to adjust, then restarting the program.

- LCD White background indicates program screens.
- LCD Orange background indicates operating system menus for parameter changes.
- OK button is used to accept changes.
- ESC button is an escape feature or to access the operating system menu when the LCD White background date/time screen is displayed.
- Arrow buttons are used to navigate both within & between LCD screens. Arrows are also used to scroll/change parameter values depending on the mode.

2.8.1 UC Set CROSSTIME (XTIME)

CROSSTIME can be set from 0000 sec to 9999 sec. Example below shows the multi-step process instructions when changing the preset XTIME timer value from 20 sec to 21 sec.

- 1) Start from LGS PROGRAM DEFAULT SCREEN [LightGuard Systems]
- 2) Press **DOWN ARROW** 5 times to access DATE/TIME SCREEN
- 3) Press **ESC** to access operating system menu (orange backlight)
- 4) Press **DOWN ARROW** to scroll cursor to PROGRAM, press **OK**
- 5) Press **DOWN ARROW** scroll to SET PARAMETER, press **OK**

- 6) Press **UP/DOWN ARROWS** to scroll to access XTIME_z1, then Press **OK**
- 7) Press **ARROWS** to move cursor to PARAMETER T, then press **OK**
- 8) Press **LEFT/RIGHT ARROWS** to move/position cursor to digit for editing
- 9) Press **UP/DOWN ARROW** to scroll digit values up/down
- 10) Press **OK** to retain new value for PARAMETER T = XTIME_z1
- 11) Press **ESC** multiple time to return to DATE/TIME SCREEN
- 12) Press **UP ARROW** 5 times to return to LGS PROGRAM DEFAULT SCREEN

2.8.2 UC Display Software Version

The software version is displayed on the LGS PROGRAM DEFAULT SCREEN

2.8.3 UC Change Current Date & Time (Clock)

De-energizing the PLC will stop the internal RTC. When the PLC is re-energized the clock will start from where it was stopped. The RTC is factory set to Pacific Time zone at the time it was assembled/tested. To change the RTC follow the multi-step process below

- 1) Start from LGS PROGRAM DEFAULT SCREEN [LightGuard Systems]
- 2) Press **DOWN ARROW** 5 times to access DATE/TIME SCREEN
- 3) Press **ESC** to access operating system menu (orange backlight)
- 4) Press **UP/DOWN ARROW** to scroll CURSOR to SETUP
- 5) Press **OK** to access SETUP SCREEN
- 6) Press **UP/DOWN ARROWS** to scroll cursor to access CLOCK, then Press **OK**
- 7) Press **UP/DOWN ARROW** to move cursor to SET CLOCK, then Press **OK**
- 8) Press **LEFT/RIGHT ARROW** to scroll cursor to locate editing digit, **UP/DOWN ARROW** to scroll digit values
- 9) Press **OK** to retain new value for CLOCK time
- 10) Press **ESC** multiple time to return to DATE/TIME SCREEN
- 11) Press **UP ARROW** 5 times to return to LGS PROGRAM DEFAULT SCREEN

2.8.4 UC Set Automatic Schedules (AUTO_TIME)

The outputs can be activated automatically via scheduled activation durations. The example below shows the multi-step process instructions to set the possible scheduled activations.

- 1) Start from LGS PROGRAM DEFAULT SCREEN [LightGuard Systems]
- 2) Press **DOWN ARROW** 5 times to access DATE/TIME SCREEN
- 3) Press **ESC** to access operating system menu (orange backlight)
- 4) Press **DOWN ARROW** to move CURSOR to PARAMETER
- 5) Press **OK** to access PARAMETER SCREEN
- 6) Press **DOWN ARROW** multiple times to scroll cursor to AUTO_TIME, then Press **OK**
- 7) Press **UP/DOWN** to move cursor to schedule O1 then Press **OK**
- 8) Press **UP/DOWN ARROW** to scroll day toggle values & **LEFT/RIGHT ARROWS** to move cursor to select days, then Press **OK**
- 9) Press **UP/DOWN ARROWS** to move cursor to ON TIME for schedule, then Press **OK**
- 10) Press **UP/DOWN ARROWS** to scroll digits for start time, then Press **OK**
- 11) Press **UP/DOWN ARROWS** to move cursor to OFF TIME for schedule, then Press **OK**
- 12) Press **UP/DOWN ARROWS** to scroll digits for stop time, then Press **OK**
- 13) Press **ESC** multiple time to return to DATE/TIME SCREEN
- 14) Press **UP ARROW** 5 times to return to LGS PROGRAM DEFAULT SCREEN

2.8.5 UC SET SCHEDULE FOR SMPL OPERATION (SMPL Schedule)

The SMPL (Surface Mount Pedestrian Luminaire) feature accesses the UC PLC Operating System Real Time Clock (RTC). Therefore, accurate local time setting must be adjusted for SMPL to operate correctly. This feature is used to schedule the activation of the SMPL output only while flashing output is active for the CROSSTIME duration. The SMPL output is used to energize the IRWL Pedestrian Luminaire (white LED illuminating pedestrians). The default SMPL setting is SMPL output only “available” between 1800 & 0600. Accordingly, the SMPL is pre-set as unavailable during daylight hours (0600 to 1800).

To change hours of operation for SMPL, follow the multi-step process below

- 15) Start from LGS PROGRAM DEFAULT SCREEN [LightGuard Systems]
- 16) Press **DOWN ARROW** 5 times to access DATE/TIME SCREEN
- 17) Press **ESC** to access operating system menu (orange backlight)
- 18) Press **DOWN ARROW** to move CURSOR to PARAMETER
- 19) Press **OK** to access PARAMETER SCREEN
- 20) Press **DOWN ARROW** multiple times to scroll cursor to SMPL Schedule, then Press **OK**
- 21) Press **UP/DOWN** to move cursor to schedule O1 then Press **OK**
- 22) Press **UP/DOWN ARROW** to scroll day toggle values & **LEFT/RIGHT ARROWS** to move cursor to select days, then Press **OK**
- 23) Press **UP/DOWN ARROWS** to move cursor to ON TIME for schedule, then Press **OK**
- 24) Press **UP/DOWN ARROWS** to scroll digits for ON TIME, then Press **OK**
- 25) Press **UP/DOWN ARROWS** to move cursor to OFF TIME for schedule, then Press **OK**
- 26) Press **UP/DOWN ARROWS** to scroll digits for stop time, then Press **OK**
- 27) Press **ESC** multiple time to return to DATE/TIME SCREEN
- 28) Press **UP ARROW** 5 times to return to LGS PROGRAM DEFAULT SCREEN

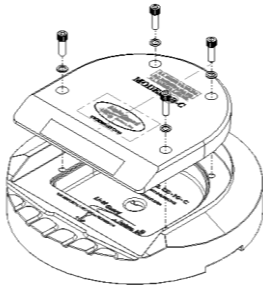
3 IN-ROADWAY WARNING LIGHT (IRWL)

3.1 GENERAL DESCRIPTION

The LightGuard Systems IRWL fixture is made of a high strength polyurethane. It is designed for mounting into a base plate assembly that is permanently attached to the roadway. This allows for any inoperable IRWL to be easily repaired with a plug-in replacement.

IN-ROADWAY WARNING LIGHT (IRWL) TYPE-M11 ASSEMBLY

General Performance Specifications

Parameter	Value	Typical Mounting	Base Plate Compatibility
Visibility	± 22.5° Horiz +10° Vert		SD-10C (composite) CHS-14 (steel)
Operating Temp	-20° to +80°C		Available Models LGS-M11-A (Amber) LGS-M11A-SMPL (Amber + White Luminaire) LGS-M11-R (Red) not for crosswalk use
Operating Voltage	9VDC to 15VDC		
DC Current @ 12VDC	0.2 Amps		
Avg Power Dissipation	2.5 watts		
Luminous Intensity	252,000 mcd		
Material	Polyurethane		
Housing Color	Clear		

3.2 IRWL FIXTURE AND BASE PLATE INSTALLATION OVERVIEW

NOTE: Correct Placement of Bases is **CRITICAL** to System Performance

Step 1 - Determine placement and site angles of in-roadway warning signals to intersect at optimum driver viewing zone as specified by Signal Alignment Drawing (refer to sections [3.3.1](#) & [3.3.2](#) & [3.3.3](#) & [3.3.4](#)). Signal assemblies can be manually aimed, but laser site method is optimal.



Step 2 - Perform saw cuts using pavement cutting device in accordance with predetermined layout to facilitate hook-ups through bottom of base plate to terminal connection points. Cuts should be ½" (12mm) wide in accordance with the CA Standard Plan ES-5A, or local standards, with a depth of 2" to 2½" (50mm to 63mm) for direct burial of wire (see section [3.3.6](#)).



Step 3 - Provide depression cut-out for base plates approximately 1 3/8" (35mm) ± 1/8" (3mm) deep on concrete or asphalt. Depression cut-out should be ¼" to ½" (6mm to 12mm), slightly larger than base plate. Depression cut-outs should be level, or even, to conform to the existing approach grade of the roadway. see section [3.3.5](#)



Step 4 - If required, dig out for traffic electric hand hole boxes and install boxes for wiring access points at predetermined locations in accordance with the CA Standard Plan ES-5E, or local standards.

Step 5 - Install all necessary wire to predetermined connection points and lay in cleared roadway cuts. Using duct seal or equivalent, create a temporary "epoxy dam" at the interface where the saw cuts enter/exit the depression cut area. The epoxy dam will temporarily hold down the wires & simultaneously dam the core drill area to prevent flow of epoxy back into the saw cut



Step 6 - Check for proper site distance angles and level depth of base plate. Mark alignment on roadway for base plate focus direction. Top of base plate (circumferential edge shown in section [3.3.6](#)) should be flush or slightly below (less than .10" = 2.5mm) roadway surface AND free from excess adhesive (See section [3.3.6](#)).

Step 7 - Using an AC powered drum mixer, mix only enough 2-part epoxy (see section 1.6) for 2 to 3 base plates. Epoxy working life is approximately 10 minutes. Surfaces should be cleaned of dirt or debris, and dry before applying adhesive. Ensure that wires are vertical in the center of the depression cut. Pour epoxy into depression cut approximately ¼" (6mm) depth. Pull wire through center hole in base plate. Secure base plates to roadway surface by pressing the base plate into the epoxy in the depression cut. Ensure that epoxy flows around the outside diameter of the base plate and slightly around the wires emerging from the center hole of the base plate, but **DOES NOT** fill the base plate. Ensure that epoxy fills outside diameter of base plate up to grade level. Ensure that the base plate is aligned with the mark made in step 6 above and is aimed toward the zone of convergence *prior to epoxy curing*. Allow minimum of 30 minutes of epoxy cure time prior to moving wires for connecting pigtail gel plugs (section [3.3.7](#)).

Step 8 - Allow minimum of 1 hour cure time (above 70°F & 2 hours if colder temperatures) before opening traffic lanes to vehicles travelling over recently epoxied base plates. Light fixtures can be secured to base plates as soon as epoxy has sufficiently hardened. *NOTE: Temperature is critical.*

Prior to securing IRWL, encapsulate conductors & splices by completely filling wiring cavity with CLEAR SILICONE SEALANT to prevent any debris or moisture from accumulating in wiring cavity + protect all wiring conductors/splices/connections from environment

Step 9 - Secure IRWL to base plates using button head cap screws using Allen Wrench or equivalent. Threadlock screws are coated with anti-seize compound for maintenance purposes to ensure that screws can be removed after exposure to the environment..

Step 10 - Complete "dress-up" saw cuts with Loop Sealant etc. DO NOT use Loop Sealant to "dress up" outside diameter of base plate to level epoxy surface with grade. Only use recommended 2 part epoxy for the outside diameter of the base plate.

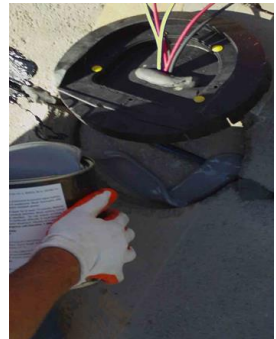


Figure 3-2A: Example of properly installed 10" composite baseplate (IRWL model 9X)



Figure 3-2B: Example of properly installed 14" baseplate in a snowplow region (IRWL model 8B)

3.3 MAJOR CONSIDERATIONS FOR IRWL INSTALLATION

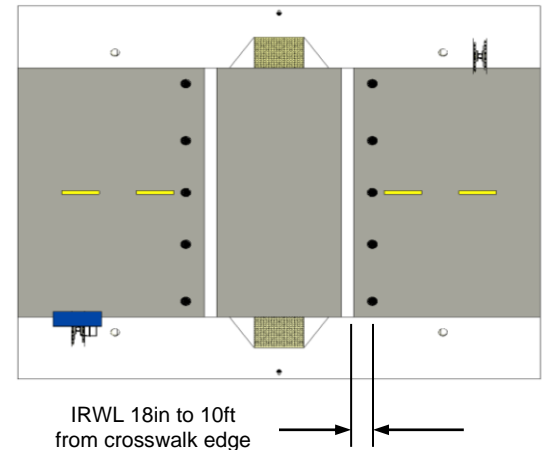
There are a number of basic considerations when determining the location and alignment direction of each IRWL for any given installation site. These items should be considered during the installation procedure for the LightGuard in-roadway warning system. Be sure to have enough specified wire/cable, 2-part epoxy, and saw cut filler (loop detector type filler) **ON SITE BEFORE BEGINNING INSTALLATION.**

3.3.1 IRWL DISTANCE FROM CROSSWALK LINES

The installer should ensure that the IRWL are located approximately 18" (1.5m) from the outward edge of the crosswalk. In general, greater distances can be used without any noticeable difference to the motorist. However, MUTCD standards indicate IRWL should be within less than 10 feet (3m) of the crosswalk lines. If required by a specific circumstance, (i.e., grade or advance curve warning layout) placement may necessitate an authorized deviation, using sound engineering judgment (thereby not conforming to MUTCD standards).

3.3.2 IRWL POSITIONING CONCERNS

Each IRWL should be located in a position that will be directionally visible to the approaching motorist from their viewing position at the wheel usually 200' to 400' (61m to 122m) in advance of the crosswalk, allowing sufficient time to recognize and react to the warning lights upon activation.



When locating IRWL in the path of street sweeping equipment, caution should be taken to consider the proper location for minimizing possible cosmetic damage to the IRWL at the "curb and gutter" locations (on the approach sides) by avoiding the "skid paths" associated with this type of equipment.

3.3.3 IRWL LAYOUT PATTERN

The pattern or layout should follow the recommended configurations that have been tested and proven effective for the type of crosswalk for which the system is being used. The MUTCD - Manual for Uniform Traffic Control Devices 2009 chapter 4N (<http://mutcd.fhwa.dot.gov/htm/2009/part4/part4n.htm>) defines the authorized use & application of IRWL. For best practice; one IRWL on the outside travel lane edge of each parking lane or bike lane (stay out of bike/parking lanes), one IRWL on the center divider lane or line, and one IRWL in each travel lane approximately under the location of each vehicle's license plate, (or centered between the tire paths of the travel lane). The "geographic" center of the lane may not be the appropriate location as vehicular traffic tends to travel "off center" of any given marked lane. The idea is to minimize the frequency of tire impact to the IRWL by placing them outside of the predominant vehicle tire wear pattern. With a raised median strip, the IRWL that is usually placed on the centerline or lane should be installed on the far left of the approach lanes next to the raised median curb or barrier. For maximum or higher level needs, an optional addition of one IRWL on each lane delineation line may be considered. Placement should be in accordance with MUTCD. Examples showing optional & required placement for California MUTCD can be found via <http://www.dot.ca.gov/hq/traffops/engineering/mutcd/pdf/CA-Chap4E-Chap4L.pdf>.

3.3.4 IRWL AIMING POINTS & ORIENTATION

The light beam view path of the IRWL should be determined by the local traffic engineer or responsible agency for the purposes of reaching the motorists viewing point 200' to 400' (61m to 122m) in advance of the crossing. *Generally*, the layout provides for the IRWL in the approach travel lanes to be aimed straight down the approaching motorist's viewing path. The parking lane IRWL (from the left and right sides) should also be aimed or aligned toward a "control point" approximately 200' to 400' (61m to 122m) in advance of the crossing, and should also converge at the approaching motorist view path. This would have the outside IRWL canted slightly inward toward the center of the lanes to that point. The IRWL on the center line and opposing travel lanes will be canted slightly toward the approaching motorist travel lanes to those "control points". Refer to section 3.3.4.1 for approach speeds to approximate "control points". Curved approaches will require a greater degree of analysis to provide the maximum benefit.

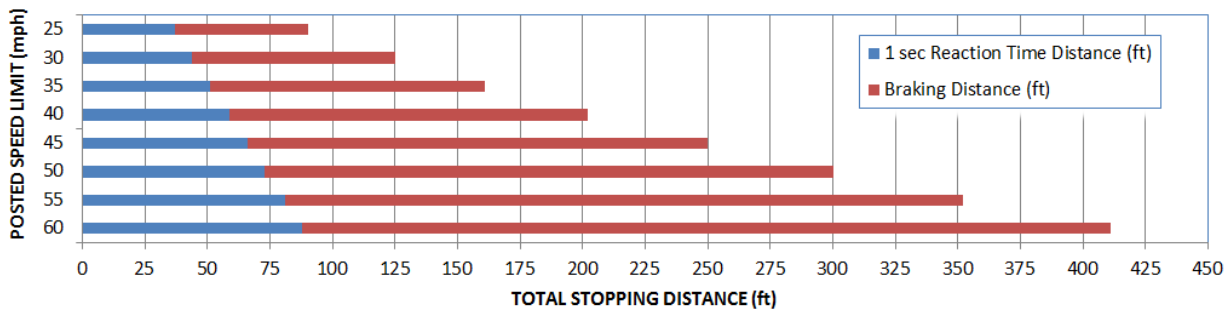
3.3.4.1 CONVERGENCE ZONES

The “Zone of Convergence” refers to the area in the lanes of travel where the beams from the in-roadway LED lights merge. This “zone” gives the driver adequate time to react to the presence of a pedestrian by drawing his/her attention to the crosswalk. When aligning IRWL, great care must be taken to position them correctly to achieve this desired distance.

If the speed limit on the roadway is 25 mph (40Kmh), the “zone” should be approximately 250’ (76m) out from the IRWL. If the speed limit is 45 mph (72Kmh), IRWL should be aligned to make the zone 350’ (106m) to 400’ (121m) away from the IRWL. See chart for additional stopping distances based on road conditions and vehicle speed.

Note: Alignment of IRWL to be site specific - city engineer or roadway authority to establish “control points” for each actual location. Control points may vary depending upon terrain, slope, vehicle approach speed, or regulation etc.

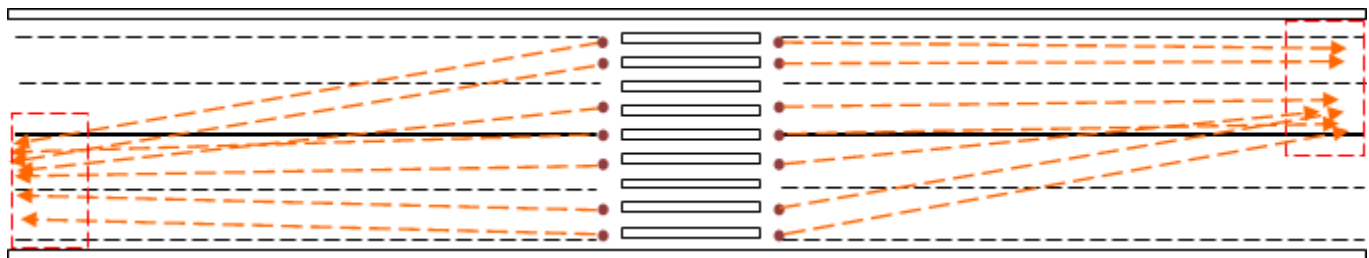
Minimum Vehicle Stopping Distance on Dry Pavement



3.3.4.2 TYPICAL IRWL ALIGNMENT - STRAIGHT ROADWAY

EXAMPLE: TYPICAL FOUR LANE MIDBLOCK CROSSWALK WITH 14 IRWL (DRAWING NOT TO SCALE)

DIRECTION OF TRAVEL
400' to 200' (121m to 61m) TYPICAL CONTROL POINTS



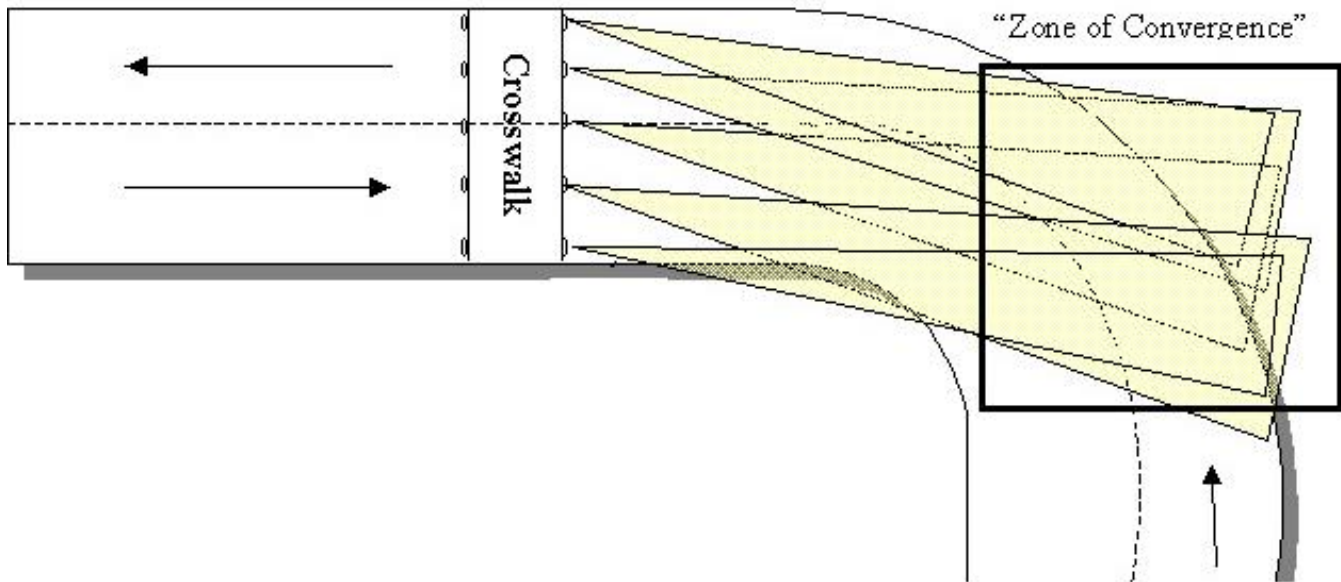
DIRECTION OF TRAVEL
400' to 200' (121m to 61m) TYPICAL CONTROL POINTS

3.3.4.3 TYPICAL IRWL ALIGNMENT - CURVED ROADWAY

Determining the location of the “Zone of Convergence” on a curved roadway is similar to a straight roadway. Using the chart showing the *Minimum Stopping Distance on Dry Pavement*, determine the total stopping distance based upon the speed limit of the roadway. The **minimum** starting point of the convergence zone is determined by the **minimum** stopping distance on dry pavement for the posted speed limit. This minimum stopping distance includes a motorist decision distance, based on a one-second reaction time, plus the necessary speed deceleration required to come to a complete stop under optimum conditions.

As an example, the minimum stopping distance on dry pavement for a roadway with a 35 mph (56Kmh) speed limit is approximately 161 ft. (49m). This minimum distance would allow a motorist to visually

recognize the flashing amber LED lights, slow down, and if necessary, bring his/her vehicle to a complete, safe stop.



IRWL should be aligned to make the LED lights and therefore the zone appear as soon as possible as the driver approaches. On curved or winding roads, the entrance to the zone isn't always at the optimal distance to provide the earliest possible notification to approaching vehicles. Optional IRWL may also be installed down the center line of the road to give even more advance warning, giving the driver time to brake and stop for the pedestrian.

3.3.5 DEPRESSION CUTS FOR IRWL BASE PLATES

The depression cuts for the base plate assemblies can be accomplished in a number of ways. Most contractors prefer core drilling or a chip hammer. Alternatively, a flat bottom "Grinding Core Drill Bit" can be used. Also, making "cross cuts" in the pavement at the IRWL location will considerably expedite the core drilling process (refer to section [3.2](#)). After determining the location and aiming direction of a particular IRWL, then core or chip out hole approximately $1\frac{3}{8}" \pm \frac{1}{8}"$ (35mm \pm 3mm) deep refer to reference dimension table. A clean "corner" is desired at the bottom (flat bottom, vertical edges). Trim interior surface to proper depth, clean and prepare for epoxy. *The size of the depression cut is VERY important. If the depression cut is too deep or the OD is too large, then excess epoxy will be required for securing to the roadway. If the depression cut is too shallow, the base plate will protrude above grade. If the depression cut OD is too small, insufficient epoxy will prevent the base plate from being permanently affixed to the roadbed.*

3.3.5.1 REFERENCE DIMENSIONS FOR BASE PLATE MOUNTING TO ROADWAY

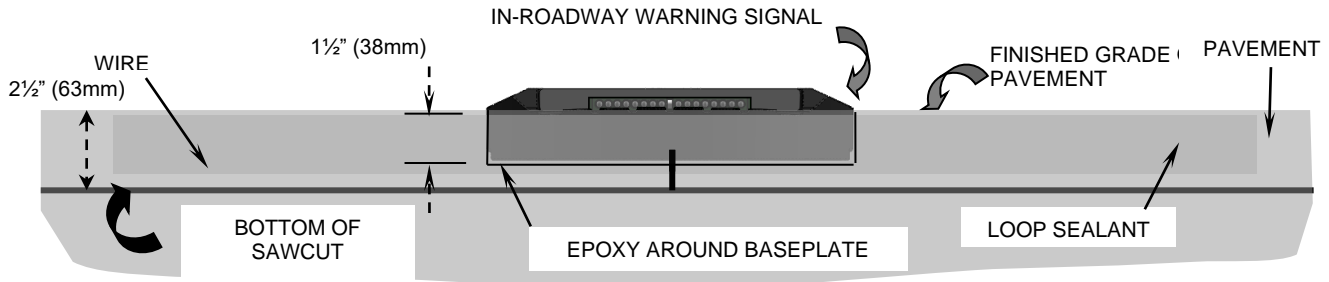
Base Model	Plate	Base Plate Material	Base Plate OD - Outside Diameter	Base Plate Height	Recommended Depression Cut Hole Diameter	Recommended Depression Cut Hole Depth
CHS-14 revH min		Steel	13 $\frac{3}{4}"$ (350mm)	1 $\frac{3}{8}"$ (35mm)	14" (356mm)	1 $\frac{1}{2}"$ max (38mm)
SD-10C		Composite	9 $\frac{7}{8}"$ (251mm)	1 $\frac{3}{8}"$ (35mm)	10" (254mm) min	1 $\frac{1}{2}"$ max (38mm)

3.3.6 SAW CUT FOR WIRING AND IRWL BASE PLATES

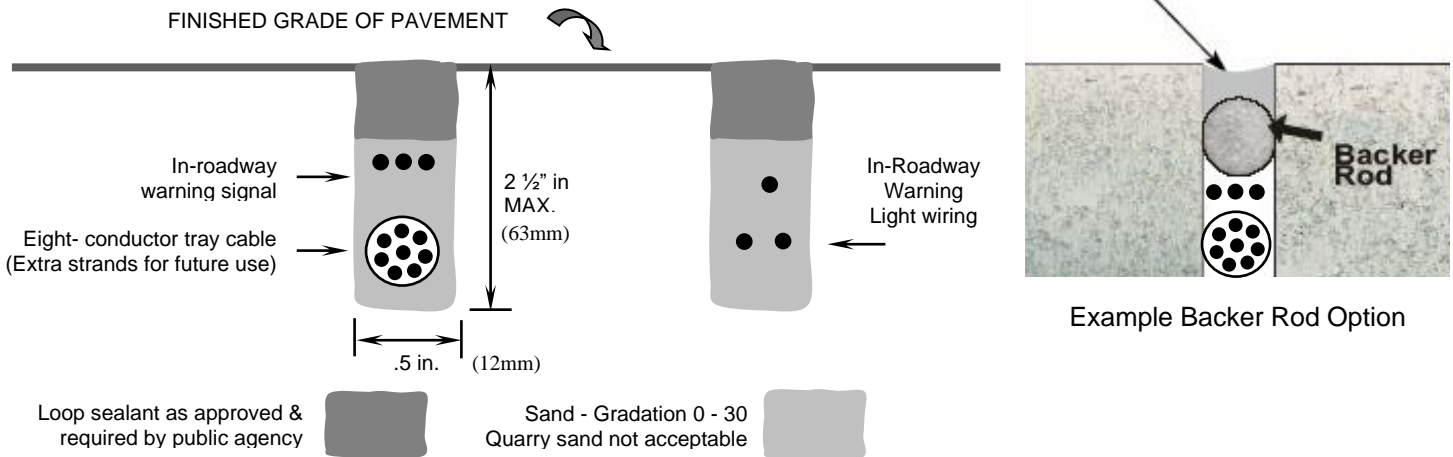
The saw cut for wiring should follow the manual for depth and width to accommodate the necessary wiring and tray cable for the installation. As a general rule, this averages $\frac{3}{8}"$ - $\frac{1}{2}"$ (9.5mm – 12mm) wide cut approximately 2 $\frac{1}{2}"$ (63mm) deep (should be below core drill depth). Operational component connections from controller to across the street can be pulled to terminal boxes for easy access

connecting activation mechanisms and other active LED components using standard type wire. Ensure that the saw cut makes a complete loop through all IRWL locations (refer to sections [2.2](#) & [3.3.8](#)).

3.3.6.1 IRWL SAW CUT CROSS SECTION FRONT VIEW - (SD10-C BASE PLATE SHOWN)



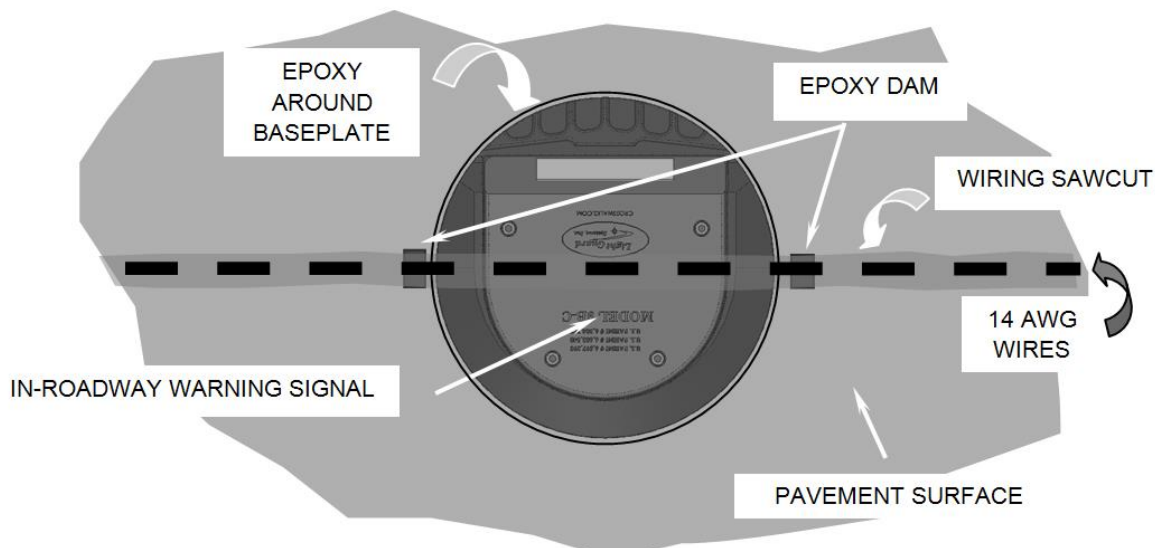
3.3.6.2 IRWL SAW CUT CROSS SECTION SIDE VIEW



DRAWING NOT TO SCALE

NOTE: USE 14 AWG WIRING, (see section [1.6](#)) APPROVED BY LOCAL AGENCY FOR IN-ROADWAY WARNING SIGNAL ARRAY HOME RUN CONNECTION. FOR BOLLARD AND PUSH BUTTON'S, ALWAYS USE 8 CONDUCTOR 18 AWG MINIMUM DIRECT BURIAL CABLE TO ROUTE FROM ENCLOSURE TO OPPOSITE SIDE OF STREET FOR BOLLARD AND PUSH BUTTON'S.

3.3.6.3 IRWL SAW CUT TOP VIEW (SD-10C BASE PLATE SHOWN)

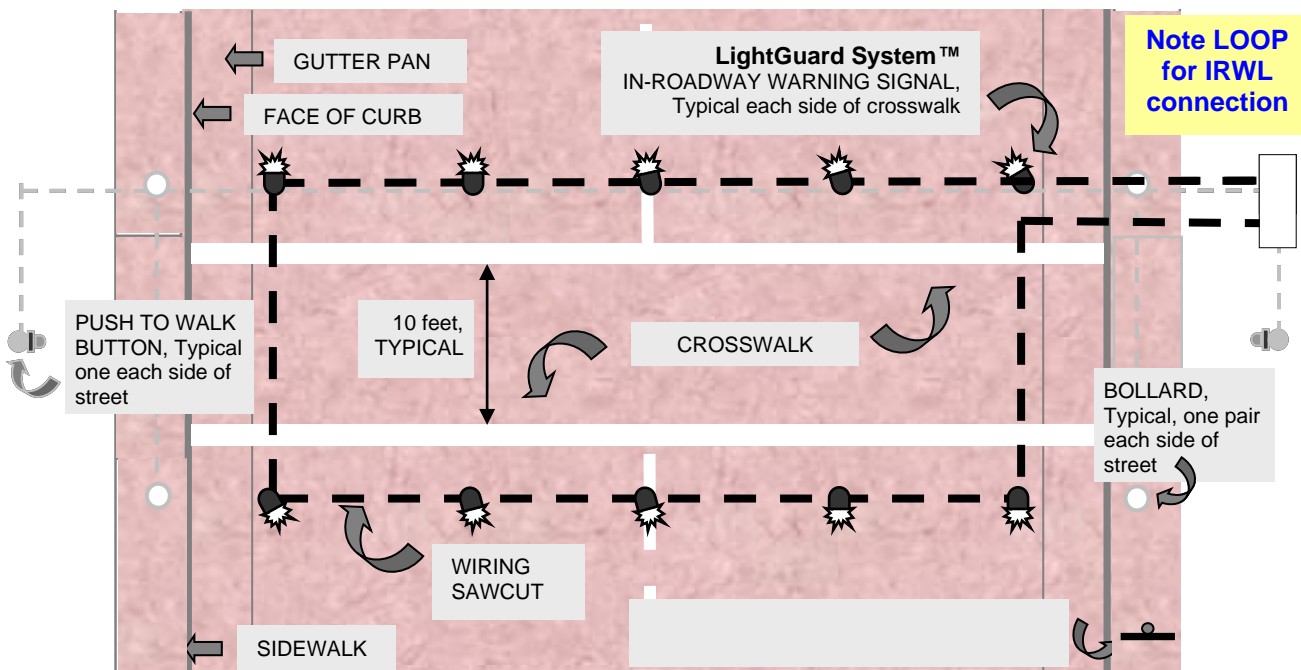


3.3.7 EPOXY

Be sure to have enough wire/cable, SPECIFIED 2 part epoxy (**Bondo 7084 Piezo/Traffic Sensor Sealant or DSB epoxy** available from LGS upon request), and saw cut filler (loop detector type filler specified by local regulations) ON SITE BEFORE BEGINNING INSTALLATION. AFTER ALL WIRES ARE IN PLACE IN THE WIRE CUTS. Using duct seal or equivalent, create a temporary “epoxy dam” section [3.3.6.3](#) at the interface where the saw cuts enter/exit the depression cut area. The temporary epoxy dam prevents epoxy from flowing from the depression cut into the saw cut.

Remove plastic thread protectors from topside threaded holes in base plate. Temporarily install socket head cap screws into threaded holes (approximately 3-4 turns) in order to use the screws for base plate leveling. Slip the wire through the center hole and “stand” the base plate on end “ready” to place into the depression. Thoroughly mix the appropriate type of epoxy for use in the base plate depression cut. Place an appropriate amount of 2 part epoxy in the depression (sufficient to completely seal bottom and rise around outside edges of the base plate when pushed into place). To insure a proper moisture seal, place the initial “glob” of epoxy in the center of the depression, move (or wiggle) wires around in the epoxy to attain wire seal, then push material to the outside edges and set the base assembly in place. The base plate should be aimed and level (use the temporarily installed screws to elevate the base plate if required during leveling) before epoxy is allowed to completely cure. Note: If the depression is for some reason cut too deep, a “few” small rocks, pebbles or BB’s can be used to maintain a proper height. It is best to have the epoxy surround the base plate edges approximately level with the surface. **NOTE: Epoxy working life is approximately 10 minutes depending upon ambient temperature. After this duration, the base plate can’t be moved. Allow epoxy time to fully set, generally 20 to 30 minutes, prior to installing IRWL.**

3.3.8 LIGHTGUARD SYSTEM IRWL WIRING DIAGRAM (EXAMPLE)



Refer to section [3.3.4](#) for IRWL Aiming and Alignment

3.3.9 IRWL CONDUCTORS/WIRES

Model **LGS-M11-A**

IRWL CONDUCTOR	PURPOSE	UC-AC CONNECTION
YEL	Motorist warning (ALERT)	Q1+
BLK	IRWL common (0VDC)	COM
RED	None	No connect

Model **LGS-M11-R**

IRWL CONDUCTOR	PURPOSE	UC-AC CONNECTION
YEL	None	No Connect
BLK	IRWL common (0VDC)	COM
RED	Motorist control (STOP)	Q2+ (Addendum)

Model **LGS-M11A - SMPL**

IRWL CONDUCTOR	PURPOSE	UC-AC CONNECTION
YEL	Motorist warning (ALERT)	Q1+
BLK	IRWL common (0VDC)	COM
RED	White Pedestrian Luminaire	Q4+

Be certain that wire (ref [section 1.6](#)) type RHW-2/USE-2/XLP **MAX OD 0.17"** (4.3mm) is the correct size and type for IRWL, and activation mechanisms (Bollards &/or Push buttons) for single run across street as recommended. Pull and cut 14 AWG wires to appropriate length. **DO NOT STRIP INSULATION** from IRWL wire. Connect to molded plug connector (pigtail cable assembly) provided in base plate assembly using provided Scotchlok Self-Stripping Pigtail Connectors-crimp to seal (see [section 3.3.11](#)).

Activation mechanism conductors for push buttons or Bollards (should be Belden cable 28601A as referenced in [section 1.6](#)) can be collocated in the same saw cut with the IRWL conductors (see [section 3.3.6.2](#)). Trim the IRWL conductors to a suitable length to work with for wiring the base plates.

3.3.10 TYPICAL IRWL SIGNAL BASE PLATE WIRING DRAWING

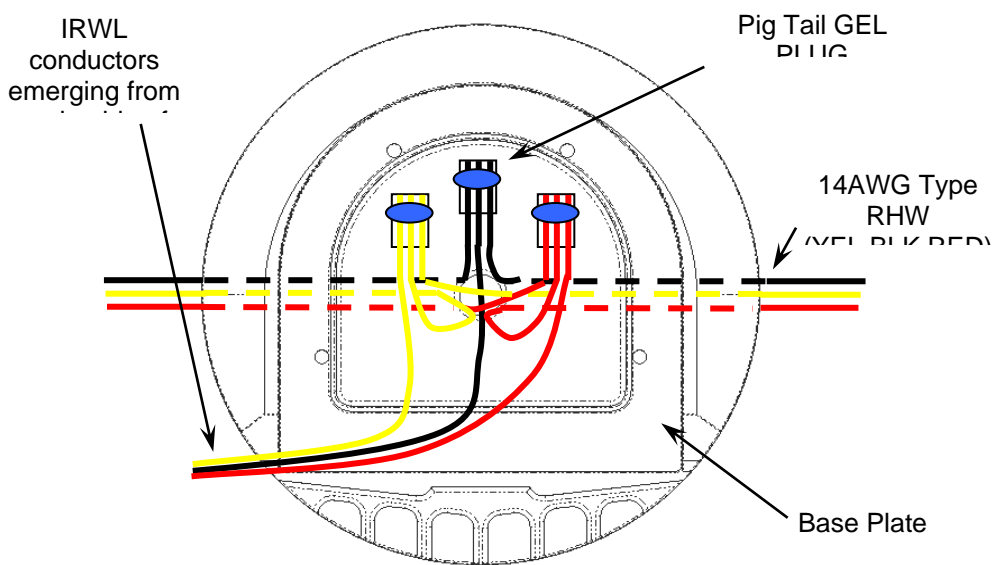
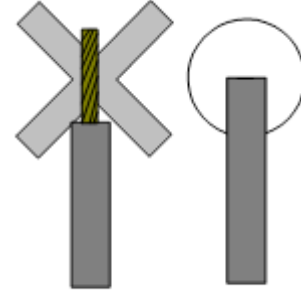


Figure 3.6A – Base Plate Wiring (SD-10C shown)

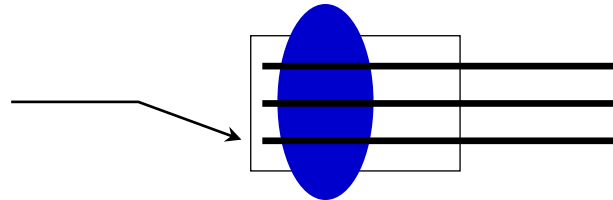
3.3.11 GEL PLUG TERMINATION INSTRUCTIONS

The Scotchlok 314 Self-Stripping Electrical Connectors are moisture resistant and do not require wire stripping. This can only be done in baseplates that have sufficient wire length extending from the roadway (minimum 2"). The GEL PLUG connector requires 3/4" (19mm) of wire to be fully inserted into it & must lay flat in wiring cavity after connection & must lay flat in wiring cavity after connection

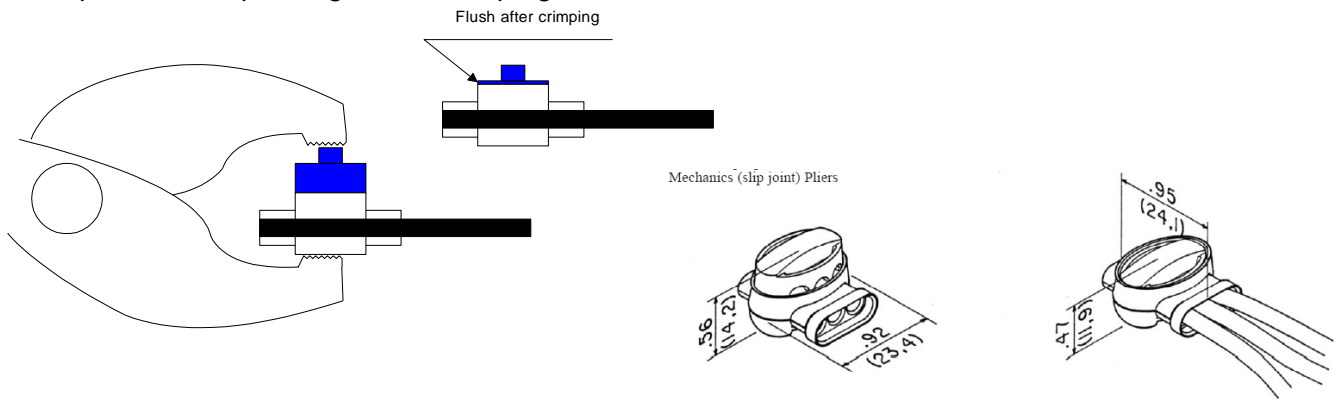
- 1) Outer Diameter of type RHW-2/USE-2/XLP wire should be **MAX OD 0.17" (4.3mm)**. This will allow the insulated wire to be inserted into the Scotchlok 314 connector. Any exposed bare wire should be clipped off from the wires when connected to ensure that no part of the conductor is exposed.
- 2) Insert all three wires to be connected into the three open holes in the connector, until they all reach the back end of the connector.



End of Insulated wire should touch back of connector



- 3) With a standard pair of slip joint pliers, pinch down on the blue cap of the connector until the outer edge of the blue cap is flush with the rim of the white connector housing. It may be necessary to wipe off the expelled gel after crimping.



- 4) Place the connector in the bottom (lowest part) of the base cavity and route the wires so no pinches will occur when the head is tightened. Double-sided adhesive tape can be used to hold connector in place until head is re-installed.

3.3.12 IRWL INSTALLATION

Using compressed air, remove dirt and all debris from base plate cavity. Ensure that mounting screw threads are clear. Plug pig-tailed base plate cable electrical connector (RECEPTACLE) into IRWL cable electrical connector (PLUG). Note appropriate alignment for 3 pin connector. Ensure that mated molded plug connectors are PROPERLY SEATED. Check for proper "O" ring placement and attach IRWL to base using **SOCKET HEAD CAP SCREWS** with **LOCK WASHERS** and **FLAT WASHERS**. Tighten using an **INCH POUND TORQUE WRENCH**.

Composite Base plate: Recommended torque value is **not to exceed 4 ft lbs** 48 in lbs (5N m) – **NO TIGHTER**. Hand tightening with a standard Allen wrench is also acceptable. **WARNING** – the

composite base plate is very sensitive to this procedure, as damage to the threads may occur if tightened over 4 ft lbs (5N m).

For extremely harsh environments, consider placing additional duct seal or plumbers putty into the gap between the base plate and under the light fixture, into the counter bore holes for the socket head cap screws, & around the IRWL outside edge perimeter to minimize the potential for moisture or debris from entering the base plate.

NOTE: It is IMPERATIVE that these steps be followed when installing the light fixtures. Failure to do so voids the manufacturer's warranty. It is highly recommended that within 30-45 days after initial installation, that the heads be re-checked to verify that the 4 ft lbs (5N m) of torque has been maintained.

Check for even contact and snug fit with base plate top surface. Verify IRWL operation and move on to next unit.

3.4 NEW ROAD SURFACE CONSTRUCTION INSTALLATIONS

If site is new construction, conduit under the roadway surface and knockout templates (to achieve base plate depression excavation for installation) is an option for the installer/contractor. This will avoid or minimize saw cutting into new roadway surfaces. Plywood cutouts or similar knockouts to match the base plate assembly size may be utilized in preparation for the installation of the base plates upon completion of the roadway surface. Precise engineering must be exercised to insure proper placement and alignment of the IRWL on the lane lines and travel lanes once the work is completed. A separate conduit is recommended for the single run of tray cable across the street.

3.5 CONCRETE INSTALLATION PROCEDURE

The following information is a basic guideline for installing LightGuard Systems In-Roadway Warning Lights at locations where new concrete is to be poured.

Conduit must be installed. It should be placed at least 3" to 4" (76mm to 101mm) below the surface of the roadway (or as required by local regulations). The single ¾" (19mm) hole in the center of the base plate can be enlarged to approx. 2½" (63mm) dia in order to insert two ¾" PVC conduits connected to 90° elbows up into the base plate wiring cavity. Alternatively, a single 1½" to 2" diameter metal or PVC conduit can be used with a TEE connection stub that extends at least 1" (25mm) above the surface (after concrete is poured) for pulling wire loops through TEE's. This is installed at each location where an In-Roadway Warning Light Base plate will be placed. Minimum recommended conduit is ¾" PVC to comply with NEC 14AWG type RHW-2/USE-2/XLP conductors.

Use a circular wooden plug or equivalent 1½" (38mm) thick by approx 10⅞" (257mm) dia for SD-10 Base plate or 14" (355mm) dia for CHS-14 Base plate) with a center hole having a diameter just larger than the conduit stub(s) protruding up from the road bed as a concrete forming tool. The plug center hole diameter should be minimum 1/8" (3mm) smaller than center hole in base plate to ensure subsequent base plate seating. The plug is placed over the conduit stub (or elbows) during the concrete pour to create a depression form for installing the base plate when concrete is dry.

After the concrete is dry, the wooden plug is removed & the base plate is affixed into the road. Excess concrete around the conduit should be removed to allow epoxy to bond the conduit to the base plate at the center hole. The extended conduit can then be cut flush to the inside surface of the base plate. Remove any excess epoxy &/or concrete from the base plate. After conductors are terminated, the exposed portion of the conduit opening should be filled with duct seal to minimize the potential of moisture or contaminants from entering the conduit.

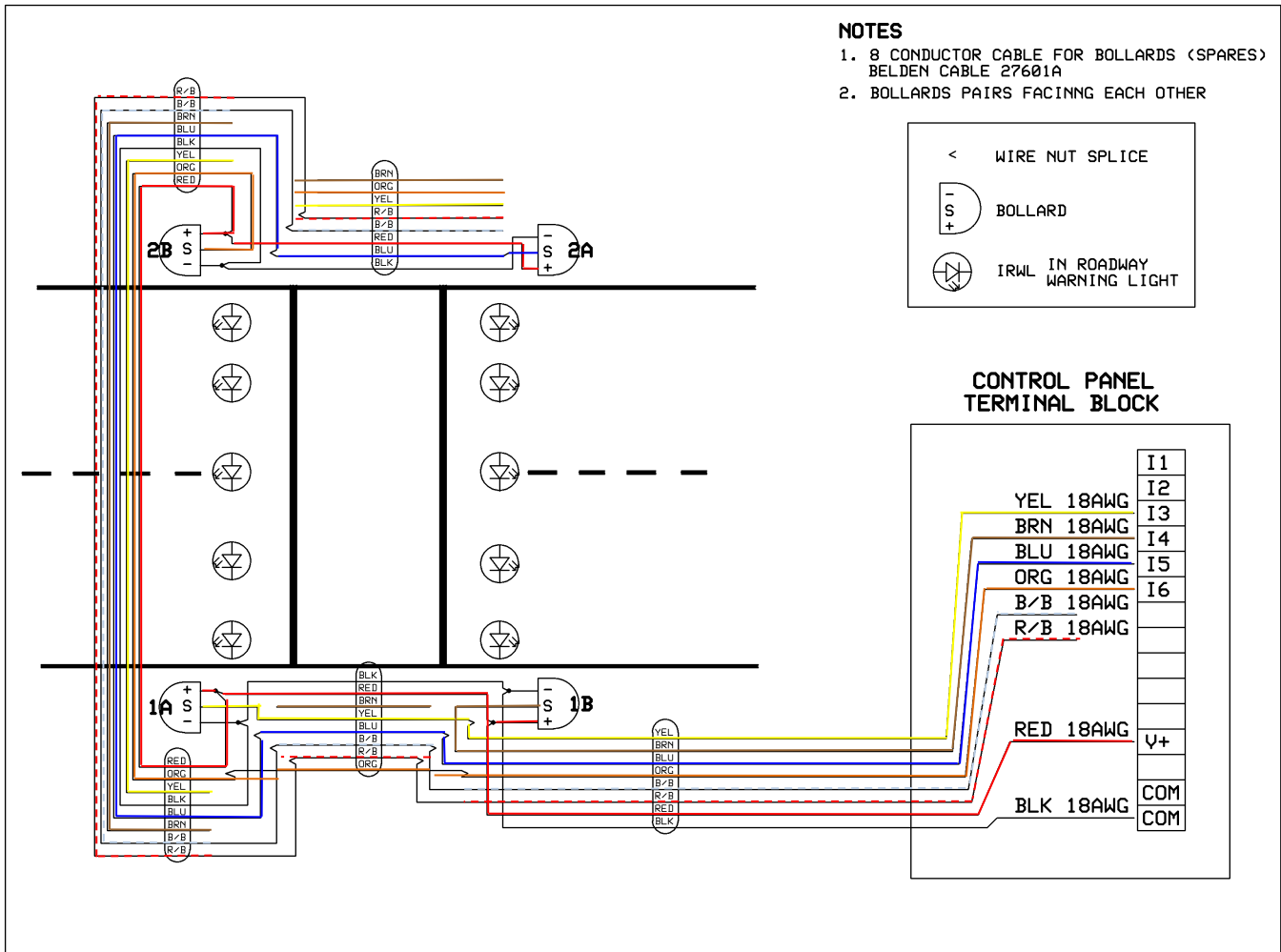
4 AUTOMATIC ACTIVATION SYSTEM - SMART CROSSWALK™

4.1 BOLLARD PEDESTRIAN DETECTION SYSTEM DESCRIPTION

Automatic Activation System consists of “gateways” comprised of Bollards or posts. Each Bollard contains sensor circuitry, and they are placed so pedestrians entering a crosswalk must pass between them automatically activating the Smart Crosswalk™. The built-in sensors detect pedestrians using the crosswalk and detect their direction of travel. The built-in sensor module projects infrared beams of modulated light to the respective receiver module. Each module incorporates a high gain detector. This allows the System to activate for Crosswalk entry, and not for exit. THE FRONT OF EACH BOLLARD PAIR SHOULD BE FACING EACH OTHER.

Bollards are used in pairs. Each Bollard sends its own signal back to the controller. When one of the input status LED indicators is illuminated, then the controller has received a signal that an object has entered the activation zone. Once sensor A is triggered, followed by sensor B, the system is activated for the desired cross time. If an input status indicator LED is illuminated but no object has entered the activation zone, then the receiver is not receiving the emitter's beam.

4.2 BOLLARD PAIR LAYOUT AND WIRING DIAGRAM (EXAMPLE)



4.3. BOLLARD INSTALLATION GUIDELINES

4.3.1. INSTALLATION STEPS

Step 1 Prior to installing Bollards, the proposed site should be inspected several times to observe the everyday habits of local citizens who utilize the crosswalk. Particular attention should be paid to how far back pedestrians may “*cut the corner*” when entering the crosswalk. Bollards, as positioned, may not detect every pedestrian using the crosswalk. For example, a 12 ft. (3.6m) wide crosswalk (dimension from outside crosswalk stripe to outside crosswalk stripe), Bollards would be positioned approximately 5 to 6 ft. (1.5m to 1.8m) outside of the outer edge of the crosswalk stripe and about 18” to 24” (46cm to 61cm) behind the face of curb. Once Bollard locations have been determined, wiring, or conduit, may be run prior to installation of the hold down bolts.

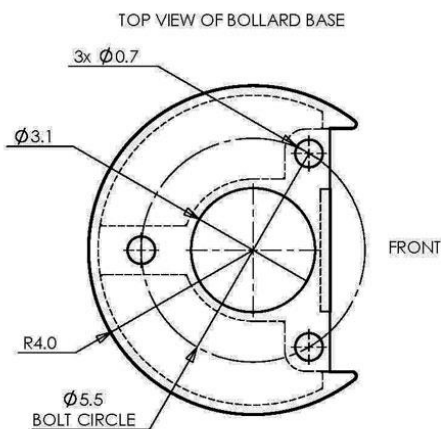
Step 2 The preferred method of securing Bollards into position is to remove an 8” (20cm) square section of sidewalk then dig approximately 18” (46cm) and set anchor bolts in 6 sack concrete mix (Refer to Bollard Mounting Detail section [4.3.2](#)). Other methods are acceptable, such as drilled anchor bolts, however, the bolts may become loose as a result of the Bollard being bumped. A loose Bollard will cause the calibrated internal sensors to become misaligned (reference section [4.4](#) for Bollard Alignment). J-Bolt alignment template is provided. Snap a “chalk line” between Bollard pair locations to ensure that j-bolt templates are directly facing each other (not skewed) FRONT facing FRONT.

Step 3 After Bollard anchor bolts have been set, and the concrete has cured, the Bollards can be secured to the anchor bolts. Position the base of the Bollard approximately 1/8” to 1/4” (3mm to 6mm) above the finished sidewalk grade, level, and secure. All hardware MUST be tightly secured. If installed on a sloping sidewalk, ensure that Bollard is vertical using leveling nuts.

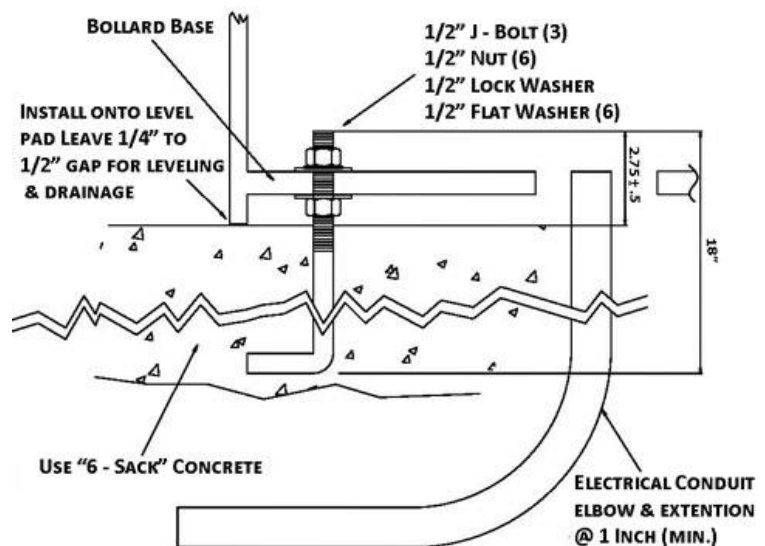
Step 4 Run wires and make final wiring connections to each Bollard (See section [4.3.3](#) & [4.3.4](#)). Make wiring connections to terminal blocks in enclosure. Once wiring connections have been completed the Bollard light sensors are ready to be aligned (See section 4.4).

4.3.2 BOLLARD MOUNTING DETAIL

NOTE: To alleviate wire access or electrical connection difficulties, conduit height should not exceed 1” above grade – unless required by local regulations



NOTE
5.5” dia Bolt Circle Template (3 Ø 120°)
 furnished by **LightGuard Systems**

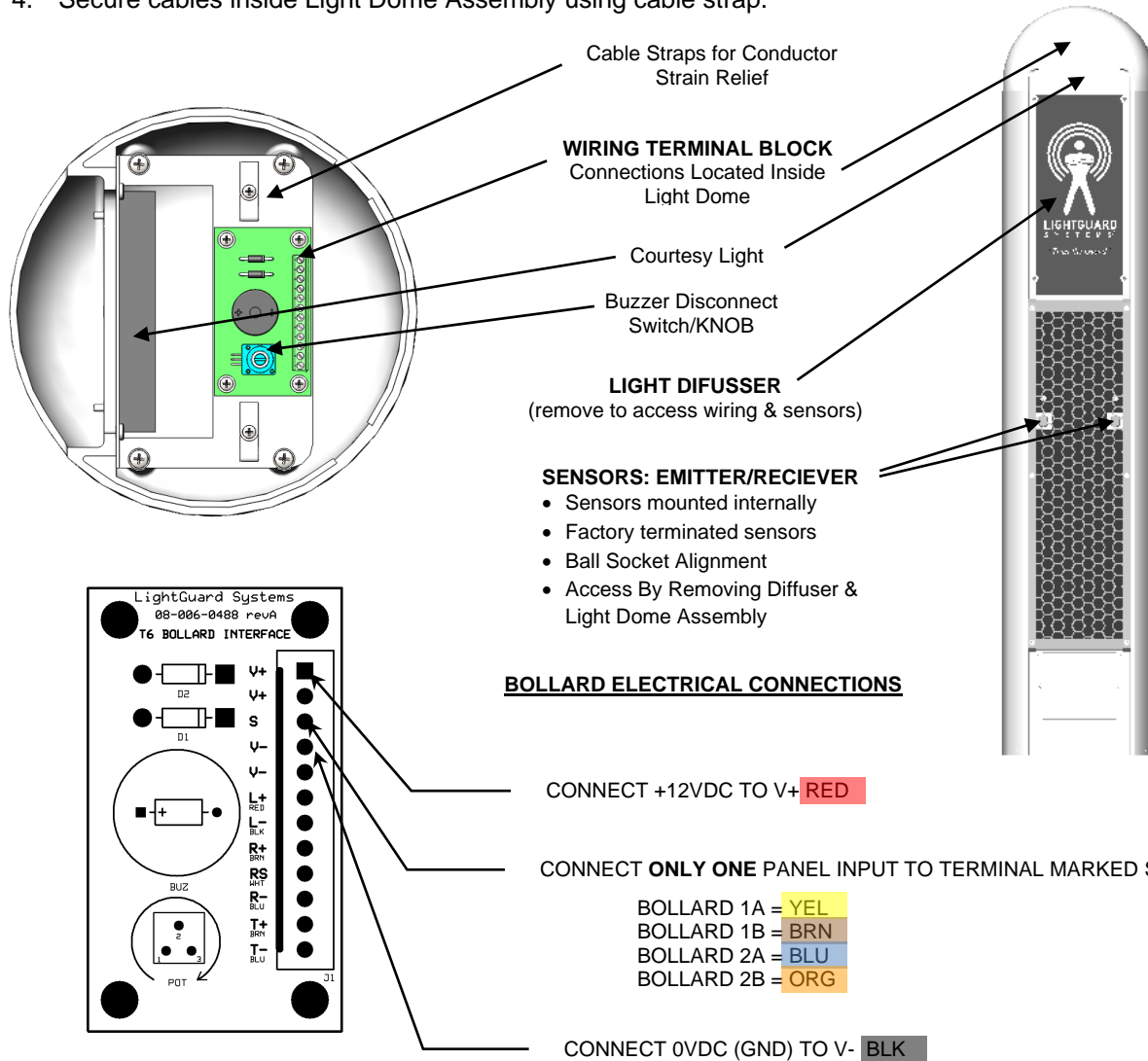


4.3.3 BOLLARD WIRING - CONTROL PANEL TERMINAL BLOCK CONNECTIONS

CONDUCTOR COLOR	PURPOSE	DESIGNATION	UC CONNECTION AC or SOLAR
RED	+12 VDC (ENERGIZE BOLLARD)	Power +	V+
BLK	0 VDC	Power -	COM
YEL	BOLLARD PAIR 1, LEFT RECEIVER SENSOR	1A	I3
BRN	BOLLARD PAIR 1, RIGHT RECEIVER SENSOR	1B	I4
BLU	BOLLARD PAIR 2, LEFT RECEIVER SENSOR	2A	I5
ORG	BOLLARD PAIR 2, RIGHT RECEIVER SENSOR	2B	I6

4.3.4 BOLLARD WIRING – BOLLARD TERMINAL BLOCKS CONNECTIONS

1. Route all cable (Belden 28601A) conductors entering from the bottom of the bollard up through the housing into the Light Dome Assembly for connections to the wiring terminal block.
2. Ensure adequate length of conductor cable (**recommend 8' each**) such that the Light Dome Assembly can be easily removed and placed on the ground without stressing the conductors.
3. Ensure that cable routing up into the Light Dome incorporates strain relief such that the weight of the wires does not stress the terminal block connections after installation.
4. Secure cables inside Light Dome Assembly using cable strap.



4.4. BOLLARD DETECTION ZONE OPERATION VERIFICATION

Each bollard receiver sends its own call signal to the controller. Since each bollard pair has its own A-B separate input to the controller, the controller will only activate the flashing sequence when the “A” bollard is detected prior to the “B” Bollard. Refer to section 4.3.3 BOLLARD TERMINAL BLOCK WIRE COLOR TABLE for recommended connection designations

Step 1 Ensure zones are correctly connected to the flashing controller by observing the input status indicator LEDs on the controller located on the left side on the UC model controller.

Step 2 Observe pedestrian entering the crosswalk between the Bollards. For bollard pair 1, the first input status indicator LED that illuminates should be 3rd from the top, the second should be 4th from the top. If the LED's illuminate in the reverse order, then the field wires 1A/1B are reversed. To correct, reverse wires 1A and 1B at the UC I3 & I4 terminal block connections.

Step 3 Observe pedestrian exiting the crosswalk. The input status indicator LED should illuminate in order of Bollard B then Bollard A. In this condition, the UC will ignore the call signal and not initiate the flashing sequence.

Step 4 Observe pedestrian returning from other side of street entering the crosswalk between Bollards 2A and 2B. Ensure that when pedestrian enters the crosswalk between Bollards that the 2A input status indicator LED on the left (5th from the top) illuminates, then the 2B input status indicator LED (6th from the top) illuminates.

4.5 BOLLARD ALIGNMENT

If after connecting & energizing the system, any LED input status indicators in the controller are illuminated, this indicates Bollard detection sensors are probably out of alignment. Generic steps for initial installation & alignment are included below.

Step 1 Determine that Bollards 1A and 1B are plumb, secure, and aimed directly at each other (FRONT facing FRONT). If the Bollards are not aimed directly at each other, then align sensors following steps in section [4.5.1](#) to compensate for Bollard misalignment.

Step 2 Make sure Bollard piezo-electric buzzer switch is engaged (rotated fully counterclockwise) = If the sensor is *not aligned* the buzzer will sound.

Step 3 Ensure there is power to emitting sensor in each Bollard, If there appears to be a power problem, correct then continue.

Step 4 Adjust a Bollard's receiver and emitter sensors (refer to sections [4.5.1](#) & [4.5.2](#)).

Step 5 With controller enclosure door open, observe the input status indicator LED (see section 2.8.1 for location of input status indicator LED).

Step 6 Repeat above procedure for each Bollard 1A, 1B, 2A, & 2B. Note that standing behind each Bollard, the emitter is always on left side & the receiver is always on right side. Once all Bollards are aligned and reassembled, ensure that all input status indicator LED are not illuminated (ref step 5 above). Reassemble the Bollards.

4.5.1 BOLLARD SENSOR ADJUSTMENT STEPS

Each Bollard is equipped with detection sensors 1 transmitter/emitter and 1 receiver. To adjust the detection sensors follow the procedure below;

Step 1 Remove 4 socket head hex drive screws from the upper portion (Acrylic light diffuser) of the Bollard (see Figure 4-5)

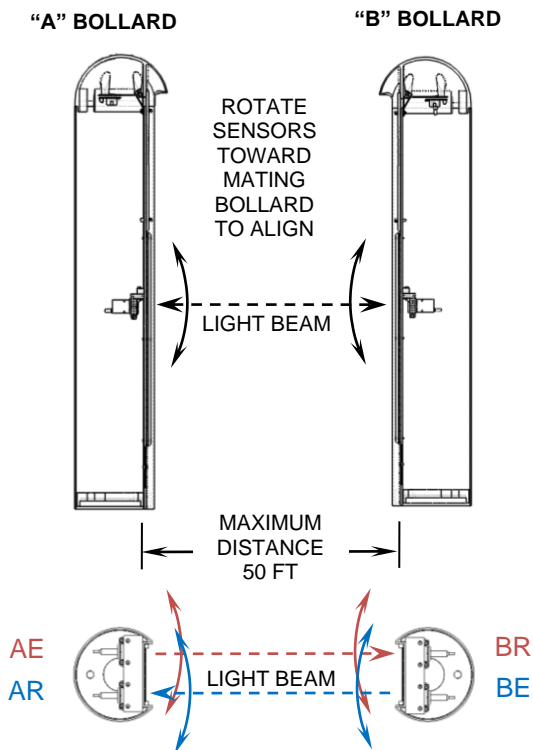
Step 2 Slide rounded top of Bollard (Light Dome Assy) upward and out.

Step 3 Standing behind the Bollard, look down 18" (45cm) into the top portion of Bollard. There are 2 black colored sensor modules. The sensor on the right is the Zone receiver and the sensor on the left is the Zone emitter (see Figure 4-5).

Step 4 SLIGHTLY loosen screws on each side of sensor and move sensor until buzzer silences. When properly aligned, each input status indicator LED in the controller will *NOT* be illuminated and the buzzer will *NOT* sound which means that both detection zones are clear and ready for operation.

Step 5 Tighten sensor screws when properly aligned and disconnect buzzer. If Buzzers are not disconnected after alignment, then the buzzer will sound each time the Bollard Beam is momentarily "broken." The LightGuard System is supplied with a portable mirror (located in electrical cabinet) that can be used to view the LED status Indicators located on the back side of each of the Bollard sensors (see Figure 4-5 to interpret the LED status indicators).

4.5.2 BOLLARD SENSOR ADJUSTMENT DETAIL

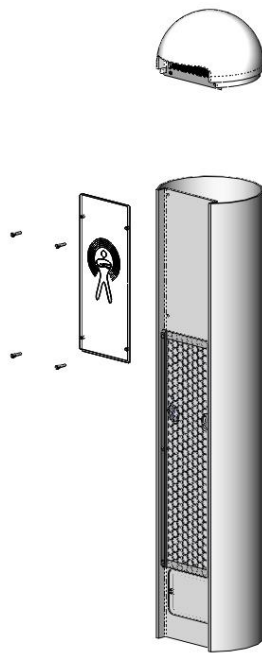


- WHEN ENTERING THE CROSSWALK, "A" BOLLARD IS ALWAYS ON THE LEFT, "B" BOLLARD IS ALWAYS ON THE RIGHT
- ENSURE THAT BOLLARDS ARE DIRECTLY FACING EACH OTHER – FRONT FACING FRONT
- MINIMIZE ELEVATION DIFFERENCES BETWEEN BOLLARDS TO PREVENT HAVING TO ALIGN SENSORS VERTICALLY
- WHEN BOLLARDS ARE INSTALLED FACINIG EACH OTHER & LEVEL, SENSORS SHOULD NOT REQUIRE ADDITIONAL ALIGNMENT

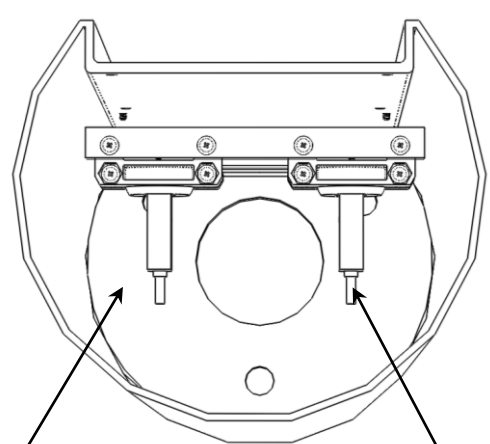
- ACCESS SENSORS BY REMOVING LIGHT/DOME ASSEMBLY
- ENGAGE BUZZER SWITCH DURING ALIGNMENT PROCESS
- SLIGHTLY LOOSEN SWIVEL MOUNT SCREWS TO ENABLE SENSOR ROTATION
- **STARTING WITH RECEIVER**, ROTATE SENSORS SIDE/SIDE & UP/DOWN TOWARD CENTER UNTIL BUZZING CEASES.
- VERIFY OPTIMAL ALIGNMENT USING MIRROR TO VIEW RECEIVER LED STATUS INDICATORS
- **ONCE SENSORS ARE ALIGNED, TIGHTEN LOCKING SCREWS TO SECURE IN PLACE**
- DISENGAGE BUZZER SWITCH AFTER ALIGNMENT

- **AE**= EMITTER INSIDE THE "A" BOLLARD LOCATED ON *LEFT SIDE* AS THE CROSSWALK IS ENTERED
- **AR**= RECEIVER INSIDE "A" BOLLARD LOCATED ON *LEFT SIDE* AS THE CROSSWALK IS ENTERED
- **BE**= EMITTER INSIDE "B" BOLLARD LOCATED ON *RIGHT SIDE* AS THE CROSSWALK IS ENTERED
- **BR**= RECEIVER INSIDE "B" BOLLARD LOCATED ON *RIGHT SIDE* AS THE CROSSWALK IS ENTERED

4.5.3 T6 BOLLARD AB SENSOR REFERENCE (MAX RANGE = 20m)

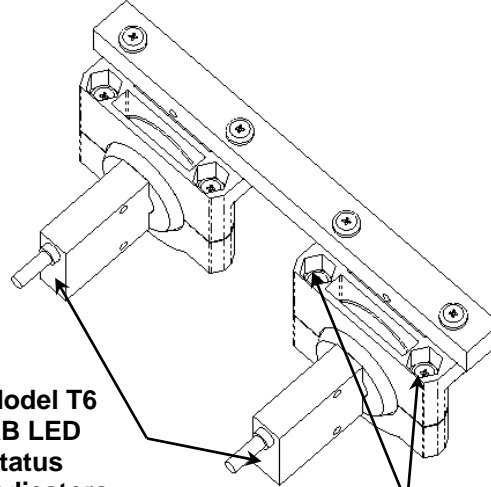


Remove Diffuser, Wires, & Light Dome Assembly



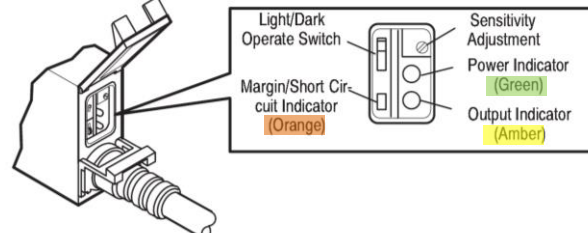
Emitter Receiver

Standing behind Bollard & looking Down, Emitter is on the Left, Receiver is on the Right



Model T6 AB LED Status Indicators

To adjust sensor orientation/alignment, LOOSEN these screws only, DO NOT REMOVE SCREWS.

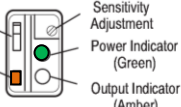
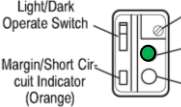
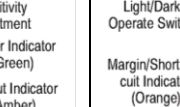
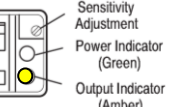


NOTE: The power indicator will turn off when the output indicator is on.

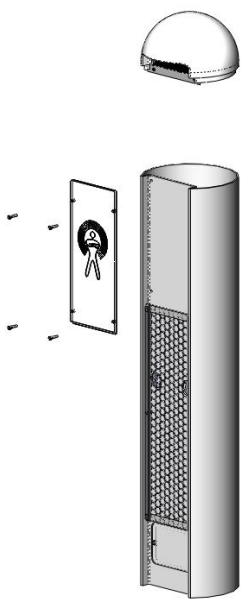
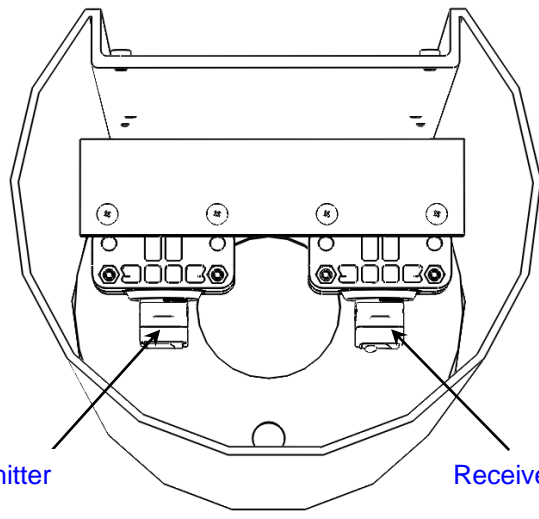
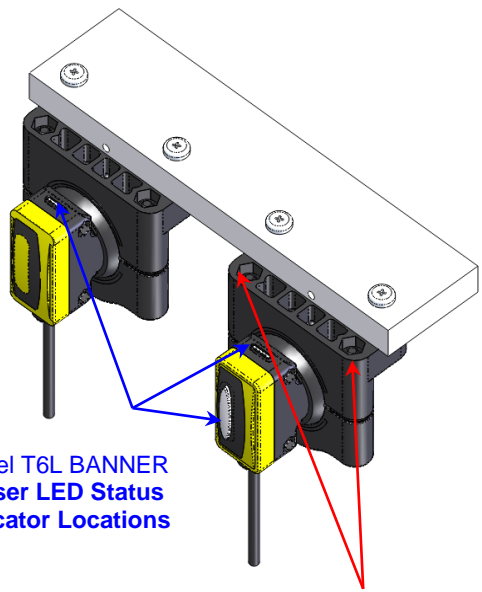
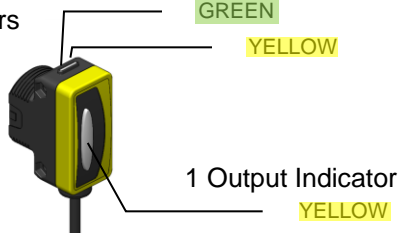
AB Receiver Sensor LED Status Indicator legend
Optimally aligned = GREEN + ORANGE
Non-Optimally aligned = GREEN ONLY
Not aligned or blocked beam = YELLOW ONLY
Shorted/failed = ORANGE ONLY
Not powered or failed = NO LED

AB Emitter Sensor LED status indicator legend
Transmitting = green only
Not powered or failed = no LED


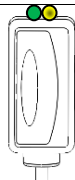
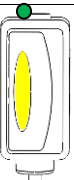
Interpreting the AB Receiver LED Status Indicators

 <p>Light/Dark Operate Switch Margin/Short Circuit Indicator (Orange) Sensitivity Adjustment Power Indicator (Green) Output Indicator (Amber)</p>	 <p>Light/Dark Operate Switch Margin/Short Circuit Indicator (Orange) Sensitivity Adjustment Power Indicator (Green) Output Indicator (Amber)</p>	 <p>Light/Dark Operate Switch Margin/Short Circuit Indicator (Orange) Sensitivity Adjustment Power Indicator (Green) Output Indicator (Amber)</p>	 <p>Light/Dark Operate Switch Margin/Short Circuit Indicator (Orange) Sensitivity Adjustment Power Indicator (Green) Output Indicator (Amber)</p>
Optimally Aligned	Non-Optimally Aligned	Not aligned or beam blocked	Shorted/failed

4.5.4 T6L BOLLARD BANNER SENSOR REFERENCE (MAX RANGE = 60m)

 <p>Remove Diffuser, Wires, & Light Dome Assembly To Access Sensors</p>	 <p style="text-align: center;">Emitter Receiver</p> <p>Standing behind Bollard & looking Down, Emitter is Left, Receiver is Right</p>
 <p>Model T6L BANNER Sensor LED Status Indicator Locations</p> <p>DO NOT REMOVE THESE SCREWS. To adjust sensor orientation/alignment, LOOSEN these screws only</p>	 <p>BANNER Receiver LED Status Indicators</p> <p>Optimally Aligned Top indicators = GREEN + YELLOW Output Indicator = OFF</p> <p>Non-Optimally Aligned Top indicators = GREEN + FLASHING YELLOW Output Indicator = OFF</p> <p>Not Aligned or Blocked Beam Top Indicators= GREEN ONLY Output Indicator = YELLOW</p> <p>Not powered or failed = NO LED (off)</p> <p>BANNER Emitter LED status indicators</p> <p>Transmitting = TOP GREEN ONLY Not powered or failed = NO LED (off)</p>

Interpreting the BANNER Receiver LED Status Indicators

	<p>Top Indicators GREEN + YELLOW</p> <p>Output Indicator OFF</p>		<p>Top Indicators GREEN + FLASHING YELLOW</p> <p>Output Indicator OFF</p>		<p>Top Indicators GREEN ONLY</p> <p>Output Indicator YELLOW</p>
Optimally Aligned		Non-Optimally Aligned		Not Aligned or Beam Blocked	

5 MANUAL ACTIVATION – PUSH BUTTON

5.1 PUSH BUTTON ACTIVATION DESCRIPTION

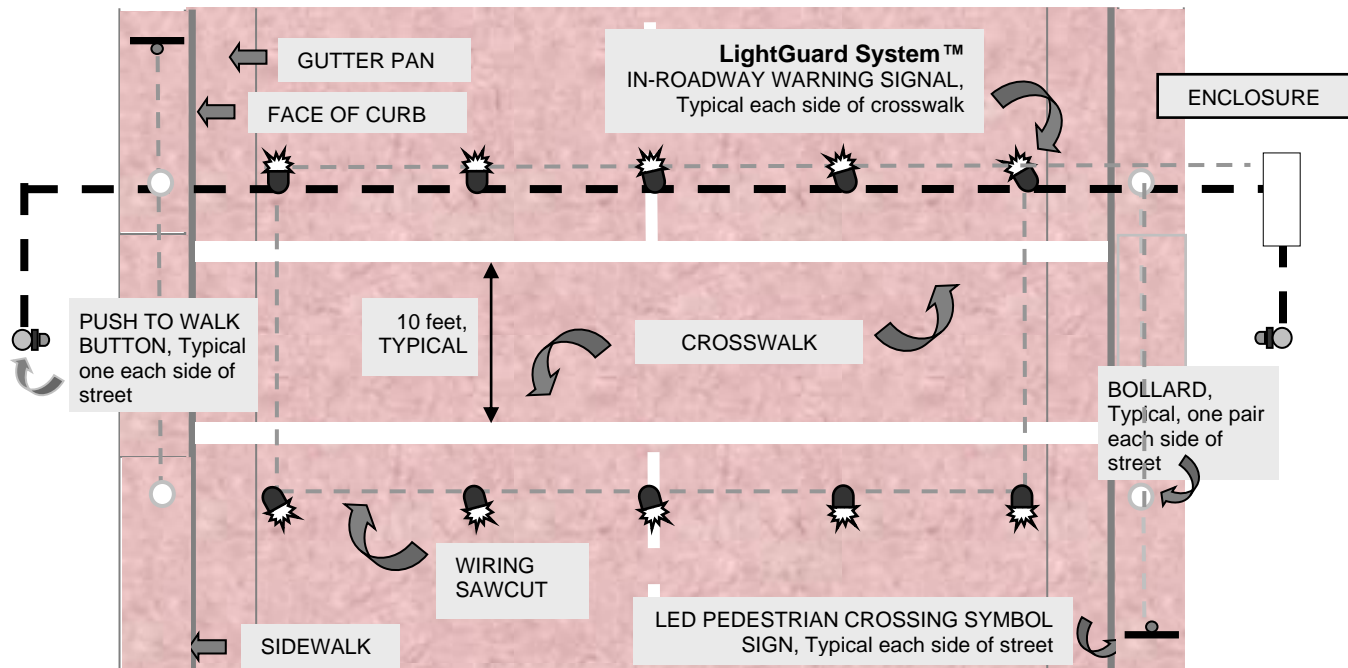
Manually activated smart crosswalk installations utilize an ADA compliant standard pedestrian operated push button assembly to activate the system. In these installations, a pole mounted push button station, (typically incorporating a small sign with the words “**CROSS WITH CAUTION**” and a row of flashing amber LEDs (see section 5.5), is placed near the entrance to crosswalk (see section 5.3). The row of flashing amber LEDs indicates to the pedestrian the warning system is activated. The words “**CROSS WITH CAUTION**” remind the pedestrian to maintain vigilance for their own safety by paying attention to traffic conditions while crossing the street. The ADA compliant standard pedestrian activation push button device should be installed as recommended in the Manual on Uniform Traffic Control Devices (MUTCD) or other local agency approved specifications.

5.1.1. ILLUMINATED PUSH BUTTON ASSEMBLY

GENERAL SPECIFICATIONS

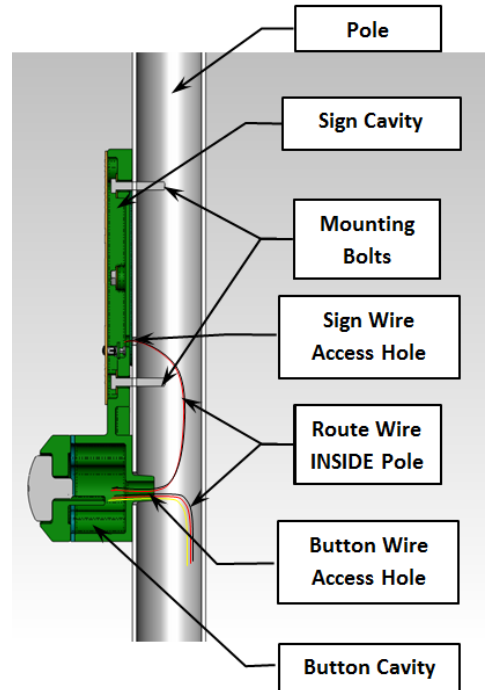
ASSEMBLY SIZE:	Height: 11¾" (300mm) - Width: 5" (127mm)
COLOR:	Green housing, yellow/black faceplate, silver tone 2 inch push button
FACEPLATE LIGHTS:	Amber Light Emitting Diodes (LEDs) which flash with system activation
MATERIAL:	Cast Aluminum
VOLTAGE:	12 VDC nominal (not to exceed 15 V)
MOUNTING:	See local agency approved standard specifications for location and height

5.1.2. PUSH BUTTON LAYOUT AND WIRING DIAGRAM (EXAMPLE)



5.1.3. PUSH BUTTON WIRING TERMINAL BLOCK CONNECTIONS

CONDUCTOR COLOR	PURPOSE	UC-CONNECTION (AC or SOLAR)
RED	FLASHING SIGNAL TO LED +	Q1
BLK	0 VDC TO BOTH BUTTON & LED -	COM
TBD	BUTTON CALL SIGNAL TO CONTROLLER	I1 or I2

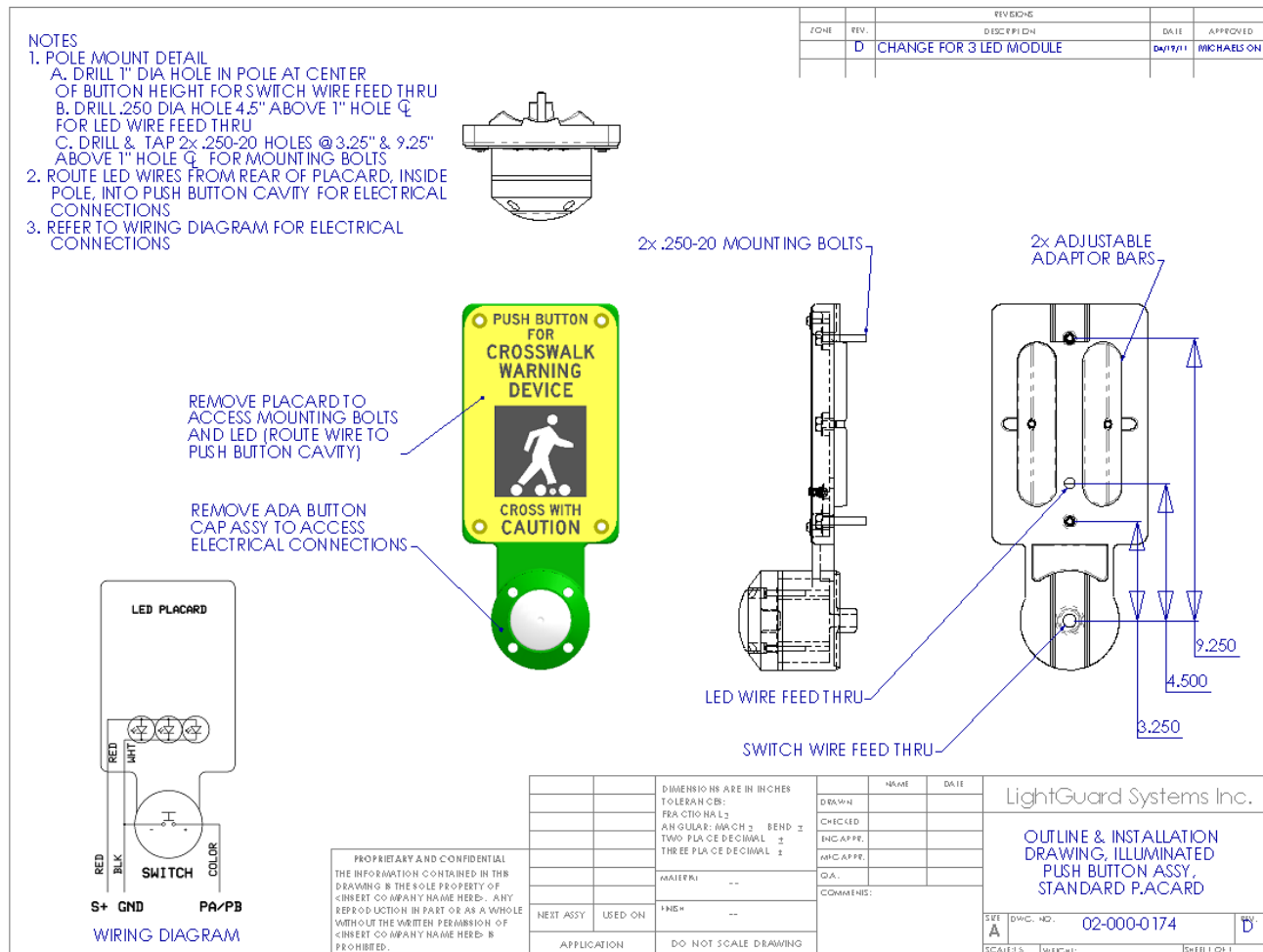


APS – Accessible Pedestrian Signal (voice messaging push button stations), refer to appropriate installation manual addendum (Campbell Guardian -or- Polara XAV)

Conductors between LED sign/placard cavity & Push button cavity MUST be routed INSIDE the pole to ensure weather tight integrity

5.1.4. PUSH BUTTON INSTALLATION DETAIL DRAWING

Follow instructions noted on drawing for pole mounting & wiring detail. Mounting bolt holes must be tapped in pole. Wire access holes should be de-burred to prevent wire insulation damage.



5.2 TOUCHLESS ACTIVATION DESCRIPTION - SMARTSENSE

LGS-PBA-SMART is part of the SmartSense™ family of touchless activation mechanisms. This section describes the process for installing and operating an LGS-PBA-SMART, a touchless switch to supplement existing pushbutton stations at uncontrolled intersections. The touchless push button sign upgrade kit uses IR technology to activate a crosswalk PED-walk cycle or LGS lighted crosswalk with the simple wave of a hand.

LGS-PBA-SMART mechanism mounts in a compatible push button station. When pedestrians reach out to press the button, the proximity sensor detects the pedestrian's action and engages the touchless mechanism to send the call signal to the crosswalk controller before pedestrian makes contact with the existing button/switch.

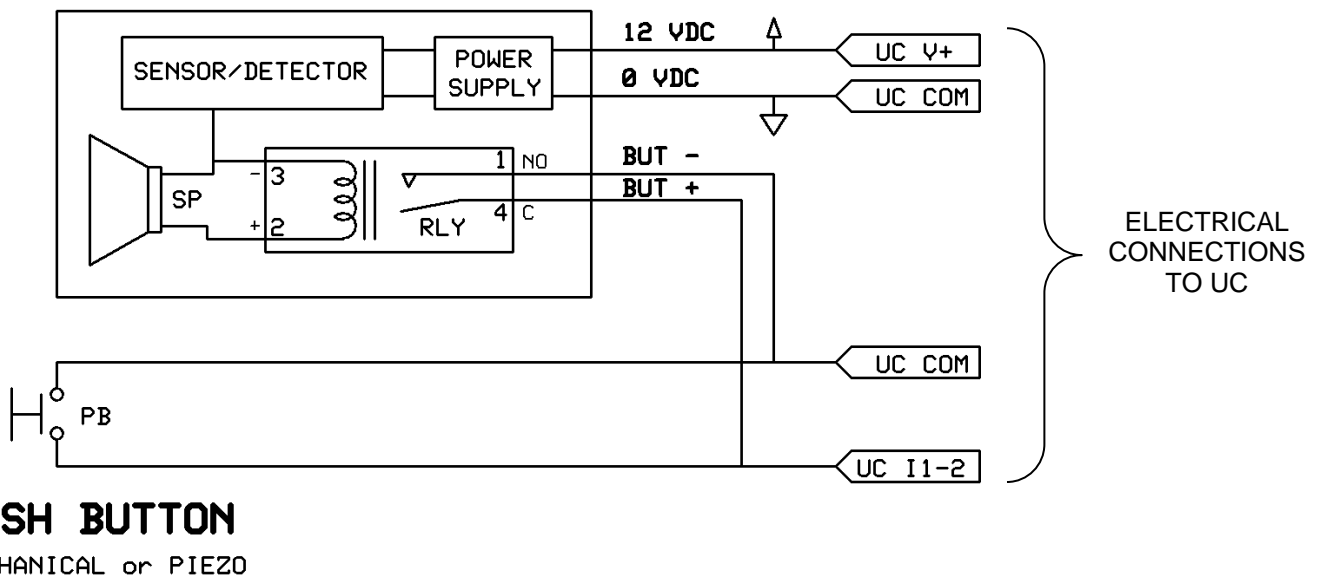
5.2.1. TOUCHLESS ACTIVATION APPLICABILITY

The LGS-PBA-SMART is applicable to standard 5x7.75 Push Button stations with ~ 0.5' deep cavity available for conductors behind the sign. It requires +12vdc to operate (12vdc energizes internal sensor).

The LGS-PBA-SMART isolated relay (output) connects in parallel to an existing ADA pedestrian push button (mechanical or piezo) operating nominal 12vdc.

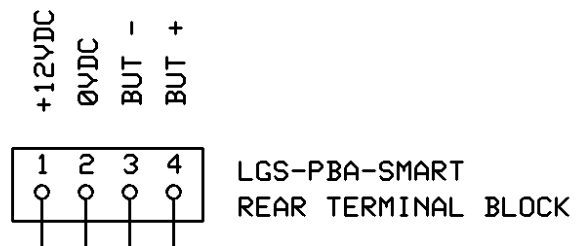
Operational Diagram

SMARTSENSE TOUCHLESS SWITCH



5.2.2. TOUCHLESS ACTIVATION WIRING DIAGRAM

Electrical connections to the LGS-PBA-SMART are made via the 4 pin terminal block on the back of the unit (refer to diagram). Pin1 is +12VDC, Pin 2 is 0VDC, Pin 3 is But-, Pin 4 is But+. Pins 1 & 2 are the low voltage power to energize the touchless switch. Pins 3 and 4 are the isolated relay connecting in parallel with push button terminals.

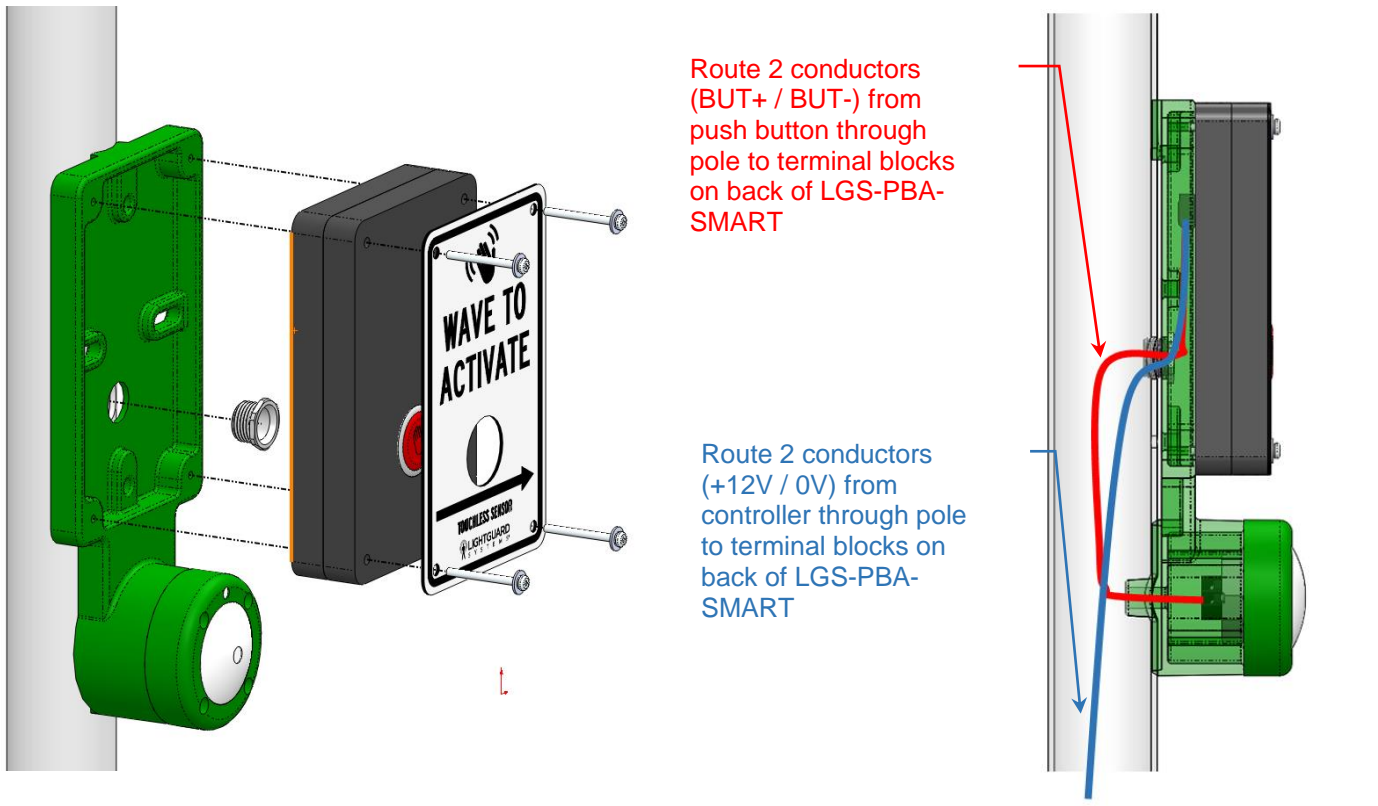


5.2.3. TOUCHLESS ACTIVATION INSTALLATION

Installation consists of removing existing sign from 5x7.75 push button station, installing a wiring feed-thru to the wiring cavity behind the sign, routing/connecting conductors from controller & existing switch, then mounting LGS-PBA-SMART in place of 5x7.75 sign.

INSTALLATION STEPS

1. remove existing sign from 5x7.75 push button station
2. drill pilot hole through push button station housing & pole for conductors
3. remove push button station from pole
4. drill & tap pole for ½ NPT nipple (chase nipple shown)
5. enlarge hole in push button station for ½" npt (7/8" dia)
6. route 2 switch conductors from switch wiring cavity in push button station through nipple into push button station wiring cavity (behind sign)
7. route 2 power conductors (+12vdc & 0 vdc) from controller through nipple into push button station wiring cavity
8. reattach push button station to pole using pre-existing hardware & ½" NPT threaded nipple
9. connect conductors to terminal blocks on back of touchless switch box (refer to wiring diagram) using phillips screwdriver
10. align "wave to activate sign" with touchless switch box & push button station, secure using tamper resistant 8-32 x 2" machine screws, washers, lock washers.
11. Energize & test. Both existing button & touchless switch should activate controller



5.2.4. TOUCHLESS ACTIVATION ELECTRICAL CONNECTIONS TO UC PANEL

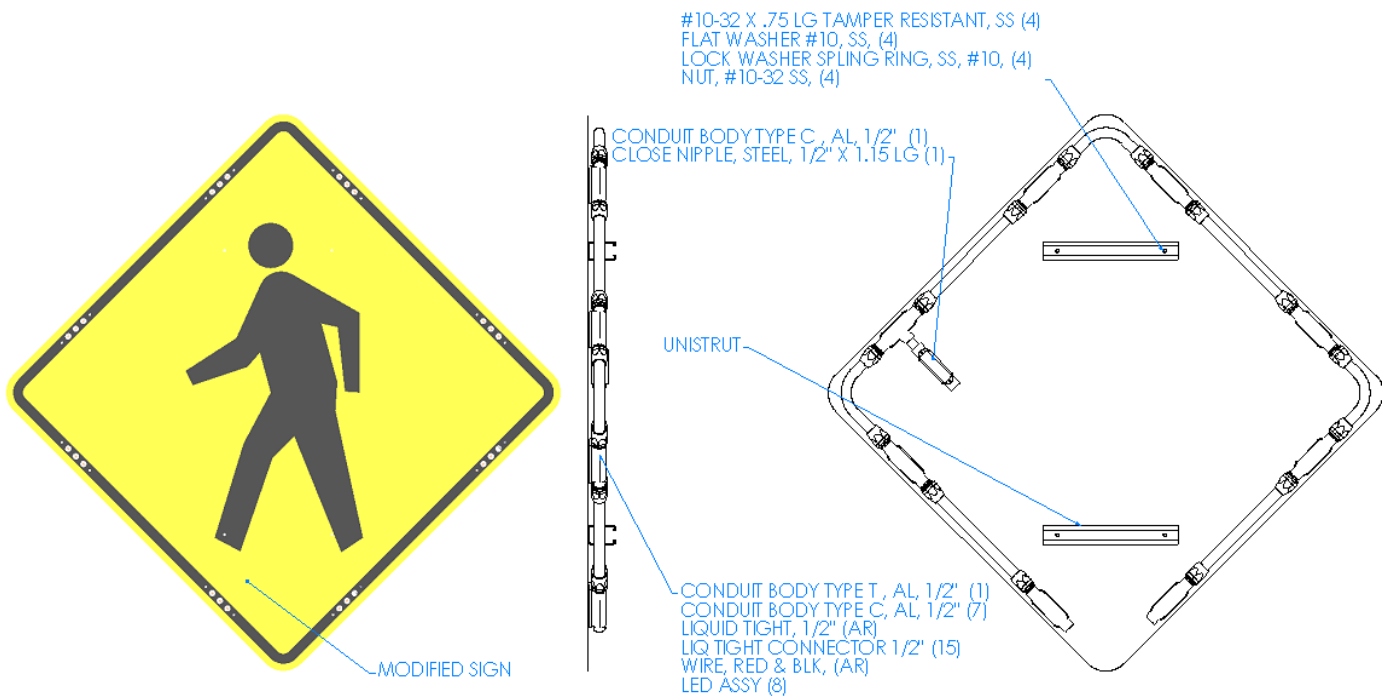
CONDUCTOR COLOR	PURPOSE	UC CONNECTION (AC or SOLAR)
RED	12VDC TO ENERGIZE SENSOR+	V+
BLK	0 VDC TO SENSOR- & BUTTON -	COM
TBD	BUTTON CALL SIGNAL TO CONTROLLER	I1 OR I2

6 FLASHING OUTPUT LIGHT FIXTURES (POLE MOUNTED, NOT IRWL)

6.1 LED “ENHANCED” SIGN GENERAL DESCRIPTION

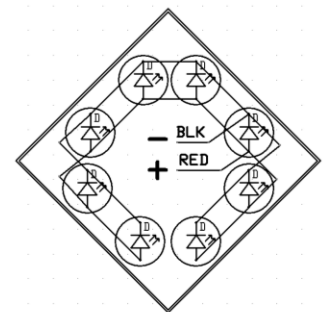
LightGuard System® installations may, as an option, utilize high retro-reflectivity MUTCD approved diamond shaped pedestrian crossing signs (e.g. W11-2) or equivalent, equipped with flashing amber LED modules located at the sign border (see below) or under the walking pedestrian symbol. These signs are placed at, or before, the crosswalk to assist in warning approaching motorists that a pedestrian is in, or about to enter the crosswalk. The embedded LED modules flash at the LightGuard System® enhanced flash rate. This LED “enhanced” pedestrian crossing sign should be installed at the crosswalk location as recommended in the Manual on Uniform Traffic Control Devices (MUTCD). For school crossings, a pentagon school sign (e.g. S1-1) is also available. NOTE: Any advance warning signs should be consistent with color of other signs (Yellow or Fluorescent Yellow/Green).

6.1.1. LED “ENHANCED” PEDESTRIAN CROSSING SIGN DRAWING



6.1.2. LED “ENHANCED” SIGN ELECTRICAL CONNECTIONS TO UC PANEL

CONDUCTOR COLOR	PURPOSE	UC CONNECTION (AC or SOLAR)
RED	FLASHING SIGNAL TO LED +	Q1
BLK	0 VDC TO LED -	COM



SIGN LED MODULE LAYOUT

6.2 RRFB GENERAL DESCRIPTION

This section describes the process for installing and operating a Rectangular Rapid Flashing Beacon model LGS-RRFB. The RRFB produces a flashing output in accordance with “MUTCD Interim Approval for Optional Use of Rectangular Rapid Flashing Beacons (IA-11)” when 12 VDC nominal is supplied to the RRFB.

6.2.1. RRFB APPLICABILITY

RRFB can be used in conjunction with IRWL or SIGNS as part of a smart crosswalk system. Model LGS-RRFB-F requires an external Smart Crosswalk™ flashing controller with timer and activation mechanisms – model UC-AC, UC-AC MP, or UC, SOLAR. The flashing controller should be in relative proximity to the RRFB to ensure proper operation.

6.2.2. RRFB INSTALLATION

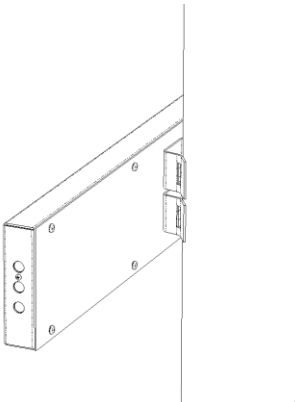
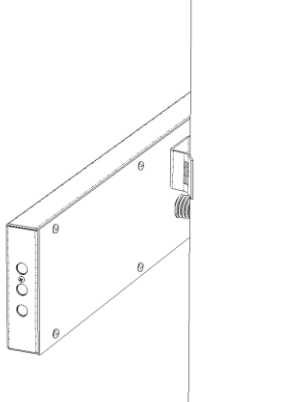
THE RRFB can be pole mounted using standard 3/8” diameter hole sign mount brackets with stainless steel straps. The provided sign mount brackets fit 2” to 12” diameter poles. Electrical access to the RRFB can be made by drilling a hole in the back of the RRFB and using NEC compliant conduit connectors. An alternate technique is to enlarge one of the existing sign mount holes & then use an NEC compliant conduit connector (threaded nipple with sealing locknut) instead of one of the sign mount brackets.

Electrical connections inside the RRFB internal flashing module should be made using wire nuts in accordance with the wiring diagram. The RRFB aluminum enclosure should be grounded using the ground terminal wire provided. Each RRFB requires 2 conductors for activation: Switched 12V & DC ground. Refer to graphic for applicable flashing controller electrical connections. Use 18 AWG minimum conductor sizes for electrical connections.

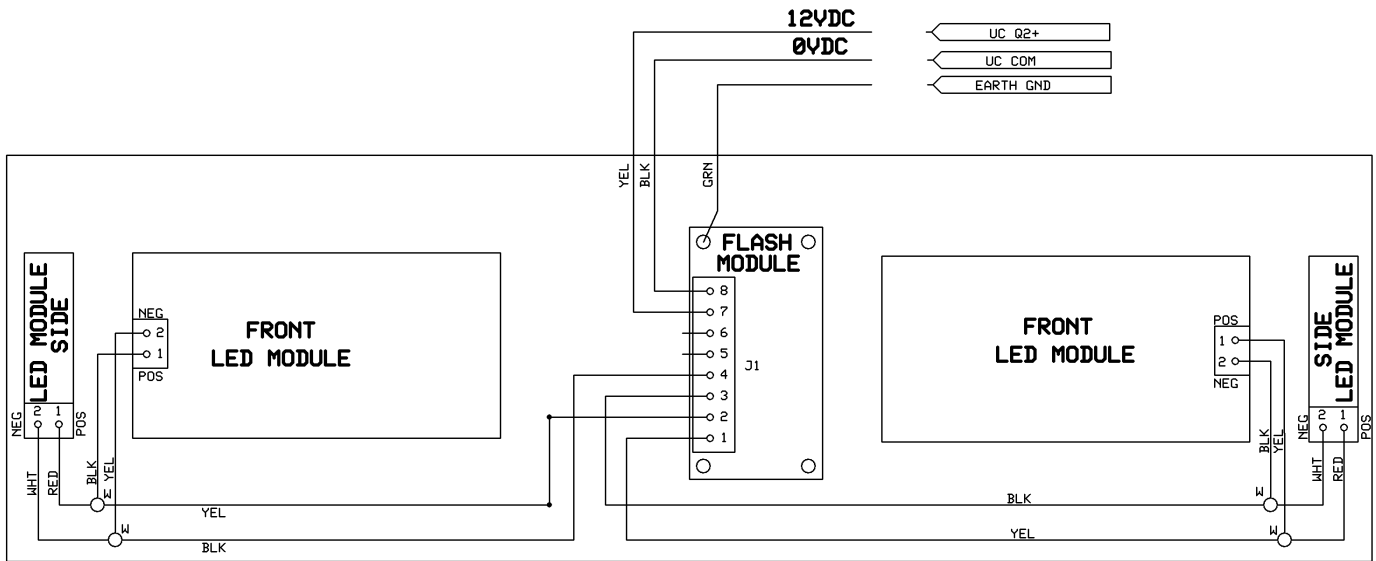
6.2.3. RRFB OPERATION

The RRFB will flash in the MUTCD approved flash rate in accordance with FHWA memo IA-21 dated March 2018 for as long as 12VDC is applied across the RRFB terminals (YEL/BLK conductors). All other previously MUTCD approved flash patterns have been disabled by software in the internal RRFB flash module.

6.2.4. RRFB RECOMMENDED MOUNTING OPTIONS

<i>2 Sign Mount Brackets</i>	<i>1 Sign Mount Bracket + Threaded Nipple</i>
	

6.2.5. RRFB INTERNAL WIRING DIAGRAM

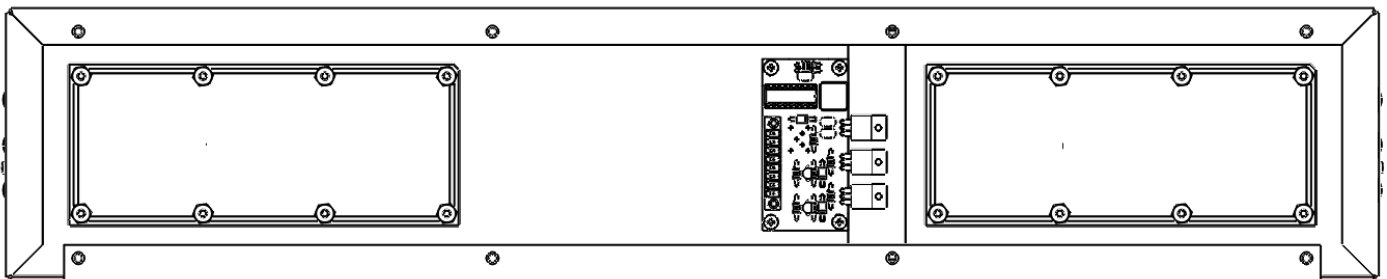


INTERNAL WIRING DIAGRAM

ALL ELECTRICAL CONNECTION MADE VIA WIRENUTS TO FLASH MODULE CONDUCTORS

REAR VIEW SHOWN WITH COVER REMOVED.

NOTE ORIENTATION WITH "DRAIN HOLES/SLOTS" LOCATED BOTTOM LEFT & RIGHT



6.2.6. RRFB ELECTRICAL CONNECTIONS TO UC PANEL

CONDUCTOR COLOR	PURPOSE	UC CONNECTION (AC or SOLAR)
RED	SWITCHED 12VDC TO ENERGIZE RRFB +	Q2
BLK	0 VDC TO LED -	COM

7 SOLAR POWERED SYSTEMS CONSIDERATIONS

7.1 SOLAR SYSTEM INSTALLATION STEPS

1. Using the drawing, assemble the Solar Panel mount with the hardware supplied.
2. Use the ¼" hardware to attach the module to the Module Rails.
3. Use the 5/16" hardware to bolt the Module Rails to the SPM-1 Pole Bracket.
4. Adjust the mount to the proper tilt angle for your site latitude.
5. Face the solar module due South (NOT MAGNETIC SOUTH) for Northern Latitudes and due North for Southern Latitudes.
6. ENSURE that the Batteries are fully charged prior to installation.

7.2 SOLAR PANEL

Use the 14 / 2 TC tray cable supplied to wire the solar module into the charge control panel inside the enclosure. It is recommended that ½" flexible metal conduit be run between the solar module junction box and the mast to protect the tray cable. An opening in the mast to accept the conduit will need to be provided.

Remove the cover of the black junction box on the back of the module and note the 6 screws. Also, note a positive (+) sign and a negative (-) sign which show the 2 positive and negative terminals. Connect 1 wire to either of the 2 positive (+) and negative (-) terminals. Use the red conductor for positive and the black for negative. Many Solar Modules are "configurable" in that depending on which terminals are used for electrical connections, different voltage levels are available. The open circuit voltage (OCV = voltage when not connected to charging circuit) should be 19 to 21 VDC. Verify that OCV = 19 to 21 volts across the Solar Module terminals when connecting to the Solar Module Terminal Blocks. Do not use any of the screws designed to secure the Terminal Block to the panel for electrical connections.

Route the tray cable down the mast into the enclosure. Make sure the solar module is covered, or not connected to the tray cable, when routing the cable through the enclosure. Even in low sunlight the module can produce 18 to 20 volts.

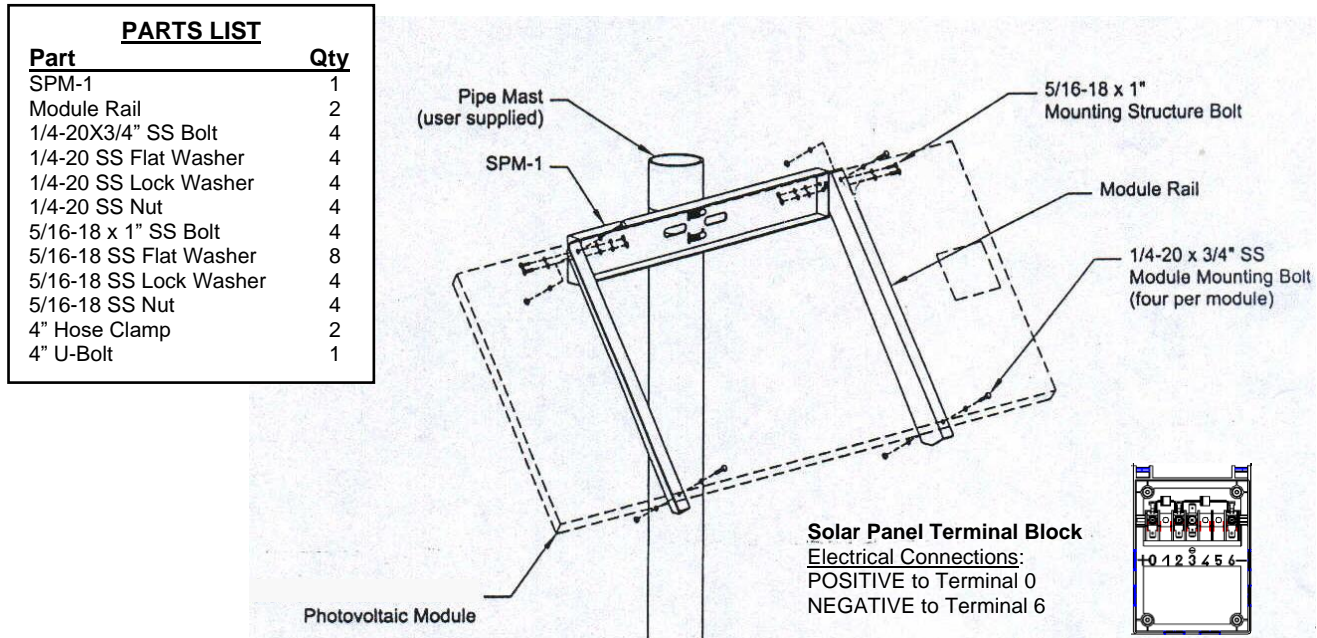
7.2.1 SOLAR PANEL DESCRIPTION

The solar array consists of a minimum 75 watt solar power module which is to be pole mounted. This solar module is designed to charge the two 12 volt batteries in the system. In full sun, this module can produce a maximum on 4.25 amps when charging the battery. During the day, the amount of charging current will vary with the intensity of the sunlight hitting the module. The open circuit voltage (voltage when not connected to charging circuit) can be up to 21 volts.

7.2.2 SOLAR PANEL MOUNTING

The solar module is to be mounted to the side of a 4" galvanized mast using the aluminum side-of-pole mount and hardware supplied. **The solar module must be oriented facing TRUE South & unobstructed to sunlight.** Attach the mounting rails to the pole bracket and adjust the tilt angle to create an angle setting for your local latitude from horizontal facing South. Refer to sections [7.2.3](#) & [7.2.4](#) for orientation details. Use U-bolts to secure the mount to the mast

Typical SOLAR PANEL MOUNT (example model #HPMH-5090, side-of-pole mounting kit)



7.2.3 ORIENTING THE SOLAR PANEL

The following information was authored by www.powerupco.com & is reprinted herein without permission

It is important for proper system operation that the array be oriented true South (if you are located in the northern hemisphere) & unobstructed to sunlight. The directions of magnetic South and true South differ from one another depending on geographic location. This variance is called declination. Check the deviation for your region in order to extrapolate true South from a compass heading of magnetic South. The map in this section shows the magnetic declination for the US. For example, central Oklahoma falls between the 8° E and the 10° E lines. This means that the north point of a compass points about 9° E of true north. So true north is actually 9° to the WEST of where the compass points.

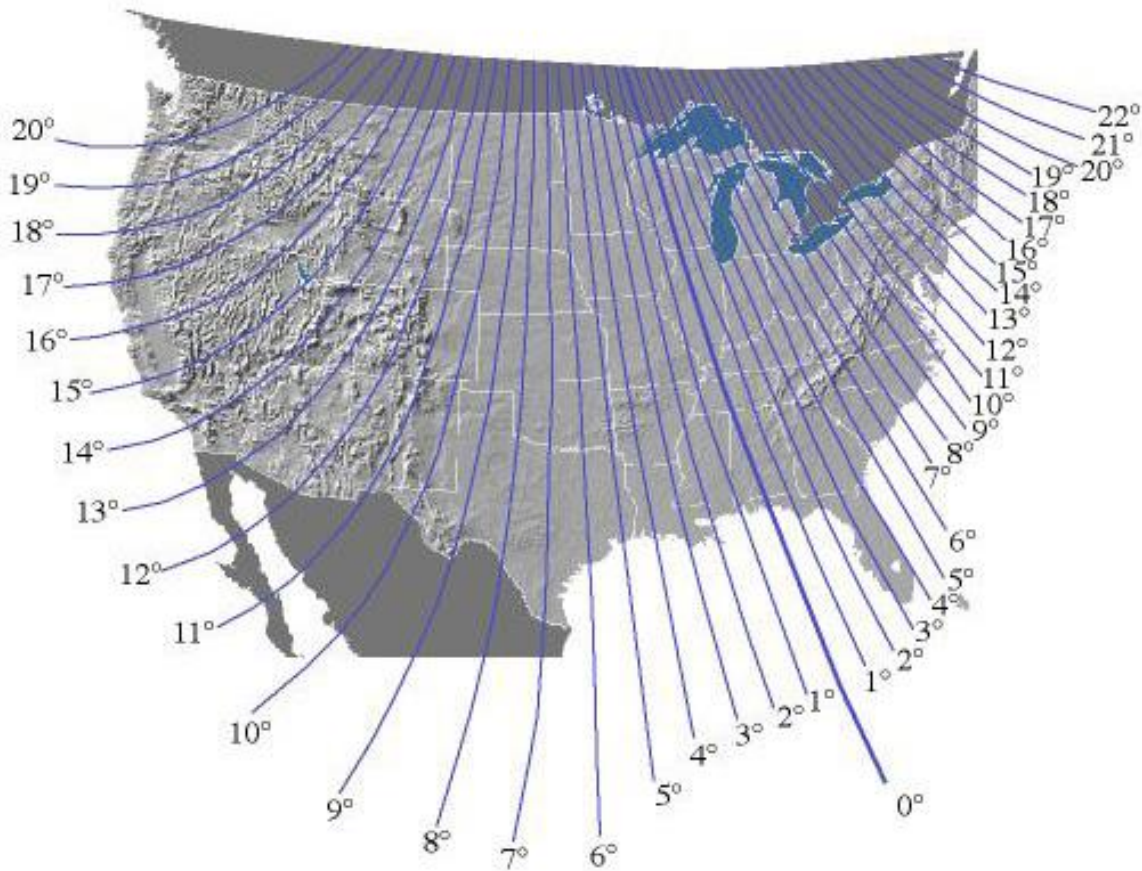
7.2.4 DECLINATION ANGLE FOR SOLAR PANELS

The following information was authored by <http://www.oksolar.com/> and is reprinted herein without permission

When installing photovoltaic modules, be aware that they generate maximum power when facing the sun directly. The fixed position which approximates this ideal over the course of the year, thus maximizing annual energy production, is facing due South (in the Northern Hemisphere) or due North (in the Southern Hemisphere) at the angle listed in the table in the next column. Note that these cardinal directions are true NOT magnetic orientations. The table below shows the fixed angle above horizontal at which modules should be installed in order to maximize annual energy output.

At some installations, it may be cost-effective to adjust the tilt seasonally. At most latitudes, performance can be improved during the summer by using an angle flatter than the chart's recommendation; conversely, a steeper angle can improve winter performance.

If modules are not cleaned regularly, it is recommended that they not be mounted at an angle flatter than 15°. Flatter angles cannot take full advantage of the cleansing action of rainfall.



7.2.5 SOLAR PANEL TILT ANGLE

Solar modules produce the most power when they are pointed directly at the sun. For installations where the solar modules are mounted to a permanent structure, the solar modules should be tilted for optimum winter performance. As a rule, if the system power production is adequate in the winter, it will be satisfactory during the rest of the year. The module tilt angle is measured between the solar modules and the ground.

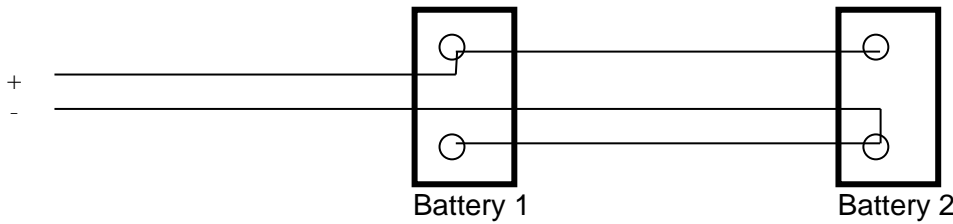
Example: A module mounted in Miami, Florida (latitude 26° should be tilted at approximately 31° from horizontal, and should be faced due South.

	Latitude Site	Tilt Angle
	0-15°	15°
	15-25°	SAME AS Latitude
	25-30°	add 5° to local latitude
	30-35°	add 10° to local latitude
	35-40°	add 15° to local latitude
	40° +	add 20° to local latitude

7.3 BATTERIES

The enclosure contains 2 SLA batteries, the flashing controller and the charge controller. Two 12 volt deep cycle sealed gel-cell batteries are supplied. Each battery is rated at approximately 100 amp hours. The batteries are to be wired in parallel (positive-to-positive and negative-to-negative) to give 12 volts nominal at 200 amp hours of storage. Use the red and black battery cables supplied to parallel the batteries. Install the wiring into the terminal blocks & circuit breaker before installing the batteries.

Use the red and black cables, supplied with the ring terminals, to make the battery connections. Connect the red cable to the positive post on 1 battery and the black cable to the negative post on the other battery. This will ensure even charging between the 2 batteries (note figure below).



Connect the red and black #14 tray cable wires, from the solar panel (PV), to the labeled circuit breaker and negative buss block (refer to Section [2.4.3](#)).

7.4 CHARGE CONTROLLER

7.4.1 CHARGE CONTROLLER WIRING

The charge controller, located inside the enclosure, provides all wiring connections for the solar module, batteries, and power to the controller & operates the in-roadway warning signals, signs, and push buttons.

Ensure all circuit breakers are OFF before making any connections. There are three 15 amp circuit breakers:

- 1) Solar Module circuit breaker: controls solar module power to the system.
- 2) Load circuit breaker: controls load power to the controller, IRWL, signs, & RRFB.
- 3) Battery Main circuit breaker: controls battery power to the system.

7.4.2 CHARGE CONTROLLER OPERATION

A charge / load controller is located on the charge control panel (for further information / specs, contact your LGS representative). This controller is being used to regulate the battery charging and protect the batteries from being over discharged. The charge controller is pre-wired and factory adjusted. Do not make any adjustments to the charge controller without contacting LightGuard Systems, Inc. first. Indicator(s) on the face of the controller indicates the battery state of charge. Note the legend on the face of the charge controller.

During normal operation, the charge controller will allow the battery voltage to rise up the approximately 14.1 volts while charging. This end-of-charge voltage will vary with temperature. The charge controller might employ a supplemental temperature probe attached to the side of one of the batteries in the enclosure. If supplied, attach the probe approximately three quarters of the way up the side of the battery case using the adhesive pad on the probe. This will ensure proper charging of the batteries throughout the year.

At night, the battery voltage should register between 12.0 and 12.8 volts depending upon how well the batteries were charge during the day. In times of exceptionally bad weather, and / or exceptionally heavy crosswalk usage, the battery voltage may drop below 12.0 volts. When the voltage drops to below approximately 11.8 volts, the charge controller will shut off power to the UC and all external equipment ensuring protection of the batteries from damage as a result of over discharge. The charge controller will not allow power back to the UC until the battery voltage rises back up to approximately 12.8 volts (after several hours of charging). This solar power system is designed to operate in all weather conditions throughout the year.

A copy of the Charge Controller Owner's Manual is available upon request.

8 TROUBLE SHOOTING / MAINTENANCE / AFTER INSTALLATION

8.1 TROUBLE SHOOTING GUIDE & TIPS

SYMPTOM	CHECK	ACTION
System will not activate	Check UC for proper operation using "TEST" switch on UC	Engage test switch, if UC LED output Indicators illuminate, then verify fuse integrity F1-F4. Ensure proper bollard alignment and sensors. Verify no obstructions. Verify push buttons connections. If LED output Indicators do not flash, then UC controller requires repair.
In-roadway warning signals (IRWL) flashing dimly, or not at all	Check all in-roadway warning signals for damage	Remove & Replace (R & R) with spare warning signal as needed.
	Check all in-roadway warning signal window ramps for blockage or debris.	Sweep any debris from pavement around IRWL signals to allow for unobstructed motorist view.
	Check all IRWL for proper flash operation	View in-roadway warning signals from 150' to 200' away for the approaching motorists' perspective. R & R with spare warning signal as needed.
	Insure that enclosure components are operational	Shut off power to controller via circuit breakers. Solar powered systems. Check battery voltage. Load test battery 10 AMP. Tighten wire connections, and/or remove, and look for corrosion and retighten. Perform a wire push/pull test to verify wires are firmly installed. Re-energize controller. Check voltage of power supply (AC system) or batteries & solar panel (solar system) for normal voltage. Document counters, log date, time of service, and name of personnel repairs. List any repair findings. Secure system door.
Graffiti or paint on equipment	Check for proper activation operation	Remove graffiti or paint. Tagster Graffiti Emulsifier from Rhomar Industries is recommended.
System on constant blink	Check for stuck PB or mis-Aligned Bollards ref section 4.4	Inspect UC display for diagnostic information. System remains in continuous flash while a "stuck" call signal is present. If the LCD does not indicate which input is "stuck", then UC controller needs repair
Pushbutton or Bollard inputs do not activate flashing output	Check: 1) button/bollard is operational 2) conductor integrity from button/bollard to panel (flashing controller) 3) verify panel is operational using JUMP TEST	UC Panel JUMP TEST is applicable to all inputs (buttons & bollards). Inputs can be simulated at the UC panel. Temporarily remove the button/bollard input field wires from the input terminal blocks (I1-I6). Affix one end of a jumper wire (~12" stripped ~1/2" at both ends) into the COMMON terminal block. Then use the "free end" of the jumper to momentarily make electrical contact with the I1-I6 inputs. If each LED input status indicator illuminates, then the UC can receive signals & the problem is with the field wiring or button(s)/bollards. If an LED input status indicator does not illuminate, UC controller requires repair
Stuck bollard signal	Check 1) bollard sensor alignment 2) bollard sensor operation 3) bollard conductors for shorts	Verify bollard sensor alignment using either buzzer or LED status indicators to ensure sensor switches when beams are blocked. Verify that call signal conductor from bollard to control panel is not shorted/compromised

ADDITIONAL TROUBLE SHOOTING TIPS

- Routine maintenance should include periodic on-site inspections (twice annually is recommended) of the System for proper operation.
- Check activation system for proper operation and tighten fastening hardware as needed.
- Clean Bollards and sensors if needed and check for proper Bollard alignment and activation.
- In-roadway warning signals should be visually checked for sufficient light output with window ramps swiped clean as needed. Should window ramp become obscured over time, remove and replace with spare warning signal.
- Check for proper adhesion of all warning signals to the roadway surface. Fill any gaps around in-roadway signal assemblies with bituminous hot stick to prevent debris or moisture intrusion.
- Inspect wire trench cuts for sufficient loop sealant and fill where needed with filler or bituminous hot stick material.
- Check enclosure and sign mounts for secure attachment and tighten fastening hardware as needed.
- Note/Record activation counts, then reset to clear
- Note and clean any graffiti from enclosure equipment. (We recommend Tagster™ Graffiti Emulsifier from Rhomar Industries - Springfield, Missouri - (800) 688-6221 - Email: rhomarind@aol.com)

8.2 FIELD RELATED TOTAL PREVENTATIVE MAINTENANCE

After initial installation, the following steps should be followed to test/validate correct operation and to ensure proper operation in the future. Installation should consist of all components secured appropriately and all electrical connections terminated as required..

Step 1 Energize all circuit breakers

Step 2 Verify that no input status indicator LED are illuminated (left side of the UC). If any of these vertically aligned input status indicators activation indicators are illuminated, check Bollard alignment, push buttons, and field wiring connections.

Step 3 Position “TEST” switch to the up position to initiate constant outputs. Verify that all IRWL & optional illuminated LED signs & Push buttons are active

Step 3 Test/verify that activation mechanisms operate (PB &/or Bollards) and activate flashing output for the cross time duration. *If any Bollards activate the system when exiting the crosswalk instead of entering the crosswalk, swap A & B wires in control panel for that Bollard pair.*

Step Set cross time as required (refer to section [2.8.3](#))

8.3 RECOMMENDED MAINTENANCE

8.3.1 SCOPE

This procedure describes the recommended process for inspecting & maintaining LGS equipment after installation. This section applies to Illuminated signs, electrical interface cabinets, In Roadway Warning Lights (IRWL), and activation mechanisms (Bollards & Push buttons).

8.3.2 MAINTENANCE PERIOD

Perform Preventative Maintenance/Inspection approximately every 6 months.

8.3.3 MATERIAL REQUIRED

- A. Battery tester
- B. Non-metallic whisk broom
- C. Soapy water and cloth

8.3.4 RECOMMENDED SPARES

- A. IRWL

8.3.5 ELECTRICAL INTERFACE CABINET (UC-AC or SOLAR)

- 1. Open Electrical Interface Cabinet
- 2. Clean any foreign matter that might have accumulated inside cabinet, (spider webs etc.)
- 3. Test battery voltage, if value is less than 12VDC refer to trouble shooting guide (section [8.1](#))
- 4. Optional activation data, (consider posting on inside cabinet door for recordation review).
 - a. use keypad 1 & 3 to display activation history, record activation data (date & number of activations) on paper and store in LGS enclosure
 - b. reset activation counters using keypad 0, then 555 to clear activation history
- 5. Press keypad 9 to verify that all light outputs activate, press 9 again to toggle outputs back to ready mode
- 6. SOLAR powered systems
 - a. If solar panel has foreign matter on it, clean solar panel using water
 - b. Verify that the charge controller indicates that the batteries are being charged & warranty period (date) on batteries is valid

8.3.6 ILLUMINATED SIGNS

- 1. Verify that light windows in illuminated signs are clear of debris, and properly aligned to target path, and all LED modules operate fully.

8.3.7 ACTIVATION MECHANISMS

- 1. Push buttons
 - a. verify that LED lenses on push button placards are clear of debris
 - b. verify that push buttons activate flash sequence (Four LED indicators each sign)
- 2. Bollards
 - c. Verify that Bollards are aligned (indicated by Electrical Interface Panel LED's LD1 through LD12 are all NOT illuminated)
 - d. Verify that Bollard courtesy lights are illuminated (refer to section [4.3](#))
 - e. Ensure that Bollard sensors are clean with no obstructions inhibiting sensor performance
 - f. Ensure that Bollards are SOLIDLY secure to mounting pads by attempting to "rock them"

8.3.8 IRWL

- 1. Verify that all IRWL illuminate when system is activated
 - a. if any IRWL do not activate, refer to troubleshooting guide in LGS Installation Manual
- 2. Verify "self clearing" design is keeping debris build-up clear from front of units, (If needed wipe window with wet cloth).
- 3. Within 60-90 days of Initial installation, verify that each IRWL is secure/seated in base plate. If loose, then remove IRWL, clean mating surfaces, and reinstall in accordance with LGS Installation Manual. Repeat at 6 month intervals.
- 4. If any IRWL are broken, then replace units
- 5. Inspect IRWL for signs of condensation. If from approximately 200 feet this presents a noticeable decrease in performance or light fixture visibility, it should be replaced. If condition does not appear to affect the light visible to the motorist, it may not need replacement (review warranty in T's & C's).

8.4 EQUIPMENT LIST

This section describes standard components of the LightGuard family of products applicable to this Installation Manual.

8.4.1 SPARES & REPLACEMENTS EQUIPMENT LIST

The following list contains LGS model names/numbers for items typically sold as spares or replacements.

ITEM	DESCRIPTION
LGS-SN-LED	Amber LED module for illuminated signs
LGS-GEL-PLUGS	IRWL electrical splice connection inside base plate
LGS-PB ONLY	Push button mechanism
LGS-M11A	Light fixture only - amber LED
LGS-M11-A SMPL	Light fixture only - amber LED + white LED Pedestrian Luminaire
LGS-CHS 14	Base plate only - 14" snowplow resistant
LGS-SD10-C-FG	Base plate only - 10" composite
LGS-SOL-PANEL-ONLY	Solar panel LGS 2' x 4' (~80 watts)
LGS-REC-ONLY	Receiver sensor for models LGS-T3 thru T6 (not T6L)
LGS-TRANS-ONLY	Transmitter sensor for models LGS-T3 thru T6 (not T6L)
LGS-GRAYHILL RELAY	Magnecraft relay for obsolete PCU back panel
LGS-CDMRLY	Crydom relay for obsolete PCU back panel

8.4.2 STANDARD EQUIPMENT LIST

The following list contains LGS model names/numbers for Standard items applicable to this Manual.

ITEM	DESCRIPTION
LGS-UC-AC	Universal Controller, 110VAC, 6 input (12VDC), 4 Output (12VDC, 5A max)
LGS-UC-AC MP	Universal Controller, 110VAC, 6 input (12VDC), 4 Output (12VDC, 10A max)
LGS-UC SOLARL	Universal Controller, 12VDC, 6 input (12VDC), 4 Output (12VDC, 10A max)
LGS-M11/CHS-14	Amber LED Light fixture w/ Snow Plow Resistant 14"Base Plate
LGS-M11/SD10-C	Amber LED Light fixture w/ 10" Composite Base Plate
LGS-PBA-BRAILLE	ADA 2" Push button Assembly w/ Braille Placard- Pair
LGS-PBA-PAIR	ADA 2" Push button Assembly w/LED Placard - Pair (L & R)
LGS-PBA-GUARDIAN	ADA 2" Push button Assembly w/LED Placard & Audible Message-Pair
LGS-RAD	Remote Activation Detector
LGS-T6	Automatic Pedestrian Detection Bollard
LGS- W11-2-B-30-FYG	Ped Sign w/o Crosswalk & LED Enhanced Border
LGS-S1-1-B-30-FYG	School Sign w/o Crosswalk & LED Enhanced Border
TWO PART EPOXY KIT	Two Part Epoxy for Securing Base Plate Into Roadway (pass thru item)
LGS-AC BEACON-KIT	Separate 110VAC Wig-Wag Output Simultaneous w/ Light fixture Flashing
LGS-AC-OUT-UPGRD	Separate 110VAC Output Simultaneous w/ Light fixture Flashing
LGS-DC BEACON-KIT	Separate 12VDC Wig-Wag Output Simultaneous w/ Light fixture Flashing
LGS-DC-OUT-UPGD	Separate 12VDC Output Simultaneous w/ Light fixture Flashing
LGS-NOVAX-UPGD	Upgrade LGS Controller for Novax Audible Alert

9 ADDENDUMS

This section is reserved for addendums typically applicable to various upgrade kits noted as optional equipment in [Section 1.6](#). Each addendum is supplied separately with appropriate upgrade kit.