LC3X

3 LEVEL LIGHTING CONTROLLER

INSTALLATION AND MAINTENANCE MANUAL (IMM)

PLC Buildings
Lighting Control Systems

205_LC3X_R.1_5-19-10

A Division of PLCMultipoint

TABLE of CONTENTS

TABLE of FIGURES

1. INTRODUCTION

1.1 GENERAL

Please read these instructions carefully to prevent any possible injury or equipment damage. For installation of the product, the installer must be a qualified and experienced technician. Prior to any installation, inspect the panel for damage and verify the product ratings to confirm that this product will satisfy your requirements and application.

1.2 OVERVIEW

The LC3X lighting control board is a low voltage circuit used to switch up to three independent lighting loads via low voltage control of lighting relays/contactors. The LC3X has a field mounted sensor which monitors natural and/or artificial light levels. This sensor sends a signal to the LC3X board, which in turn, opens or closes three independent Form-c dry contact for low voltage control. The light levels at which the relays switch are determined by three, user adjusted, single setpoints. Typically, these relays will each control a Powercube Switcher unit, which can each switch up to 20A. The single setpoints limit the application to control of a zone with one primary light source. The LC3X is well suited to either Indoor or Outdoor lighting control.

The field mounted sensor can be either a photo-conductive (PC) or a photo-diode (PD) type sensor. For a PD sensor, a 3X/PD adaptor board is required. Finally, an optional 3x/T Hold-ON-Timer board is available for each of the three light levels on the LC3X.

2. INSTALLATION

2.1 SENSORS

2.1.1 Indoor Sensor (Ceiling)

Mount the Indoor sensor in a 3/8" hole in the false ceiling tile using the adhesive backing. For most general applications the sensor should be mounted between 6-8 feet of the window area, central to the area illuminated by the electrical lighting that will be controlled. In all cases the sensor must be mounted so that it looks at reflected light only and not at any direct light. **(See Fig. 1A)**

2.1.2 Indoor Sensor (Reflecting Wall)

Mount the Indoor sensor at reflecting wall. When sconces are in place in the light well, make sure not to mount sensor in direct level as the sconces. Place sensor 18" from the bottom corner of the ceiling. Remember, the Fresnel lens will see light with a field of view that is 1.15 times the distance to the wall. No direct lighting should be within the field of view. (**See Fig. 1C**)

2.1.3 Outdoor Sensor

Mount the Indoor sensor at reflecting wall. When sconces are in place in the light well, make sure not to mount sensor in direct level as the sconces. Place sensor 18" from the bottom corner of the ceiling. Remember, the Fresnel lens will see light with a field of view that is 1.15 times the distance to the wall. No direct lighting should be within the field of view. (**See Fig. 1C**)

2.1.4 Atrium Sensor

Mount the Atrium Sensor in a standard threaded 1/2" conduit or 1/2" knockout.
Locate the sensor at the opposite side of the window mounting the sensor against the wall or ideally in the middle of the atrium glass facing towards the Atrium glass. **(See Fig. 1B)**

2.1.5 Skylight Sensor

Mount the Skylight sensor in a standard threaded 1/2" conduit or 1/2" knockout. Locate the assembly near the center of the skylight well (at least 12" from the side) that is exposed to full daylight and is not shadowed. For the best results, use unistrut with a 1/4" angle support, making sure the top of the light sensor is level with top of skylight curb. Sensor must be mounted vertically with the domed portion facing up. **(See Fig. 1D)**

2.2 CONTROLLER

The LC3X is typically part of a pre-wired lighting control panel. The board is mounted on a standoffs and the optional Powercube Switcher (s) are mounted on a barrier strip. All power, input and output connections are via terminal blocks. If your LC3X is not included in a control panel system, it must be mounted in a Nema rated enclosure. The LC3X will require a 24VAC, 60Hz supply. For most applications a 40VA transformer will suffice. This must also be mounted in the same enclosure.

2.3 POWERCUBE SWITCHER (OPTIONAL)

Any Powercube Switcher (s) (PCS) must also be mounted in the same enclosure since they are wired directly to the LC3X. The PCS is designed to fit into a 0.85" hole and secured with the two tabs on the PCS. Alternately, the PCS can be taped or glued to an enclosure back pan.

3. CONNECTION

3.1 CONTROLLER AND SENSOR

Do not run the sensor wires near any high voltage area or near anyplace with high electrical noise. Use shielded cable and clip back the drain wire at the sensor and connect the other end at the controller to a good earth ground.

PC Sensor: Connect the two green wires from the sensor to 2 conductor 20AWG shielded wire. There is no polarity. Connect the sensor wires to the two terminals marked “PC Sensor” on TB5 (Terminal Block + number) on the LC3X.

PD Sensor: You must have the optional 3X/PD adaptor board (p/n 101333201R) to use a PD sensor with the LC3X. Mount the PD adaptor on standoffs above the LC3X in the two holes provided. Plug the cable from the PD adaptor board into J1-Cal on the LC3X. Connect the 4 wires from the PD sensor to 4 conductor 20AWG shielded wire. Note the wire colors you are using. Connect the Black wire of the sensor to the terminal marked BLK on the adaptor board. Likewise, connect the RED, GREEN and YELLOW wires. Figure 4, located at the end of the text, shows the PD adaptor board.

This adaptor board is required because the PD type sensors are 4 wire active devices that require special biasing that the LC3X main board does not supply. The sensor returns a voltage between 1 and 12 volts proportional to the amount of light it sees. The PD adaptor board has a “CAL ADJUST” which controls the sensitivity of the sensor, therefore enabling the user to field calibrate each sensor to a specific application. This and the fact that the response is linear make the PD sensor far superior to the PC sensor.

NOTE: The remaining majority of these connection instructions pertain to LC3X’s not sold in a completed enclosure.

3.2 LC3X POWER

The LC3X is designed to be powered by 24VAC, 60Hz. For most applications a 40VA transformer will suffice. Wire the 24VAC to TB7, the two pole terminal block located at the lower left corner of the PCB.

TB7-IN 24VAC HOT
TB7-COM 24VAC NEUTRAL

WARNING!DO NOT CONNECT 120VAC OR HIGHER VOLTAGE. THE LC3X IS A LOW VOLTAGE CONTROL DEVICE. MAKE SURE THE SYSTEM IS ADEQUATELY GROUNDED. GROUND THE LC3X AT THE 24VAC INPUT: TB7-COM. THIS IS THE
INPUT FOR THE 24VAC NEUTRAL AND WILL PREVENT THE 24VAC SOURCE FROM FLOATING TO A DANGEROUSLY HIGH POTENTIAL. MAKE SURE THAT THE 24VAC SOURCE TO THE LC3X CIRCUIT IS PROPERLY FUSED.

3.3 OUTPUT CONNECTIONS

The LC3X has three Form-C dry contact pilot duty outputs for wiring to three discrete loads. The circuit is class-2 low voltage which typically switches 24VAC or 24VDC.

"Level 1 output" is TB1

DAY LIGHTING:	TB1-COMMON & TB1-NORMALLY OPEN
CONTRAST LIGHTING:	TB1-COMMON & TB1-NORMALLY CLOSED

"Level 2 output" is TB2

DAY LIGHTING:	TB2-COMMON & TB2-NORMALLY OPEN
CONTRAST LIGHTING:	TB2-COMMON & TB2-NORMALLY CLOSED

"Level 3 output" is TB3

DAY LIGHTING:	TB3-COMMON & TB3-NORMALLY OPEN
CONTRAST LIGHTING:	TB3-COMMON & TB3-NORMALLY CLOSED

If your system uses a PCS, connect the 20AWG red wire from the PCS to the COMMON terminal on the LC3X. Connect the blue wire from the PCS to either the NORMALLY CLOSED or NORMALLY OPEN terminal, depending on your application. The black wire is normally not used.

If your system does not use a PCS connect your load between the COMMON and NORMALLY CLOSED or NORMALLY OPEN terminal, depending on your application. Observe the current rating stated above.

3.4 POWERCUBE SWITCHER

Turn OFF supply voltage to the circuit before continuing with the wiring. Be sure that the correctly rated PCS is being used and that the proper amperage rating is being observed. The usual connection of power lines to the fixture are 16ga. BLACK for the hot power wire and 16ga. WHITE for the neutral lead. Connect the WHITE lead of the cube to neutral and ensure that this same WHITE wire is the neutral for the load. Connect the BLACK lead of the PCS to incoming hot wire AND connect it to one of the RED leads of the cube. Connect the other RED lead of the cube to the hot side of the load. The cube will not only switch the fixture that it is installed in but all other fixtures and components on the same circuit. In some cases it may be necessary to rewire the circuit to obtain the desired lighting fixture control.

WARNING! THE 120VAC OR 277VAC IS FUSED EXTERNAL TO THE PCS. THE POWER MUST BE DISCONNECTED BY A REMOTE CIRCUIT BREAKER BEFORE SERVICING.

3.5 REMOTE OFF CONNECTIONS

Up to three dry contact inputs can be wired to the LC3X at TB6, which is a 4 pole terminal block located above the "power ON indicator", to activate the remote OFF functions.

Level 1 remote OFF:	Wire to TB6-level 1 and TB6-Common
Level 2 remote OFF:	Wire to TB6-level 2 and TB6-Common
Level 3 remote OFF:	Wire to TB6-level 3 and TB6-Common

3.6 PC EXPAND

The LC3X has three Form-C dry contact pilot duty outputs for wiring to three discrete loads. The circuit is class-2 low voltage which typically switches 24VAC or 24VDC.

4. CALIBRATION

Calibration is necessary to set the switching points for each of the three levels on the LC3X. If you have a PD sensor, it must be calibrated first and then the three levels can be set. Follow part 1 of this section for a PD sensor. For a PC sensor, there is no sensor calibration, prior to setting the three levels. Follow part 2 of this section for a PC sensor.

4.1 PC SENSOR

This adjustment is only necessary when using a PD sensor with the PD adaptor board. Calculate an offset voltage and then a calibration voltage from the sensor for a given light level. Connect a DVM to the LC3X and expose the sensor to the given light level, then rotate the CAL. ADJUST pot on the PD adaptor board until the DVM displays the calibration voltage. Finally, set the switching points for levels 1,2 and 3.

On the adaptor board is a 20 turn potentiometer labeled CAL. ADJUST. The purpose of this is to set the sensitivity or gain of the PD sensor such that it is optimized for the application. A curve of footcandle vs. signal voltage can be plotted for the PD sensor. Since the PD sensor is a linear device, this curve becomes a straight line. The adjustment affects the slope of the line, with a fixed point at 0Fc and 1VDC signal output. Note that the slope is negative since the sensor outputs more voltage for less light. (See Figure 2)

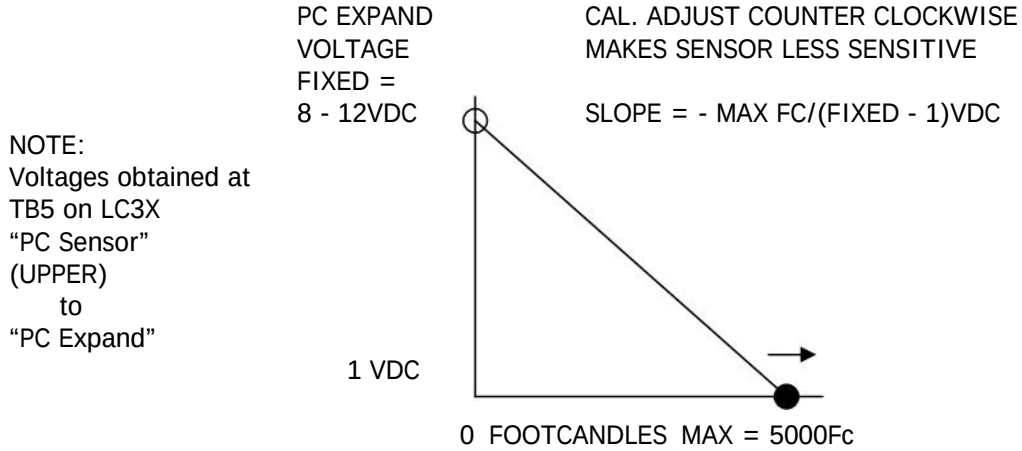
4.1.1 Calculations

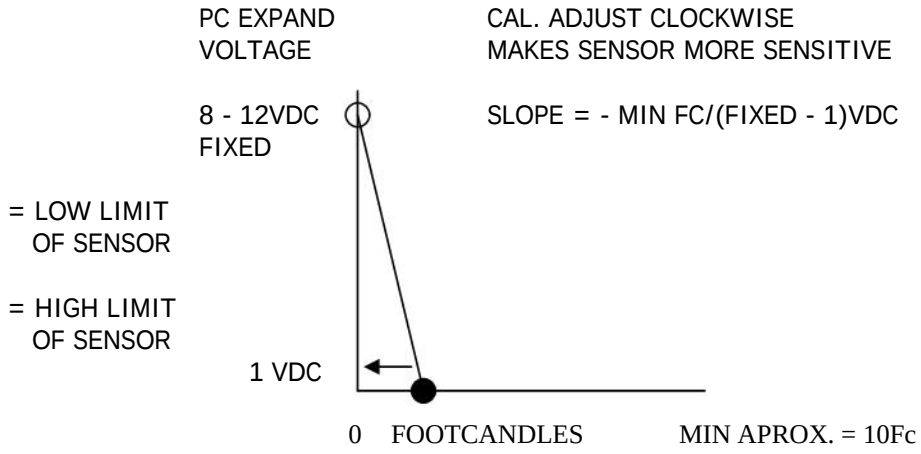
Obtain your lighting level switching points. Record switching points and voltages on the LC3X calibration worksheet. For this example, we'll use the following figures:

Setpoint 1 = Level 1 Output =	200	Footcandles (Fc)
Setpoint 2 = Level 2 Output =	500	Fc
Setpoint 3 = Level 3 Output =	1500	Fc

The calibration is set such that the maximum light that the sensor detects is 30% above the highest setpoint. For this example the maximum light level will be 1800 Fc. We will calculate what voltage the sensor output should be for this light level using the equation:

Slope = -maximum light level Fc/(max fixed –1) VDC





The max fixed VDC is the maximum voltage the sensor can output. This can be as High as 12VDC, but is normally 10VDC, which is what we will use here and always. Hence the equation for our example becomes:

Slope = - 1800Fc/(10VDC - 1VDC)
= - 1800Fc/9VDC
= - 200.00 Fc/VDC

Log this number on the LC3X calibration worksheet. Since the curve is fixed at 0Fc and is linear, if one point along this curve is calibrated the entire curve is calibrated. This point will be the light level midway between level 1 and level 3 or:

Midway light level = (1500 - 200)/2 = 650Fc

Divide the midway light level by the slope to yield an offset sensor voltage:

Offset sensor voltage = Midway light level / slope
= 650Fc/-200Fc/VDC
= -3.25VDC

This is an offset from the maximum fixed sensor output voltage of 10VDC. Adding the offset to the maximum yields the calibration voltage for 650Fc.

Calibration voltage = Max fixed voltage + offset voltage
= 10VDC + (-3.25VDC)
= 6.75VDC

4.1.2 Adjustment

Connect the DVM to the upper "PC sensor" and "PC expand" poles of TB5.
Set to read VDC. Place a light meter next to the sensor and expose both devices to the midway light level of 650Fc. It is critical that the sensor and meter "see" this light level during the entire calibration. Shade or shine a light on the pair to obtain this Fc level. It is very important that this is done accurately otherwise the calibration will be in error. Power up the LC3X and rotate the CAL. ADJUST pot clockwise or counter-clockwise until the DVM displays the calibration voltage. Verify that the light meter still displays the calibration voltage. Verify that the light meter still displays the midway light level. If it doesn't, adjust and recalibrate. If it does, proceed further.

4.1.3 Level Setting

Calculate the offset and then the calibration voltages for each of the three light level switch points. You will then connect a PD simulator and a DVM to the LC3X. You will rotate the simulator control until the DVM displays the calibration voltage. You will then rotate the Level 1, 2 or 3 F/C ADJ pot until the corresponding LED just comes on. The calibrated signal from the sensor is sent into a 3 level comparator circuit. As the light level changes so does the signal from the sensor. Each level has a user-adjustable pot for triggering the corresponding relay. When the LED comes on, this indicates that the light level is lower than the setpoint and the relay has been activated.

Calculate the offset sensor voltages for each light level using the equation: Offset sensor voltage = light level / slope.

FOR EXAMPLE:
Setpoint level 1 = 200Fc
Offset level 1 = 200Fc/(-200Fc/VDC) = -1.00VDC
Setpoint level 2 = 500Fc
Offset level 2 = 500Fc/(-200Fc/VDC) = -2.5VDC
Setpoint level 3 = 1500Fc
Offset level 3 = 1500Fc/(-200Fc/VDC) = -7.5VDC

Calculate the calibration voltages using the equation: Calibration voltage = maximum fixed voltage + offset voltage.

FOR EXAMPLE:

Setpoint 1 = 10VDC - 1.00VDC = 9.0VDC at 200Fc
Setpoint 2 = 10VDC - 2.5VDC = 7.5VDC at 500Fc
Setpoint 3 = 10VDC - 8.0VDC = 2.0VDC at 1500Fc

Power down the LC3X. Disconnect the 4 PD sensor leads from the PD adaptor. Plug the PD Simulator into the phone jack connector on the PD adaptor. Set the switch on the simulator to simulate. Connect the DVM to the black and red terminals on the PD Simulator. Set to read VDC.

Power up the LC3X. Switch the OVERRIDE DELAY to OFF. Rotate the knob on the simulator until you read the calibration voltage for Level 1 (in this example 9.0VDC) on your DVM. Rotate the LEVEL 1 F/C ADJ pot until the light next to it just comes on. Rotate the knob on the simulator back and forth several times and verify that the light comes on at your calibration voltage. Readjust if necessary. Repeat this portion of the procedure using the Level 2 and Level 3 Calibration voltages. Switch the OVERRIDE DELAY back to ON.

4.2 PD SENSOR CALIBRATION WORKSHEET

ENTER SETPOINTS TO SWITCH LIGHT LEVELS:

LEVEL 1 = _____Fc

LEVEL 2 = _____Fc

LEVEL 3 = _____Fc

DETERMINE FC/VOLT SLOPE OF SENSOR:
Use the maximum switching setpoint of the controller to determine the FC/Volt slope of the sensor. All unused levels are not counted. The safety margin is 30%. The full scale voltage of the PD sensors is 10 Volts. The minimum voltage is 1 Volt. The calculation is:

(10-1)V/[(Max Fc*safety margin) - Min Fc] = slope
9V/[(_____Fc* 1.3) - ____Fc] = _____

DETERMINE SETPOINT VOLTAGES:
To determine setpoint voltages, multiply the slope by each setpoint.

LEVEL 1_____* SLOP_____= LEVEL 1 VOLTS_____

LEVEL 2_____* SLOP_____= LEVEL 2 VOLTS_____

LEVEL 3_____* SLOP_____= LEVEL 3 VOLTS_____

4.3 PC SENSOR

There is no sensor calibration for the PC sensor - only level setting. Place a light meter next to the sensor and expose both devices to the level 1 lighting, or in this example 200Fc. It is critical that the sensor and meter “see” this light level during the entire calibration. Shade or shine a light on the pair to obtain this Fc level. It is very important that this is done accurately otherwise the calibration will be in error.

Switch the OVERRIDE DELAY to OFF. Power up the LC3X and rotate the LEVEL 1 F/C ADJ until the LED next to the pot just comes ON. Repeat this procedure using the Level 2 and Level 3 light levels and the LEVEL 2 and LEVEL 3 F/C ADJ pots. Switch the OVERRIDE DELAY back to ON.

5. OPERATION

Once installed and calibrated, theLC3X needs no further attention. This section describes the indicators and controls on the LC3X.

5.1 INDICATORS

Figure 3, located at the end of the text shows all the indicators and controls for the LC3X.

LED 4 - Sensor warning indicator. NORMAL operation is yellow LED OFF. If the LED is illuminated than this may indicate a possible problem with the sensor. Check for open or short circuits between the LC3X sensor input and the sensor.
LED 5 - Power on indicator. This is a green LED which is NORMALLY ON. When illuminated this indicates that 24VAC is being supplied to the LC3X board and on the board voltage regulator is operational.
LED 1 - Status indicator for level 1 output relay (red LED). When the light level is lower than the setpoint, the LED is turned ON.
LED 2 - Status indicator for level 2 output relay (red LED). When the light level is lower than the setpoint, the LED is turned ON.
LED 3 - Status indicator for level 3 output relay (red LED). When the light level is lower than the setpoint, the LED is turned ON.

5.2 CONTROLS

POSITION HEADER - P2 LEVEL 3 OPTION. Most applications should have a 2-pole jumper shorting pin 2 to pin 3. FOOTCANDLE SET POINT. There are three such adjustments, one for each output. They are single turn potentiometers that are labeled “LEVEL 1 F/C ADJ, LEVEL 2 F/C ADJ and LEVEL 3 F/C ADJ”. Rotating the potentiometers clockwise increases the footcandle setpoint.

5.2.1 OVERRIDE DELAY OFF / ON

This slide switch, located between the delay pots and the setpoint pots, turns off/on the photocell delay for setup/testing. When OFF the delay pots are overridden such that any light change at the sensor is instantaneously seen at the LC3X as a voltage change. It should be turned OFF for testing or adjusting the footcandle setpoints, such that the effects of the adjustments are immediately realized. During adjustment of the delay pots the switch should be in the OFF position. During normal operation the switch should be in the ON position.

5.2.2 DELAY ADJUST

The delay adjust will effect the response of the system. The sensor converts units of light to units of volts. The response of the conversion is instantaneous. Therefore a transient source of the light will create a voltage signal, which can cross the setpoints and cause the outputs to toggle undesirably. The delay will prevent the light transients from being converted into voltage transients through integration, or “averaging” of the signal. The period of time for which the light is averaged is from several seconds to 10 minutes. There are two potentiometers that set delays.

The DELAY ADJUST LIGHTS “ON” will average out the transients caused by “dark spots”. The “ON” refers to the fact that these transients being delayed cause the red output status LED from turning ON intermittently.
The DELAY ADJUST LIGHTS “OFF” will average out the transients caused by “bright spots”. The “OFF” refers to the fact that these transients being delayed cause the red output status LED from turning OFF intermittently.

6. OPTIONS

6.1 PHOTODIODE ADAPTOR CARD

See Calibration section - “Background In formation” for the PD sensor.

6.2 TIMER CARD

This optional timer card overrides the photocell signal within a specified time period. The period set/reset point, time period and mode of operation are all field selectable. Up to three timer cards can be used, as 1 card controls one of the three outputs. The timers plug into the 8-pole headers J1, J2 and J3. These are also labeled timer1, timer2 and timer3, which directly correspond to the level1, level2 and level3 outputs. Typically the timer options are selected if the load is a HID lamp, the purpose being to use the timer as a minimum time on or as a minimum time off before re-striking the lamp. Figure 5, located at the end of the end of the text shows all of the controls for the Timer Card.

6.2.1 DIP Switch Settings

The 5 position dip switch is located on the top of the timer card. The individual switches select the modes of operation of the timer card. When the switch is set to OPEN, the switch is OFF. When the switch is set to the NUMBERED SIDE the switch is ON. All switches should normally be in the OFF position. See Figure 6A.

6.2.2 Timer Card Activation / De-Activation

Dip switch 5 will turn the timer card ON/OFF. If the timer card is OFF, it will have no effect on the LC3X. When dip switch 5 is in the ON position the timer card is activated. See Figure 6B.

6.2.3 Timer Range Select

The length of time that the timer card will “HOLD” is field settable. The dip switches 3 and 4 set the range of time, and the potentiometer adjusts the time within this range. See Figure 6C for dip switch time range settings.

6.2.4 Timer Card Mode of Operation Select

Dip switches 1 and 2 set the mode of operation of the timer card. The following are the 4 modes of operation that the timer can be configured for:

HOLD ON - minimum timer
HOLD OFF - minimum timer
HOLD ON - additive timer
HOLD OFF - additive timer

These four modes of operation are selected as shown in Figure 6D. Notice the 4 modes of operation have two overlapping functions. ON/OFF FUNCTION - The ON / OFF functions refer to the effect that the timer card has on the relay control for each of the three outputs. In the HOLD ON mode, once the sensor turns the relay ON, the timer card will HOLD the relay ON for the specific time, regardless of the signal from the sensor. Likewise, when the timer card is on the HOLD OFF mode, once the sensor turns the relay OFF, the timer card will HOLD the relay OFF until the timer times-out, regardless of the signal from the sensor.

MINIMUM or ADDITIVE - This function controls how the timer card is set/reset, and therefore determines when the card starts to HOLD. While the period that the timer holds is not effected, the period that the relay is held ON, will be effected.

In all cases the ADDITIVE mode will HOLD the relay ON for a longer period of time than the MINIMUM mode will. This is because the MINIMUM timer starts timing when the relay is activated, whereas the ADDITIVE timer starts timing when the relay tries to deactivate. Therefore if the sensor ON / OFF period is longer than the timer hold ON / OFF period, the effect of the MINIMUM timer will not be seen since the timer will time-out before the sensor releases the relay. However, the effect of the ADDITIVE timer will always be seen since its timing cycle begins at the end of the sensor ON /OFF period or just when the relay tries to deactivate. See Figure 6A through 7B for comparison between how the MINIMUM and ADDITIVE timers effect the output, and how they set, reset and time-out.

7. SPECIFICATIONS

Power Supply:	24VAX Input, 60 Hz, 0.45A
Input:	Photo Conductive (PC) Sensor Photo Diode (PD) Sensor with 3X/PD adaptor board
Output:	3 Form-C Relay, 5A dry contacts Connections are rated for 24VAC or 24VDC at 5A.
Dimensions:	6.25” x 6.5” x 1.25”
Options:	3X/T - Plug in timer cards for “Hold” functions 3X/PD - Photo Diode sensor adaptor

8. TABLE OF FIGURES

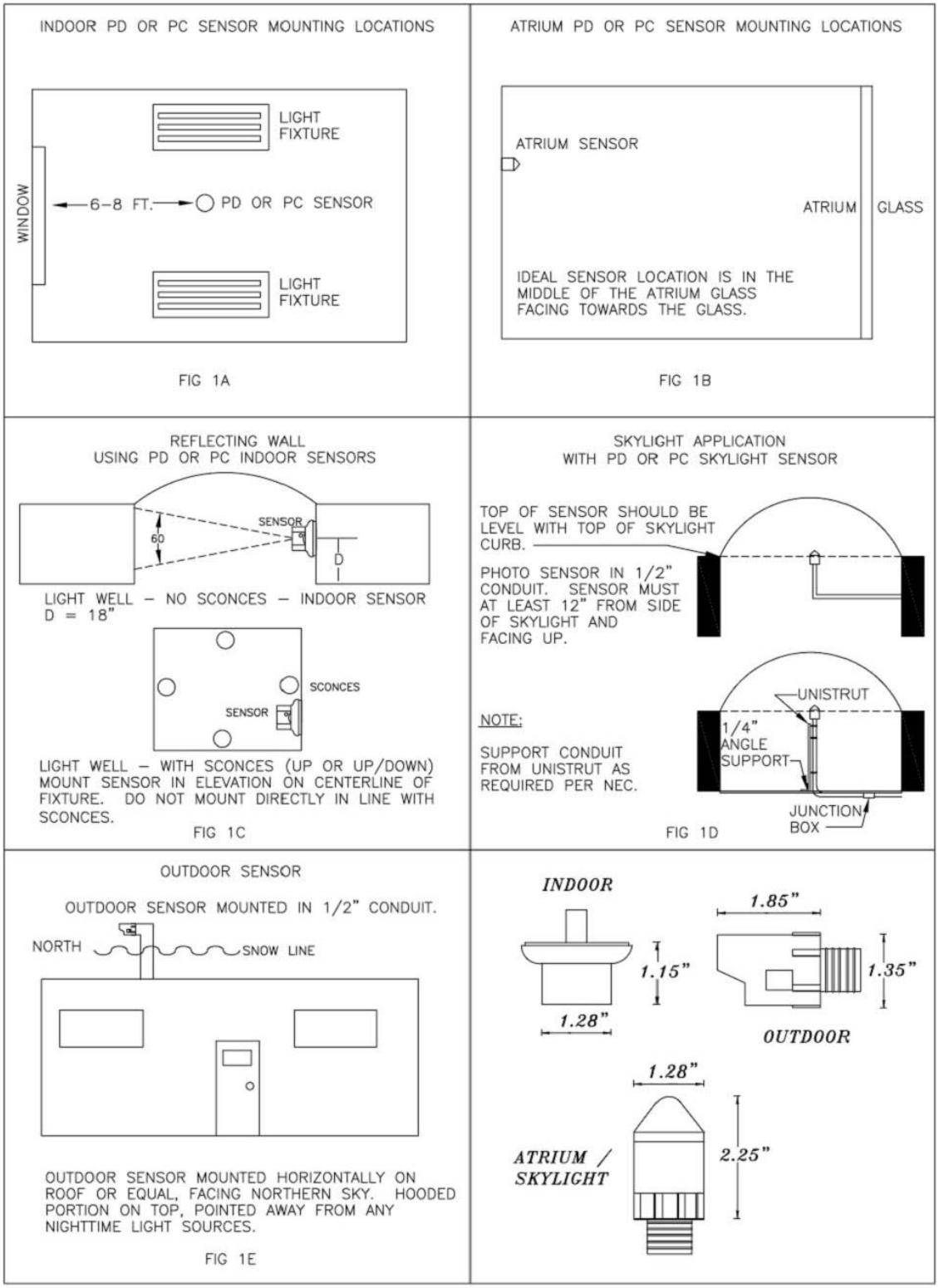


Figure 1: 1A – 1E PC Sensor Location

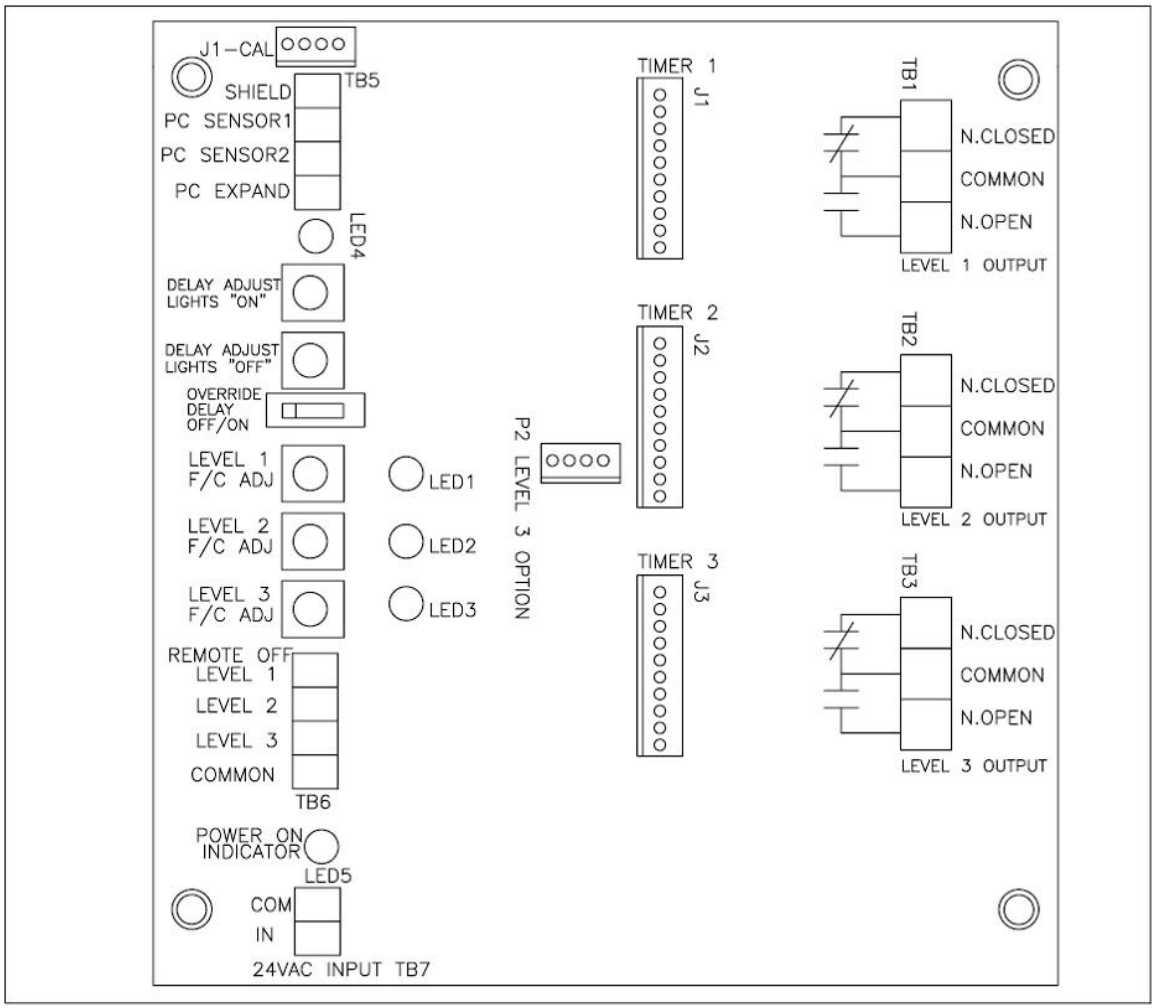


Figure 2: LC3X Layout

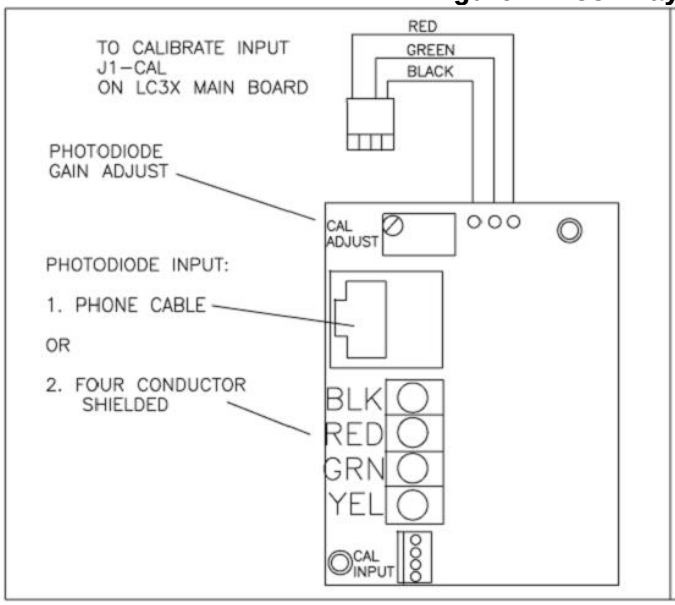


Figure 3: 3X / PD Adaptor Layout

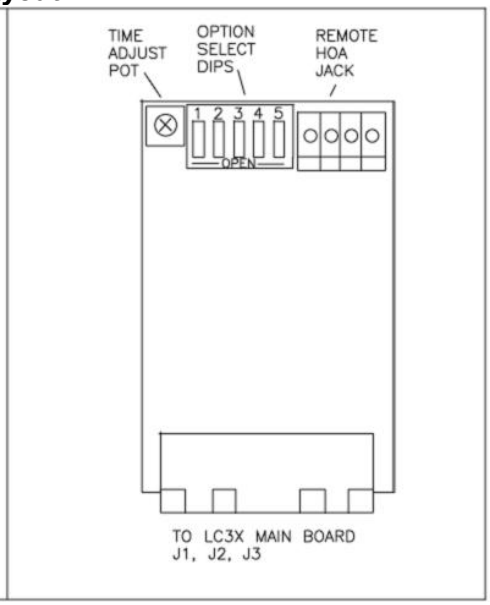


Figure 4: Timer Layout

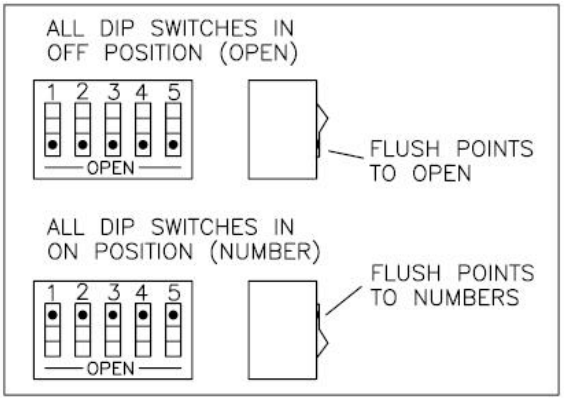


Figure 5A: Timer Switch Diagram

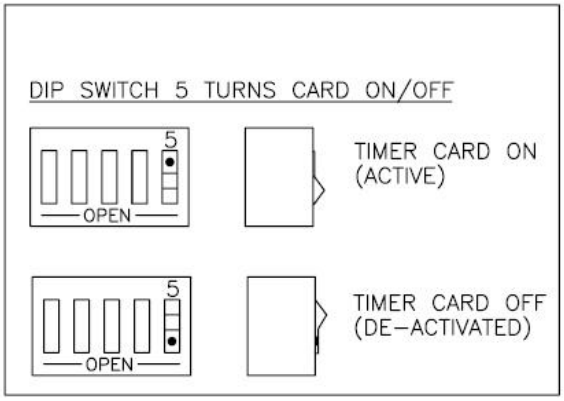


Figure 5B: Timer Card Activation

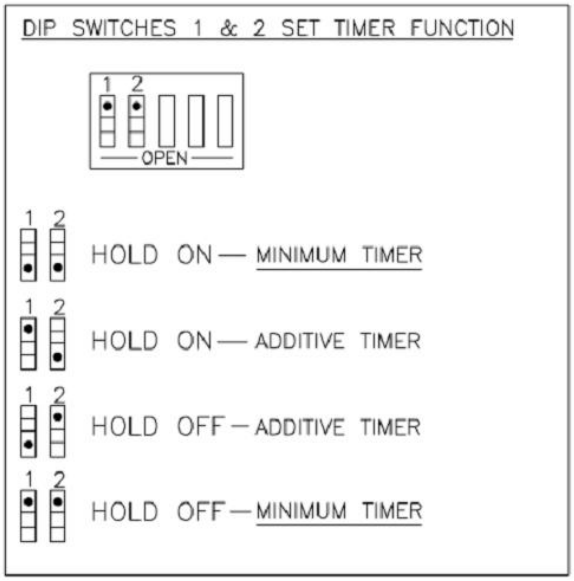


Figure 5C: Timer Range Select

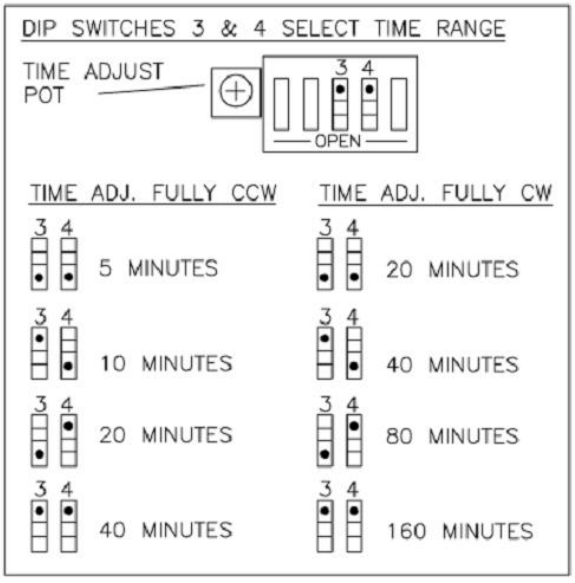


Figure 5D: Timer Mode Select

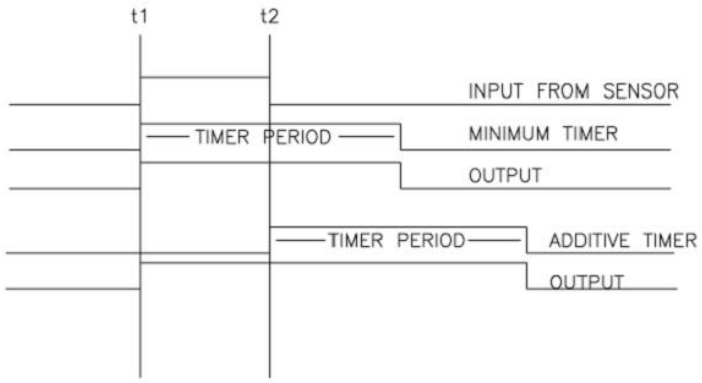


Figure 6A: Timer Range Select

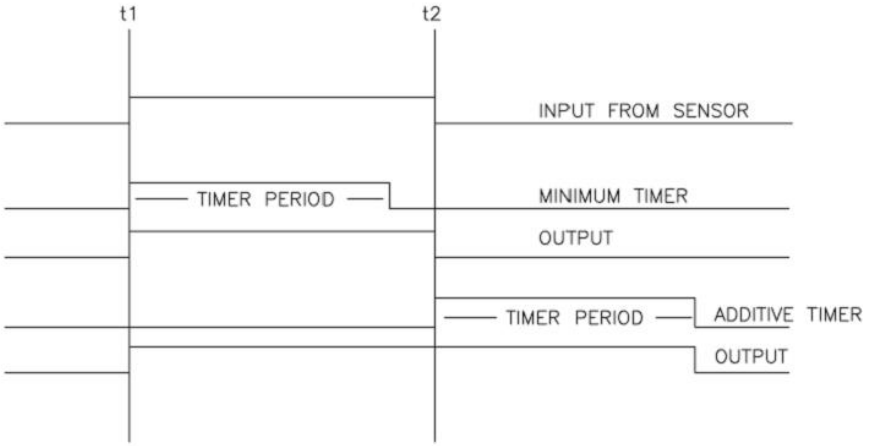


Figure 6B: Timer Mode Select

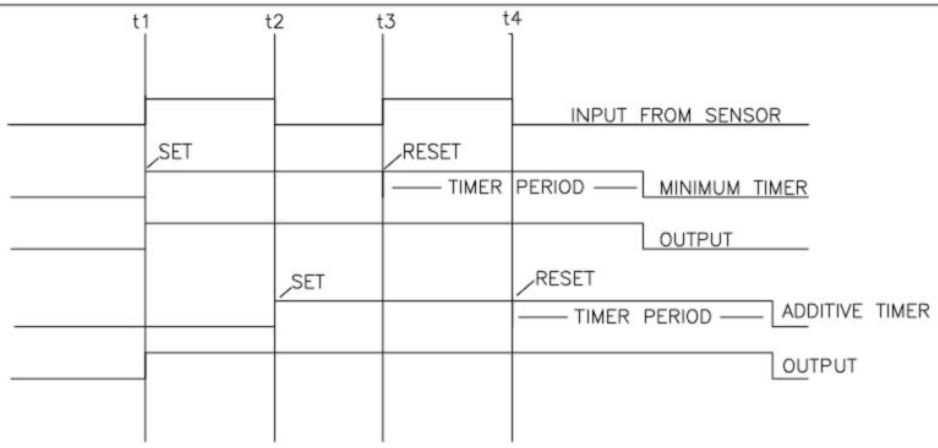


Figure 6C: Timer Mode Select