

# Alan's Electronic Projects

## Stair Lights Installation Guide

Rev 1.1

January 24, 2006

[www.alan-parekh.com](http://www.alan-parekh.com)

Copyright © 2005 - 2006 Alan Parekh's Electronic Projects

# Stair Lights Installation Guide

<b>1. Introduction</b> .....	<b>4</b>
1.1 Concept of Operation .....	4
1.2 Lighting Unit Features .....	4
<b>2. Kit Assembly</b> .....	<b>5</b>
2.1 Control Board Assembly.....	5
2.2 Stair Light Assembly .....	10
2.3 IR Transmitter Assembly .....	13
2.4 IR Receiver Assembly .....	16
<b>3. Testing a Control Unit</b> .....	<b>18</b>
<b>4. Field Wiring</b> .....	<b>21</b>
4.1 Mount Lighting Control Unit.....	21
4.2 Connect Power .....	21
4.3 Install Stair Lights.....	21
4.3.1 Wiring 10 or Less Stair Lights to Controller .....	22
4.3.1 Wiring 11 to 20 Stair Lights to Controller.....	22
4.4 Install Infrared Beams.....	22
4.4.1 Determine IR Beam Location .....	23
4.4.2 Install IR Beams.....	23
4.4.3 Wiring IR Beam Sensors to Controller.....	23
<b>5. System Setup and Testing</b> .....	<b>23</b>
5.1 Entering Setup Mode .....	24
5.2 IR Beam Alignment .....	24
5.3 Stair Light Alignment .....	24
5.4 System Testing.....	24
<b>6. Programming Light On Duration</b> .....	<b>25</b>
6.1 Entering Program Mode.....	25
6.2 Reading Program Mode On Time Code .....	25
6.3 Changing the Program Mode On Time Code .....	26
<b>7. Maintenance</b> .....	<b>26</b>
<b>8. Troubleshooting</b> .....	<b>26</b>
<b>9. Optional System Features</b> .....	<b>28</b>
9.1 Installing Laser Beams.....	28
9.2 Auxiliary Output .....	29
9.3 Installing Piezo Buzzer .....	29
<b>10. Stair Lighting Wire Calculation Guide</b> .....	<b>29</b>
<b>11. Appendix</b> .....	<b>32</b>
11.1 Stair Light Control Board Schematic.....	32
11.2 Stair Light External Connections.....	33
11.3 Circuit Board Layout Diagram .....	34
11.4 Circuit Board Component Photo.....	35

## Stair Lights Installation Guide

### Revision History

<b>Date</b>	<b>Revision</b>	<b>Author(s)</b>	<b>Description</b>
<i>Oct 10, 2005</i>	<i>1.0</i>	<i>Alan Parekh, Bill Alexander</i>	<i>Document creation.</i>
<i>Jan 24, 2006</i>	<i>1.1</i>	<i>Alan Parekh, Bill Alexander</i>	<i>Section 2.2 revision. Spelling and Grammar.</i>

# 1. Introduction

Thank you for purchasing a Stair Lighting kit. This document will walk you through the installation of your stair light kit. There are many options available when purchasing this kit so some section might not pertain to your situation. For example if you purchased the unit fully assembled you can skip directly to the Field Wiring section. Each section requires a few basic tools, these will be listed

## 1.1 Concept of Operation

The Lighting Control Unit is microcontroller based, what this means is there is a small self contained computer that controls the unit. Stair lights are wired up to the control unit, an IR (Infrared) transmitter and receiver are used at the top and bottom of the stairs to create a beam of invisible light. When this beam is broken (crossed) the Lighting Control Unit will be able to sense this and turn on the lights. The controller performs a soft start to the lights so they ramp up nicely instead of just turning on. The controller also keeps track of which beam was broken and turns off the lights following the person. For example if the bottom beam was broken to turn the lights on the lights will turn off following the person up the stairs. The lights fade out slowly to provide a nice visual effect.

## 1.2 Lighting Unit Features

- 10 separate stair lighting outputs. Each output can drive 2 stair lights allowing for between 1 and 20 lights to be controlled. Please note that even though 20 lights can be connected all 20 will not have independent control, in this case every pair of lights would mirror each other. A more likely scenario would be 11 stairs, in this case it could be wired so that each stair has independent control and the 2 center ones would act as one, fading together etc.
- 2 separate IR (Infrared) beam sensor inputs. This allows independent sensing of how the stairs were entered allowing separate patterns to turn the lights off. The kit comes with the 2 resistors that would allow laser pointers to be installed instead of the invisible supplied beam. Laser pointers are inexpensive and are quite easy to modify for use with the system. In fact the prototype is using visible lasers. Instructions on how to convert the system to use lasers is available in the optional system features section.
- Programmable on time. You will be able to use the default 20 second on time or change it to something shorter or longer if you need to.
- Flash memory storage. The on time you select will be retained even if power is removed from the control unit, this is because it is stored in flash memory.
- Versatile Power Requirements. The unit can be powered from any plug in wall transformer that outputs anything from 9 to 12VDC at 500mA (.5A) or greater.
- Reverse Polarity Protection. If the power is connected with reverse polarity the unit will not be damaged, it will just not power up.

## Stair Lights Installation Guide

- **Lighting Output Short Circuit Protection.** If one of the lighting outputs are accidentally short circuited the control unit will self current limit to protect the outputs. Once the short is removed normal operation will resume immediately. Correct electronic installation practices should still be followed such as powering the unit down when making any electrical connections.
- **Auxiliary Output.** This is meant for those that are advanced and want to control something else when the lights are on. There is an output that is provided that can sink up to 20mA at 5V when the lights are on. For those that are not electronically savvy you can just ignore this.

## 2. Kit Assembly

### 2.1 Control Board Assembly

To assemble the Stair Lighting control board you will need a soldering iron, solder, wire cutters, screw driver and pliers.

Many of the components of the kit are sensitive to static discharge. Before you begin it is important that you remove any static electricity from your body by grounding yourself. This is done by touching any grounded metal that is by the area you are going to be assembling the board. For example a bare metal computer power supply. You must ground yourself again if you walk away and return to the location you are assembling your control board.

Many of the components look the same but if installed in the incorrect location can cause damage to the control board. It is very important to ensure that the correct components are installed in the correct position. We are going to start by installing the shortest components and progress to the larger ones. When the instructions say to “install” this means to place the leads through the required holes allowing the component to sit close to the board, soldering the component in place and trimming the leads. See the appendix for diagrams of the control board. Appendix 11.3 is a board diagram showing component numbers and appendix 11.4 is a picture of the completed board for a visual reference. When component references are made such as R1, D1 C1 these can be found on the Appendix 11.3 diagram.

- 1. Install all resistors.** Resistors positions are marked with an “R” followed by a number. Resistors are non polarized, this means that they can be install in either direction. It is very important that the correct value of resistors be used in the correct location!

There are three types of resistors used on the control board, 220 ohms and 10K ohms. The value of the resistor is represented by colored bands on the resistor.  
*220 ohms is RED, RED, BROWN, GOLD.*  
*10K ohms is BROWN, BLACK, ORANGE, GOLD.*  
*0 ohm is BLACK.*

## Stair Lights Installation Guide

**R1:** 220 ohms

**R2:** 220 ohms

**R3:** 10K ohms

**R4:** 220 ohms

**R5:** 10K ohms

**R6:** 10K ohms

**R7:** 10K ohms

**R8:** 10K ohms

**R9:** 10K ohms

**R10:** 10K ohms

**R11:** 10K ohms

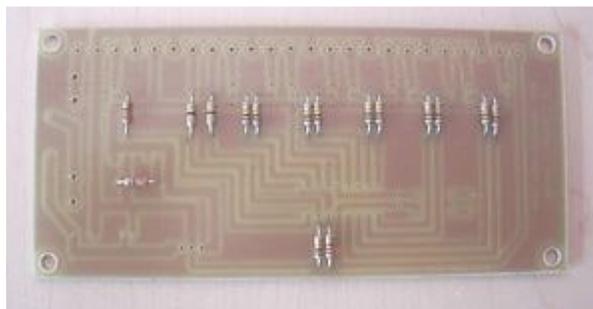
**R12:** 10K ohms

**R13:** 10K ohms

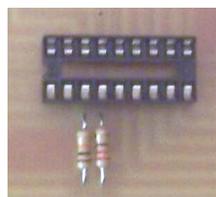
**R14:** 10K ohms

**R15:** 0 ohms, this resistor is not shown on the schematic since it is simply being used as a jumper.

**R16:** 0 ohms, this resistor is not shown on the schematic since it is simply being used as a jumper.

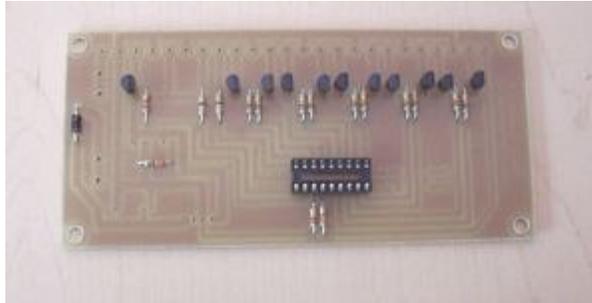


- 2. Install the diode.** There is a single diode to install, it is polarity sensitive. This component is listed as D1 on the schematic. The white bar on one end of the diode represents negative. The negative lead must be installed in the hole furthest away from the terminal block location.
- 3. Install 18 pin chip socket.** Do not install the microcontroller at this time! The socket goes in the location marked as U1, this is actually referring to the microcontroller chip but the location is the same since the microcontroller plugs into this socket. To orientate the socket properly, locate the notch. With the terminal block location at the top, install the socket with the notch facing left.

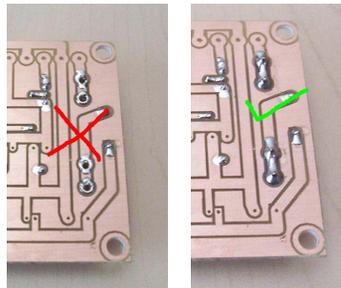


## Stair Lights Installation Guide

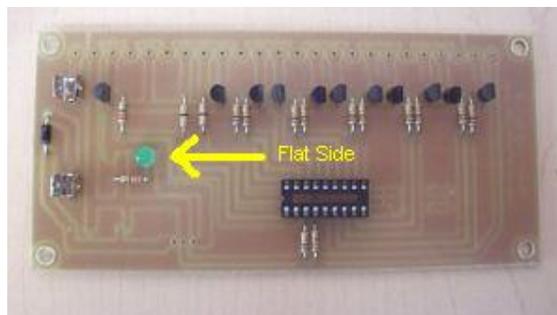
- 4. Install transistors.** Transistors must be installed with the correct orientation. These components are marked as Q1 through Q11. All of the transistors are located adjacent to the terminal block location. With the terminal block location at the top, install the transistor with the curved portion facing left.



- 5. Install fuse holder.** Do not install the fuse at this time! The fuse holder is two separate clips that the fuse will snap into. Install both clips. The fuse location is marked as F1. The fuse holder clips are mounted at both ends of the fuse. It is important to solder the fuse holder in securely; it will take quite a bit of heat and solder to install it properly. See the picture for an example of a proper solder joint.

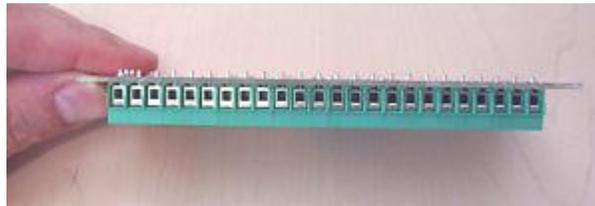
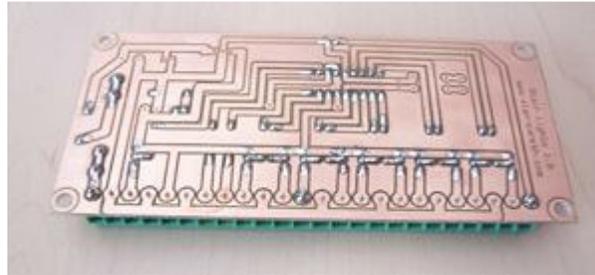


- 6. Install Power on LED.** The power on LED is polarity sensitive. Its location is marked as D2. There is a flat side on the LED that represents the LED's cathode (negative) side. With the terminal block location at the top, install the LED so that the negative side is on the right. When soldering an LED you should solder one lead then wait about 5 seconds before soldering the second lead. This will allow the LED to cool before soldering the 2<sup>nd</sup> lead. Do not apply heat to the LED for an extended time, it can damage the LED.



## Stair Lights Installation Guide

- 7. Install terminal block.** When orientating the 24 position terminal block make sure the large holes for the wires are facing away from the board. It is marked at TB1 but it is hard to miss! When soldering this in place it is important that there is no space between it and the circuit board. The easiest way to do this is solder the end pins and a center pin. Then closely inspect it to ensure there is no gap, if there is simply reheat the solder while applying moderate pressure on the terminal block. Once the 3 pins are soldered correctly you can now solder all of the other pins.



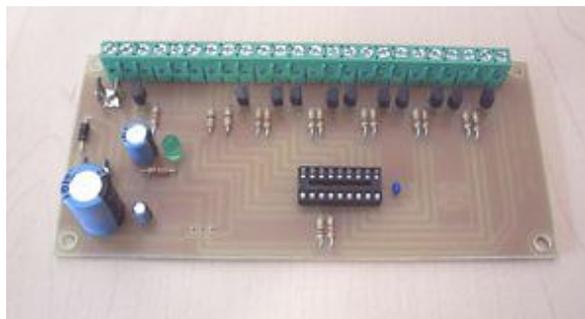
- 8. Install capacitors.** There are four capacitors to install, three of these are polarized and must be installed in the correct orientation. Capacitors C1, C2 and C3 are polarized. There is a stripe on one side that points to the negative lead. With the terminal block location at the top, install the capacitors so that the negative side of the capacitors go to the right. Since C4 has no polarity it can be installed in any direction. Note C4 is a very small capacitor, it might not have any identification on it that specifies it to be a 0.1uF capacitor. These capacitors are usually tiny rectangular devices where the component is the size of a match head.

**C1:** 1000uF

**C2:** 0.33uF

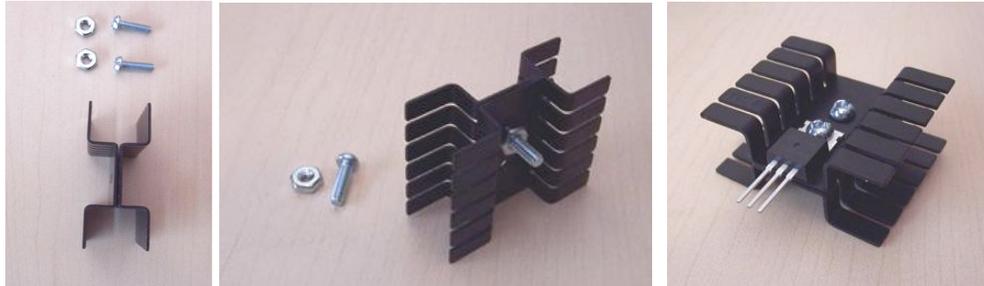
**C3:** 470uF

**C4:** 0.1uF

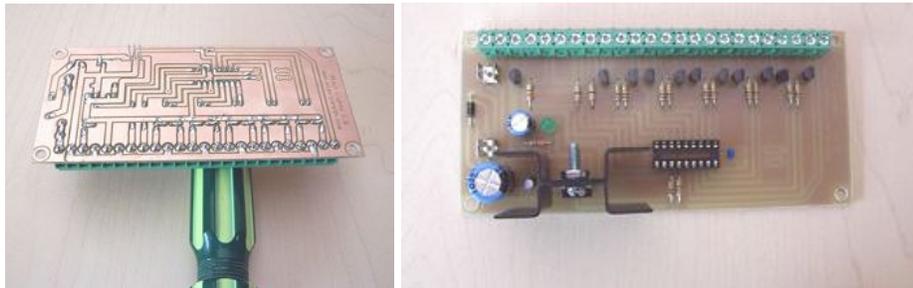


## Stair Lights Installation Guide

- 9. Assemble heatsink and voltage regulator.** There are two pieces that make up a single heatsink. Place the heatsink pieces back to back and insert the first nut and bolt into one of the two heatsink holes. Bolt the voltage regulator to the heatsink using the second heat sink hole. The metal back of the regulator must be placed flat against the heatsink.



- 10. Install voltage regulator/heatsink assembly.** The voltage regulator must be installed in the correct orientation. With the terminal block location at the top, install the regulator so that the face of the regulator (side with writing) is facing away from the terminal block. When soldering it may be easier if something such as a screwdriver is used to raise the board to the same height as the heatsink.

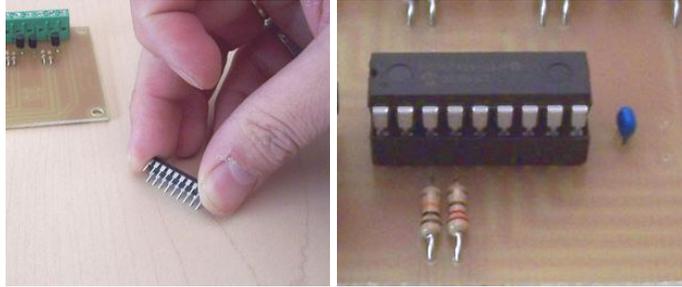


- 11. Install fuse.** Snap the fuse into the fuse holders. Ensure that the metal end caps of the fuse are being held by the clips and not the glass portion of the fuse.



- 12. Install Chip.** The chip is very sensitive to static electricity. Ground yourself again before removing it from its antistatic package. Do not handle the chip excessively; simply insert it into the socket that was installed in step 3. If the chip pins do not line up very easily it may be necessary to gently adjust the width of the pins by applying slight pressure against a table. When aligning the chip, place the notch of the chip in the same orientation as the notch on the socket.

## Stair Lights Installation Guide



### **2.2 Stair Light Assembly**

To assemble a Stair Light you will need a soldering iron, solder, wire cutters and pliers. Another tool that makes assembly very simple is a set of “Helping Hands”, this is a tool that has 2 clips that can hold electronic parts in place while you solder them together. If you use a set of helping hands wrap the clips with electrical tape to protect the electronics.

*CAUTION: All LEDs are very sensitive to heat. When soldering LED leads make sure to prep the joint correctly, then apply heat and flow the solder in a quick motion. The total time heat is applied should not exceed 1 second. Also wait at least 5 seconds before attempting to solder the 2<sup>nd</sup> lead. When applying heat shrink to the Stair Light pay close attention to how much heat is being used. Keep your fingers on the LED body, if the heat is too much for your fingers to handle it is also too hot for the LED.*

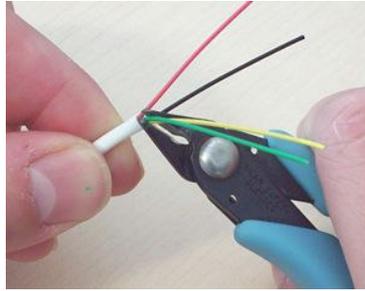
The stair light assembly consists of a current limited super bright LED light source that can be directly controlled by the Stair Lighting Controller. The wire leads are 10 inches long; this is long enough to connect the stair light to a wire that runs to the controller. Each stair light includes 2 crimp connectors for this purpose.

- 1. Prepare the cable.** Cut a section of cable to 10 inches. Strip the end off the cable exposing the 4 conductors inside.



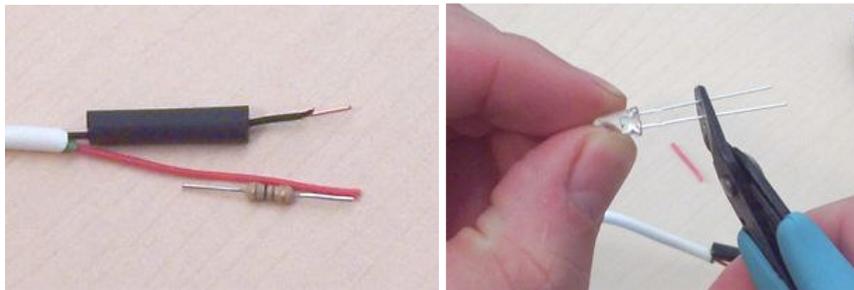
- 2. Remove extra conductors.** We only require the red and black conductors; the yellow and green ones can be cut out. Cut them as close to the jacket as possible.

## Stair Lights Installation Guide

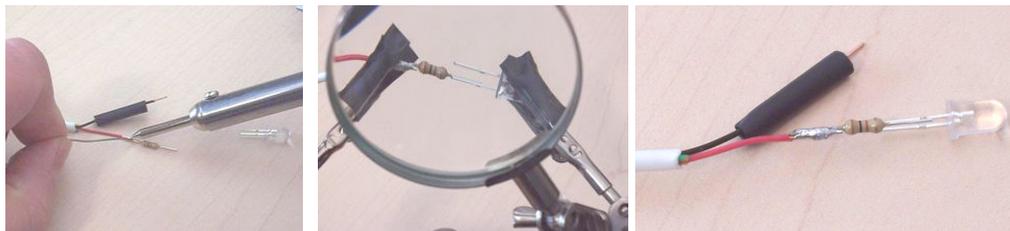


- 3. Trim components.** Trim the resistor as shown, trim and strip the red wire to match the left lead of the resistor. Trim the leads of the white LED.

The value of the resistor is represented by colored bands on the resistor.  
*100 ohms is BROWN BLACK BROWN GOLD.*



- 4. Solder the resistor.** Hold the resistor in place while soldering it to the red wire. The first picture shows a poor method of holding the wire and component in place while soldering. The second picture shows a set of “helping hands” in action. These allow the components to be precisely aligned for a good solder connection. Next align the white LED to the resistor. The LED lead that the resistor gets connected to is important; if the wires are connected backwards the LED will not light but no damage will occur. The positive side (anode) of the LED is to be connected to the resistor. The anode does not have any special markings to identify it, however the negative lead (cathode) does. Look for a flat spot on the LED, this is the cathode (negative side). The cathode is the lead that the black wire will be connected to eventually. Remember not to apply too much heat when soldering the LED.

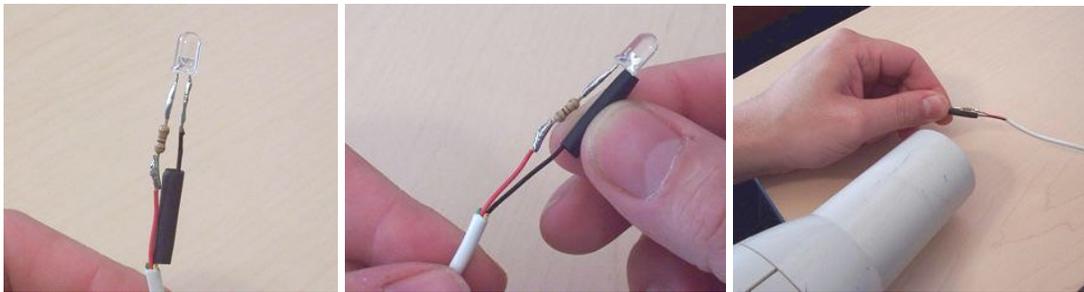


- 5. Solder the LED to the resistor.** Solder the resistor to the lead of the LED that was discussed in the previous step. Make sure the black heat shrink is on the black wire and solder it to the LEDs other lead.

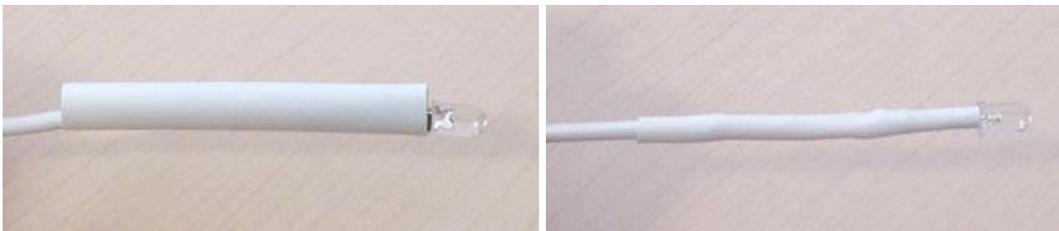
## Stair Lights Installation Guide



- 6. Install black heat shrink.** Slide the black heat shrink tight to the LED body. Carefully heat the heat shrink using an appropriate heat source while making sure the LED does not get hot (read the caution again)! Once the heat shrink is in place there should be no exposed wire on the black side.



- 7. Install white heat shrink.** To protect all of your hard work slide the white heat shrink over the resistors and the exposed wires. Carefully heat the heat shrink using an appropriate heat source.



Prepare the wire connection end. Strip the end and remove the wires that are not being used, only keep the black and red wire. Then strip the ends of the black and red wires and you are done!



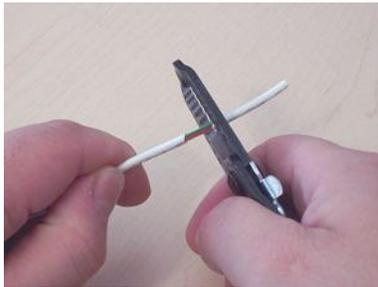
### **2.3 IR Transmitter Assembly**

To assemble an IR Transmitter you will need a soldering iron, solder, wire cutters and pliers. Another tool that makes assembly very simple is a set of “Helping Hands”. This is a tool that has 2 clips that can hold electronic parts in place while you solder them together. If you use a set of helping hands wrap the clips with electrical tape to protect the electronics.

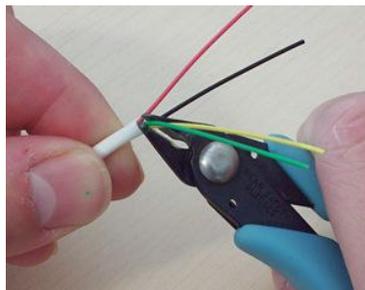
*CAUTION: Read the caution in the Stair Light Assembly section. It also applies to the IR transmitter. It is also very important that the IR transmitter is only connected to the IR port on the Lighting Control Unit located at terminals 3 and 4. Connecting the transmitter to any other terminals (or direct power) will cause damage to the unit.*

The IR Transmitter assembly consists of a current limited IR LED that can be directly controlled by the Stair Lighting Controller to produce a beam of invisible light, this light will be used to detect people entering the stairs. The wire leads are 10 inches long; this is long enough to connect the IR Transmitter to a wire that runs to the controller. Each IR Transmitter includes 2 crimp connectors for this purpose.

- 1. Prepare the cable.** Cut a section of cable to 10 inches. Strip the end off the cable exposing the 4 conductors inside.



- 2. Remove extra conductors.** We only require the red and black conductors; the yellow and green ones can be cut out. Cut them as close to the jacket as possible.



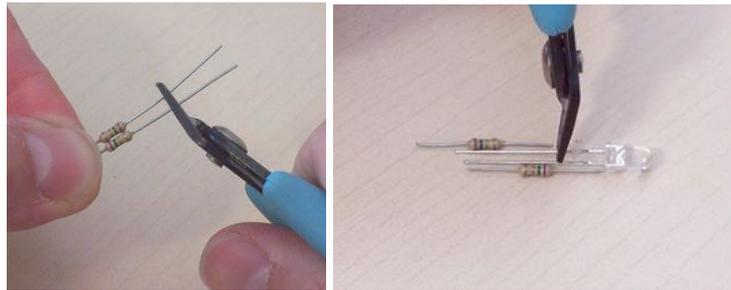
## Stair Lights Installation Guide

- 3. Trim components.** Trim the resistors as shown and place them beside the IR transmitter in a staggered fashion. This layout will give the unit the slimmest profile possible when completed. Clip the IR transmitter's leads to match the resistor lead placement. In the picture the cathode (negative side) of the IR Transmitter is down, it is important to orientate it the same way at this point otherwise the IR transmitter will be hooked up backwards and will not work. To identify the cathode look for a flat side on the IR Transmitter.

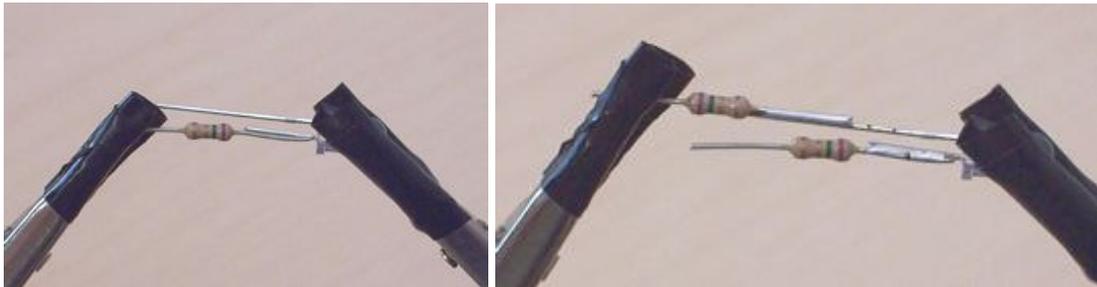
Both resistors used are the same value, 7.5 ohms.

The value of the resistors are represented by colored bands on the resistor.

*7.5 ohms is BROWN GREEN GOLD GOLD.*

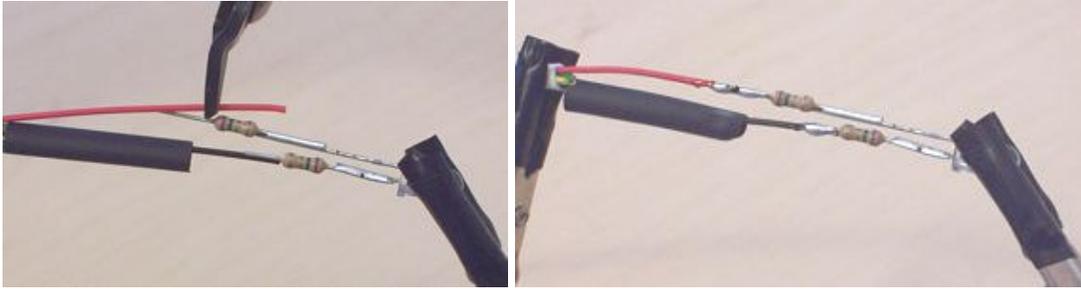


- 4. Solder the resistors.** Hold the resistor in place while soldering the IR transmitter lead to the lead of the resistor. Remember not to apply too much heat, read the caution. Next solder the 2<sup>nd</sup> resistor in place, remember to stagger the resistors as shown.



- 5. Trim and connect the wires.** Ensure the long and short resistors were hooked up correctly as described in step 3 before progressing. The resistor closest to the IR transmitter should be connected to the lead that is beside the flat side of the IR transmitter. If this is not the case reverse the color of wires that are shown in the picture when connecting them. Trim and strip the wires long enough to connect to the resistors. Slide the heat shrink over the black wire. Solder both wires to the resistors.

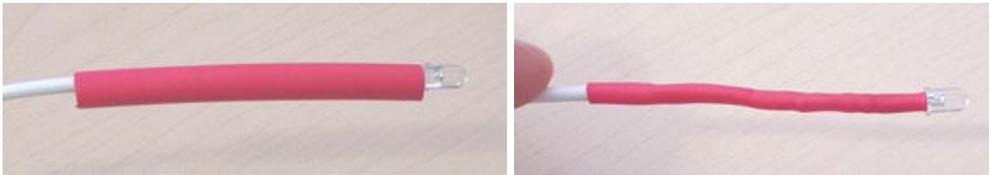
## Stair Lights Installation Guide



- 6. Install black heat shrink.** Slide the black heat shrink over the resistor and bring it tight to the IR Transmitter body. Carefully heat the heat shrink using an appropriate heat source while making sure the IR Transmitter does not get hot (read the caution again)! Once the heat shrink is in place there should be no exposed wire on the black side.



- 7. Install red heat shrink.** To protect all of your hard work slide the red heat shrink over the resistors and the exposed wires. Carefully heat the heat shrink using an appropriate heat source.



- 8. Prepare the wire connection end.** Strip the end and remove the wires that are not being used, only keep the black and red wire. Then strip the ends of the black and red wires and you are done!



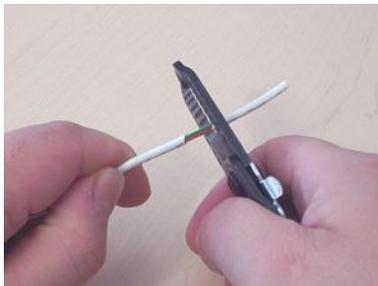
### 2.4 IR Receiver Assembly

To assemble an IR Receiver you will need a soldering iron, solder, wire cutters and pliers. Another tool that makes assembly very simple is a set of “Helping Hands”. This is a tool that has 2 clips that can hold electronic parts in place while you solder them together. If you use a set of helping hands wrap the clips with electrical tape to protect the electronics.

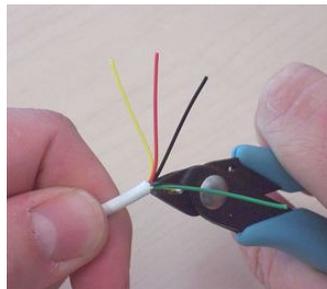
*CAUTION: Read the caution in the Stair Light Assembly section. It also applies to the IR receiver.*

The IR Receiver assembly consists of a resistor in series with an IR transistor. The receiver detects the invisible light produced by the IR transmitter and then sends a signal to the stair light controller. The wire leads are 10 inches long; this is long enough to connect the IR Receiver to a wire that runs to the controller. Each IR Receiver includes 3 crimp connectors for this purpose.

1. **Prepare the cable.** Cut a section of cable to 10 inches. Strip the end off the cable exposing the 4 conductors inside.



2. **Remove extra conductors.** We require all but the green conductor. Cut the green wire out as close to the jacket as possible.



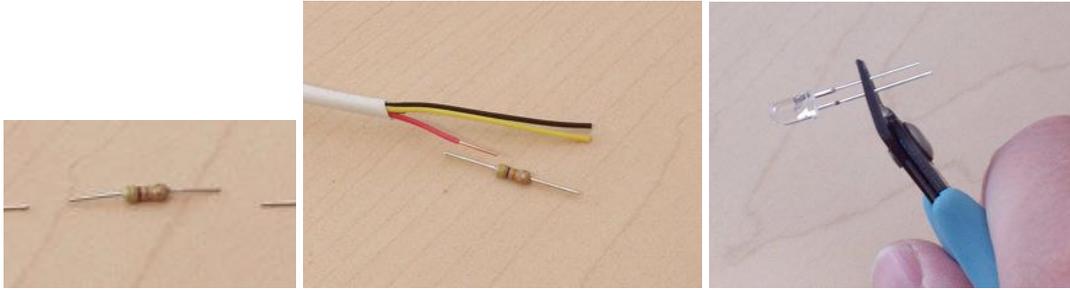
3. **Trim components.** Trim the resistor as shown and place it beside the red wire so that the red wire can be cut and stripped to match the left lead of the resistor. Clip the IR receiver's leads as shown.

The resistor used has a value of 47K ohms.

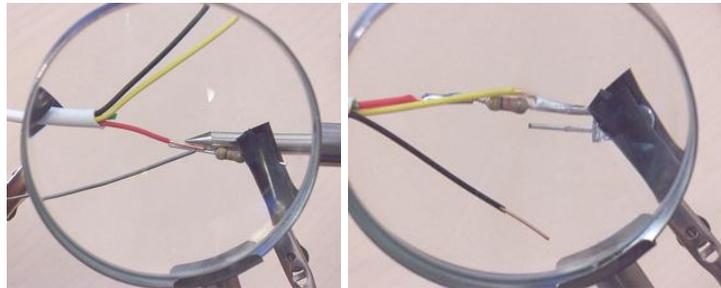
The value of the resistor is represented by colored bands on the resistor.

*47K ohms is YELLOW VIOLET ORANGE GOLD.*

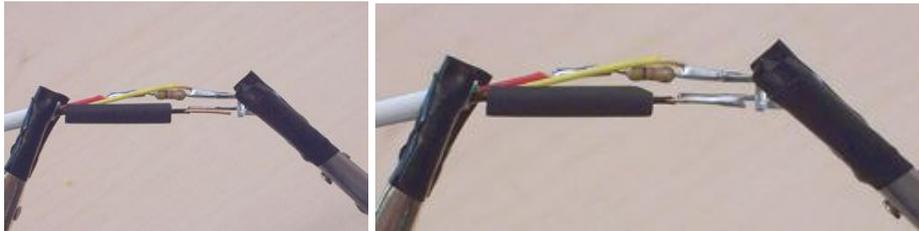
## Stair Lights Installation Guide



- 4. Solder the resistor.** Hold the resistor in place while soldering the red wire to it. Next attach the other side of the resistor and the yellow wire to the collector of the IR Receiver, this side has a flat spot on it to easily identify it. Remember not to apply too much heat, read the caution.



- 5. Connect the negative wire.** Slide the black heat shrink over the black wire, solder the black wire to the IR Receiver.



- 6. Install black heat shrink.** Slide the black heat shrink tight to the IR Receiver's body. Carefully heat the heat shrink using an appropriate heat source while making sure the IR Receiver does not get hot (read the caution again)! Once the heat shrink is in place there should be no exposed wire on the black side.

## Stair Lights Installation Guide



- 7. Install blue heat shrink.** To protect all of your hard work slide the blue heat shrink over the resistors and the exposed wires. Carefully heat the heat shrink using an appropriate heat source.



- 8. Prepare the wire connection end.** Strip the end and remove the wires that are not being used; only keep the black, red and yellow wires. Then strip the ends of the black and red wires and you are done!



### 3. Testing a Control Unit

Once the board has been constructed it is a good idea to fully test it before you start on the field wiring. Follow the following steps and ensure you get the correct results. These steps are assuming that you have just completed all of the steps in the Control Board Assembly section. During the testing it is very important to ensure you are working on a non metallic surface with no metal particles on it (no resistor clippings etc). It is also important that no wires are connected or removed while the unit has power attached. To power down the control unit unplug the wall transformer and consider the circuit dead 10 seconds after the power on indicator goes out.

## Stair Lights Installation Guide

To use this table perform the task in the “Do This” column, check to see that you get the expected result that is listed in the “Check Results” column. If you do not get the expected result the “Solution” column will provide some ideas of what the problem could be.

Do This	Check Results	Solution
<ul style="list-style-type: none"> <li>Start with nothing connected to the terminal block.</li> </ul>	N/A	N/A
<ul style="list-style-type: none"> <li>Connect the power supply wires to the unit. See the connecting power section for directions on how to do this.</li> <li>Plug in the wall transformer. (Power up)</li> </ul>	Green power on light should turn on.	<ul style="list-style-type: none"> <li>Reverse the power wires at terminal 1 and 2.</li> <li>Ensure the fuse element is not blown.</li> <li>Check to see that D1, D2, U2 are installed with the correct orientation.</li> </ul>
<ul style="list-style-type: none"> <li>Power down.</li> <li>Connect a wire from terminal 5 to terminal 24.</li> <li>Connect a wire from terminal 6 to terminal 7.</li> <li>Connect a wire from terminal 6 to terminal 8.</li> <li>Power up.</li> </ul>	Using a stair light as a voltage tester check to see if all of the stair outputs have power. Look at the Stair Light External Connections for the connection locations. Once you are done 10 Outputs will have been tested and terminals 9 through 23 would have been used.	<ul style="list-style-type: none"> <li>If any of the outputs do not have any power check the Stair Lighting Control Board schematic to see what transistor and resistor are connected to the bad output. Check the solder joints on these components.</li> <li>If output terminal 11, 14, 17, 20 and 23 are not functioning ensure terminal 7 has no poor solder joints, trace this all the way back to the chip pin.</li> <li>If output terminal 9, 12, 15, 18 and 21 are not functioning ensure terminal 8 has no poor solder joints, trace this all the way back to the chip pin.</li> </ul>

## Stair Lights Installation Guide

Do This	Check Results	Solution
<ul style="list-style-type: none"> <li>• Power down.</li> <li>• Remove the wire from terminal 7 to terminal 6.</li> <li>• Connect a wire from 7 to terminal 5.</li> <li>• Power up.</li> </ul>	<p>Using a stair light as a voltage tester check to see which stair outputs have power. Look at the Stair Light External Connections for the connection locations. Once you are done 10 Outputs will have been tested and terminals 9 through 23 would have been used. The only outputs that should be powered are terminals 9, 12, 15, 18 and 21.</p>	<p>Ensure terminal 7 has no poor solder joints, trace this all the way back to the chip pin.</p>
<ul style="list-style-type: none"> <li>• Power down.</li> <li>• Remove the wire from terminal 7 to terminal 5.</li> <li>• Connect a wire from 7 to terminal 6.</li> <li>• Remove the wire from terminal 8 to terminal 6.</li> <li>• Connect a wire from 8 to terminal 5.</li> <li>• Power up.</li> </ul>	<p>Using a stair light as a voltage tester check to see which stair outputs have power. Look at the Stair Light External Connections for the connection locations. Once you are done 10 Outputs will have been tested and terminals 9 through 23 would have been used. The only outputs that should be powered are terminals 11, 14, 17, 20 and 23.</p>	<p>Ensure terminal 8 has no poor solder joints, trace this all the way back to the chip pin.</p>
<ul style="list-style-type: none"> <li>• Power down.</li> <li>• Connect a stair light to terminals 3 and 4. Red to terminal 3 and black to terminal 4.</li> <li>• Power up.</li> </ul>	<p>Check to see that the stair light is dimly flickering; you might have to turn off the lights in the room to see that it is flickering.</p>	<p>Check the Q1, R2 and pin 2 of the chip for poor solder joints.</p>
<ul style="list-style-type: none"> <li>• Power down.</li> <li>• Remove all wires from all of the terminal blocks.</li> <li>• Testing is complete.</li> </ul>	<p>N/A</p>	<p>N/A</p>

## 4. Field Wiring

The next step is to mount the Stair Lighting control module in a suitable location and connect the field devices to it. You will need wire strippers, pliers, a few screw drivers (small flat blade and a #6 Robertson), some silicone, a drill and a ¼ inch drill bit. Some additional tools may be required if a wire needs to be fished into a location.

### 4.1 Mount Lighting Control Unit

The control module should be installed close to the stair lights and an electrical outlet for the plug in power supply. If there is no optimal location mount the control unit closer to the stairs and extend the wiring from the plug in power supply. Mount the control unit using the standoffs and screw provided in the kit to a solid surface such as plywood (mounting holes are predrilled in the circuit board).

### 4.2 Connect Power

*Note: This control unit only accepts power supplies that output 9 Volts DC to 12 Volts DC. The power supply must also have a current rating of at least 500mA (0.5A). These ratings MUST be met, these are not just recommendations.*

Power can be connected to the control unit, keep the power supply unplugged from the wall outlet when connecting it. Only apply power when required, never wire anything to the control unit with power applied! If the plug in power supply has a connector at the end instead of the required wire ends simply cut off the connector and strip the wires. The control unit accepts only standard wire connections. Since the power input is DC, polarity matters. Positive gets connected to terminal 1 and negative gets connected to terminal 2. The control unit does have reverse voltage protection so accidentally reversing the power input will not cause any damage. The board has a power on indicator that will light when power is applied.

### 4.3 Install Stair Lights

Determine the optimal location for mounting the stair lights. A stair light can be temporarily powered up by connecting it to the control unit's terminals 5 and 6. Connecting the stair light's black negative wire to terminal 6 and the red positive wire to 5 will cause it to light. The stair lights will operate from any 5 Volt power source, do not connect them to anything higher than this or damage will occur.

Once the correct location has been found, drill a 1/4 inch hole through the side of the stairs. Push the wires end of the stair lights through the holes and leave the lights hanging out a few inches, these will be mounted and aligned in a later step.

### 4.3.1 Wiring 10 or Less Stair Lights to Controller

If you are using the recommended 4 conductor wire. Start with the 2 lowest lights and connect them as shown in Appendix 11.2. Use the supplied crimp connectors to join the wires together. Simply push 2 wires into the connector and squeeze it with a pair of pliers.

1. Connect the lowest light's red wire to the 4 conductor's red wire
2. Connect the lower light's black wire to the 4 conductor's black wire
3. Connect the 2nd lowest light's red wire to the 4 conductor's yellow wire
4. Connect the 2nd lowest light's black wire to the 4 conductor's green wire.
5. On the control unit connect the red wire to terminal 9, the yellow wire to terminal 11 and the black and green wires to terminal 10. For each set of lights simply use the next 3 terminals in the same order.
6. Repeat step 1 through 5 with the next 2 sets of unconnected lights until all lights are tied into control unit.

### 4.3.1 Wiring 11 to 20 Stair Lights to Controller

The stair lighting control unit has 10 separate light outputs, each one can power two stair lights. You must determine which lights will be tied to a common output before you start wiring the lights to the control unit.

#### Example Scenarios

- If you have 11 lights you might want to connect stair light 1 through 5 on separate outputs, have 6 and 7 share a common output and 8 through 11 would also be on separate outputs.
- If you have 14 steps you could tie the first 2 steps together, the next two steps together. Then the same with the last 4 steps. This would mean that these 4 steps would be tied to 2 controller outputs and the remaining lights between these ones would be tied to separate outputs.

When connecting 2 lights to one output you will connect both red wires together and both black wires together. Now you can follow the same steps listed in the "Wiring 10 or Less Stair Lights" to connect these to the control unit.

## 4.4 Install Infrared Beams

The Stair Lighting unit uses IR (infrared) beams to detect a person or animal entering the stairs allowing the control unit to sense when the lights should be turned on. IR will produce an invisible beam, if a visible laser beam is desired please read section 9.1 for instructions.

There are 2 types of IR modules that will be used, a transmitter and receiver. These will act together to create one beam that the control unit can monitor. A pair at the top and a pair at the bottom of the stairs will be connected to the lighting control unit to provide proper detection.

### 4.4.1 Determine IR Beam Location

When determining the best location of the beam you must consider the height that will detect everything that must trip the beam. For example we might have no problem breaking a beam that is 3 feet off the ground however your cat or dog may not break it.

After the correct beam location has been determined you must determine which side of the beam will get the least ambient light. Strong sunlight or very bright indoor lights can interfere with the normal operation of the beam. You want to put the transmitter (red heat shrink) in the brighter of the 2 locations and the receiver (blue heat shrink) in the dark location. There are 2 small sections of white heat shrink that can be installed on the receiver if ambient light is a problem. This will prevent light from entering the receive module from the side.

### 4.4.2 Install IR Beams

Drill a 1/4 inch hole in the desired location and push the IR beam sensor wires through the wall leaving the module hanging out a few inches. These will be aligned and installed in the next section.

### 4.4.3 Wiring IR Beam Sensors to Controller

#### Wiring the IR Transmitter

The IR transmitter has 2 wires, red and black. Both of the IR transmitters get connected to the same location. Use the supplied wire connectors to extend the red and black wires to the control panel. Connect both red wires to terminal 3, and both black wires to terminal 4. See the Appendix 11.2 diagram.

*CAUTION: These IR transmitters emit light that is invisible to us. It is very important that this is only ever connected to IR transmitter output; connecting it to any other power source will damage the IR transmitter.*

#### Wiring the IR Receiver

The IR receiver has 3 wires, red, black and yellow. Use the supplied wire connectors to extend the red, black and yellow wires to the control panel. Connect both red wires to terminal 5, both black wires to terminal 6. These red and black wires provide power to the units. Next connect the sensor output to the control unit. The yellow wire of the bottom IR receiver gets connected to terminal 7. The yellow wire of the top IR receiver gets connected to terminal 8. See the Appendix 11.2 diagram.

## 5. System Setup and Testing

The system has a setup mode that is used to initially align the beams and stair lights during final placement. This mode can also be used for testing to make sure everything is set up correctly.

### **5.1 Entering Setup Mode**

A wire that is approximately 6 inches will be needed to put the system into setup mode.

- Power the unit down.
- Connect the wire from terminal 5 to terminal 24.
- Power the unit up.
- System is now in setup mode.

### **5.2 IR Beam Alignment**

In the setup mode you will have visual confirmation from the stair lights while aligning the beams. This procedure requires at least 2 stair lights be connected to the control unit. If you are only controlling one light you will have to install a second light to get the correct visual indication.

With the control unit in setup mode for the first time all of the stair lights are probably off. This indicates that the both the top and bottom beams are not aligned. Starting with the top beam use a small amount of silicone with a color of your choice to mount the receiver. The receiver is the one with blue heat shrink; align by pointing in the direction of the transmitter. Next mount the transmitter; this is the one with red heat shrink. Once a beam is aligned some stair lights will turn on indicating that the beam is good, for the top beam the stair lights that are connected to terminal 9, 12, 15, 18, and 21 will light. Once the beam is aligned it is now time to fine tune them. Starting with the transmitter adjust it right and left noting the outer limits of where the receiver can detect the beam. The same procedure is used to find the outer limits when moving the transmitter up and down. Once we know the outer limits in both directions the final position we want is in the middle of both of these outer limits. Next do the same procedure for the receiver. This beam should be functioning correctly now, when something passes between the beam the associated stair lights should turn off then immediately turn back on when the obstacle is removed.

Next the bottom beam will be aligned using the same procedure that was used to align the top beam. The successful completion of this step should have all the stair lights on.

### **5.3 Stair Light Alignment**

After aligning the IR beams as described in 5.2 all of the stair lights should now be on. Use a small amount of silicone to mount the stair light, adjust until the beam is at the desired location on the step.

### **5.4 System Testing**

Now that the beams are mounted / aligned and the stair lights are now mounted in the correct locations you can now take the control unit out of setup mode and test the operation of the system. The following steps are used to take the system out of setup mode.

- Power the unit down.
- Remove the wire from terminal 5 and terminal 24.

## Stair Lights Installation Guide

- Power the unit up.
- System is now in run mode (this is the normal operating mode).

Once a beam is broken (interrupted) the lights will ramp on together. If the time delay has not been modified the lights will stay on for 20 seconds. After the time delay the light outputs will fade off one by one in the direction the person was walking. For example if the person is walking up the stairs they will break the bottom beam as they enter the stairs. This will cause the lights to turn on. After the time delay the lights will fade off one at a time starting with the lower stairs working their way up until all the lights are back off. This works in the opposite fashion if the top beam was broken to activate the lights.

Once both beams have been activated and the lights turn on and off correctly you are done. The installation is now complete!

## 6. Programming Light On Duration

It is possible to change the on time of the lights. The default time that is preprogrammed into the control units is 20 seconds. If you want more or less time you can use the following steps to adjust the time.

### 6.1 Entering Program Mode

Use the following steps to put the unit into program mode.

- Power the system down.
- Cover the top and bottom IR transmitter, a flap of paper works well. Anything that will prevent the receiver from seeing the IR light will do.
- Power up the system.

### 6.2 Reading Program Mode On Time Code

Once in program mode all of the stair lights will flash a pattern representing the current time setting. For example the default on time of 20 seconds is a program code of 3, this is represented by 3 half second flashes followed by a 1.5 second pause. There are 5 codes that are possible to be programmed depending on your on time requirements. When this code is changed it is stored in EEPROM memory, this means that it will remain even if power is lost.

Flash Code	Represented On Time
1	5 Seconds
2	10 Seconds
3	20 Seconds
4	30 Seconds
5	100 Seconds

### **6.3 Changing the Program Mode On Time Code**

Based on the table shown in section 5.2 select the time you desire and adjust the code by allowing the top IR beam to activate the beam receiver. This will cause the lights to perform a multi flash to indicate your input was registered. The code will now be advanced to the next code. Read the flash code using the procedure in section 6.2. When you advance past code 5 the system will cycle back to code 1.

Once you the system is flashing the code of the time you desire perform the following steps to put the system back to normal using the new on time.

- Power the system down.
- Remove the obstruction from the top and bottom IR transmitter.
- Power up the system.

## **7. Maintenance**

Any dust accumulation on the Stair Light Control Unit circuit board should be blown off. Canned compressed air (such as “Dust Off”) works well for this purpose and is available at any computer store. We recommend powering down the controller during cleaning.

Stair lights can be cleaned with a cotton swab moistened with water.

IR beam detectors and transmitters can be gently cleaned with a dry cotton swab. Cleaning of these should be done with care; too much force could misalign the beam.

## **8. Troubleshooting**

<b>Problem</b>	<b>Solution</b>
Stair Light Control Unit will not power up. (power on light is not on)	<ul style="list-style-type: none"><li>• Confirm transformer is plugged in and wired to the correct terminals on the circuit board.</li><li>• Check 1 amp fuse, replace if element is melted.</li><li>• On self built kits, check that component location, type and orientation is exactly as shown on assembly diagram</li><li>• Check the polarity of the power wires at terminal 1 and 2, reversing will not harm the unit (it has built in protection for that). Terminal 1 should be positive and 2 should be negative.</li></ul>

## Stair Lights Installation Guide

<b>Problem</b>	<b>Solution</b>
Stair Light Control Unit will not go into setup mode.	<ul style="list-style-type: none"> <li>• Set up jumper must be installed from terminal 5 to terminal 24.</li> <li>• On self built kits check that component location, type and orientation is exactly as shown on assembly diagram</li> <li>• Check wiring from Stair Lights, IR transmitters and IR detectors to circuit board terminal block. Wiring must be exactly as shown on wiring diagram. These components will not operate if polarity is reversed.</li> </ul>
Stair Light Control Unit will not go into program mode.	<ul style="list-style-type: none"> <li>• Set up jumper must not be installed (terminals 5 &amp; 24)</li> <li>• Ensure the beam receivers are being covered incase there is an excessively bright light source that is interfering with the beams operation.</li> <li>• Ensure the beams are operating as they should be. Put the unit into setup mode and test them, see the System Setup and Testing section.</li> </ul>
One or more Stair Lights fail to operate or operate out of sequence.	<ul style="list-style-type: none"> <li>• Check wiring from Stair Lights to terminal block. Confirm correct order and polarity as per wiring diagram.</li> <li>• Check connection at wire connectors by gently trying to pull out wire (wire should be tight).</li> <li>• Confirm Stair Light is not defective by connecting wires to the terminals of a working Stair Light.</li> <li>• On self build kits, check that component location, type and orientation is exactly as shown on assembly diagram.</li> </ul>
Stair Light Control Unit was working and stopped or does not work during the day.	<ul style="list-style-type: none"> <li>• Excessively bright light shining directly on IR receiver can impair it's ability to monitor the IR light from the beam transmitter. Remove any bright sources of light to see if this is the problem. Install the shade tubes that came with the IR detectors and realign if ambient light intensity is the problem, see the Install Infrared Beams section.</li> </ul> <p><i>Note: As mentioned in the manual the detector must be located on the darkest side of the two sensors.</i></p>
The stair lights are "ON" continuously.	<ul style="list-style-type: none"> <li>• IR detector is blocked.</li> <li>• IR detector is dirty (see cleaning IR detector in maintenance section).</li> <li>• IR detector is out of alignment (see the Install Infrared Beams section).</li> <li>• Check connections to the Control Unit terminal blocks for the beams; ensure the beam wire connections are tight.</li> </ul>

## 9. Optional System Features

These features are optional; the system will be fully functional without doing any of these. They are available to provide some additional functionality that may be desired.

### 9.1 Installing Laser Beams

To convert the IR beam to a laser beam you will need 2 laser pointers, drill, drill bits, soldering iron, and adequate mounting hardware. Two 100 ohm resistors are also required, these are included in the kit.

This stair light kit can be used with the included invisible IR (Infra Red) beams or optionally visible laser beams can be used. Instead of installing a IR transmitter a laser beam will be used. The IR beam detector will still be used since it can also detect laser light. The easiest and cheapest way to acquire an adequate laser is from an inexpensive laser pointer. We need to power the lasers from the control unit instead of using the batteries that they come with.

1. Remove the back screw cap and take the batteries out.
2. Notice the small spring inside the laser pointer that the batteries came in contact with, this is negative.
3. Connect a wire to the negative battery spring mentioned in the above step. This can be done by drilling a hole in the body of the pointer in the right location so that a soldering iron could be used to solder a wire to the spring. A black wire should be used to identify it as negative.
4. Scuff the body of the laser pointer in a desired spot to connect the positive lead. Scuffing the metal is normally required to allow the solder to a surface it can bite onto. The wire soldered to the body should be red to identify it as positive.
5. Connect the 100 ohm resistor. This can be added to the positive wire or the negative wire, which ever is easier. For example if the negative wire is selected the one end of the resistor (doesn't matter which end) will be soldered directly to the black wire coming out of the laser pointer. The other end of the resistor will then be used as the negative connection when powering the laser pointer. This resistor is very important, it serves 2 purposes. The first is to allow the laser to operate at a higher voltage than it was meant for. The three batteries usually provide the laser pointer with 4.5 Volts; we are going to be powering it from a 5 Volt source. The second is purpose is to reduce the intensity of the laser; we want it to be visible but not as intense as it usually is. Normally the current draw of the laser is about 28mA, we are going to be giving it approximately 17mA.
6. Mount the laser units. Find a suitable location for the lasers, beside a wall stud is a good choice. Something will be needed to hold the unit firmly in place but still allow adjustment. A simple L bracket could be used, using screws that are undersized for the bracket holes could allow bracket adjustment. A hole will be needed to allow the laser to travel across the detection area to the beam receiver.
7. To power the units run the red wires from both laser units to terminal 5 of the control unit, run black wires from both laser units to terminal 4 of the control unit. *Note: when making any terminal connections to the control unit disconnect*

## Stair Lights Installation Guide

*its power to avoid accidental wire shorting that can cause damage to the control unit.*

8. The laser beam units should now be powered. Align the beams so that they hit the beam receivers in the center. Breaking this beam will now operate the same as breaking an invisible IR beam.

### **9.2 Auxiliary Output**

There is an auxiliary output that sinks current to ground when the stair lights are active. This output is connected to the microcontroller at pin 3. This is physically located below R15 and R16. Using this auxiliary output requires care and some knowledge of electronics. Do not connect anything to this output if you don't realize the consequences of doing something wrong. This output provides a MAXIMUM of 20mA (0.02A) of sink current. To power a device you would connect the devices negative power input to the auxiliary power output and the devices positive power input to the lighting controllers positive power output point. The physical location of the positive and negative output points are beside C4. With the terminal block up the upper point is 5 Volts and the lower point is negative. See the Appendix 11.3 board diagram for the exact locations of these points. Now this device will be activated whenever the stair lights are active. Section 9.3 describes an example of something that can be connected to the auxiliary output.

### **9.3 Installing Piezo Buzzer**

Section 9.2 introduced the auxiliary output; powering a piezo buzzer is a practical use for it. A piezo buzzer is a device that makes noise when power is applied to it. There are 2 types of piezo buzzers, ones with an internal drive circuit and ones that require an external drive circuit. For use with this control unit a piezo buzzer with an internal drive circuit must be used. The Piezo must operate at 5 Volts and draw 20mA or less (less is better). An example of one with these specifications is the Radio Shack model 273-060. Connecting the positive piezo wire to 5 Volts beside C4 and the negative piezo wire to the auxiliary output is all that needs to be done. It is also possible to pad the volume of the piezo down using a current limiting resistor, calculate the required resistor value and install the jumper from the 5 Volt pin to the jumper location. Then connect the positive wire to the jumper location beside the resistor.

## **10. Stair Lighting Wire Calculation Guide**

The amount of cable needed to install a set of stair lights will vary for each installation. The number of stair that need to be lit and the location of the Stair Lighting Control Unit are the main factors. This guide will allow you to estimate how much wire you will need.

*Note: The word "Cable" is used to represent the 4 conductor wire that is available from the online store. A conductor is a single wire.*

### **Lighting Control Unit Location**

The control module should be installed in a location that is close to the stairs that it will be controlling the lights on. A plug should also be close so that the power supply can be

## Stair Lights Installation Guide

plugged in. If there is no optimal location is it preferable to mount the control unit close to the stairs and extend the two power supply wires.

### **Infrared Beam Location**

When determining the best location of the beam you must consider the height that will detect everything that must trip the beam. For example we might have no problem breaking a beam that is 3 feet off the ground however your cat or dog may not break it.

*Note: Breaking the beam means that something came between the transmitter and receiver.*

### **Individual Stair Light Locations**

A single stair light can light one step quite well; generally the light is mounted to one side of the step. Determine the location that the lights are to be installed.

### **Calculating Required Wire**

Now that we have an idea of where everything will be going all we have to do is measure the cable runs.

- Each IR (Infrared) transmitter and receiver will have a dedicated cable run back to the Lighting Control Unit. You need a transmitter and receiver at the top and bottom of the stairs. These devices will be mounted on opposite sides of the wall to make a beam that will detect someone entering the stairs.
- Each adjacent pair of stair lights requires one cable run back to the Lighting Control Unit. Each light requires 2 conductors; our cable has 4 conductors allowing 2 stair lights to be powered from one cable. When calculating the cable length measure to the farther of the 2 lights.
- If the power supply is being located further away from the Lighting Control Unit than its power cord you will have to extend the wires to reach. A single cable will be required from the power supply to the Lighting Control Unit.

### **Things to Keep In Mind**

When calculating your required wire distance make sure you have enough to properly route the wire. A straight point to point distance might not be the actual distance when the wire is being run. Leave yourself some slack, you do not want any of these wires tight, each end should have about 1 foot of extra wire. This extra slack eliminates any possible connector stress and also allow for a neat installation.

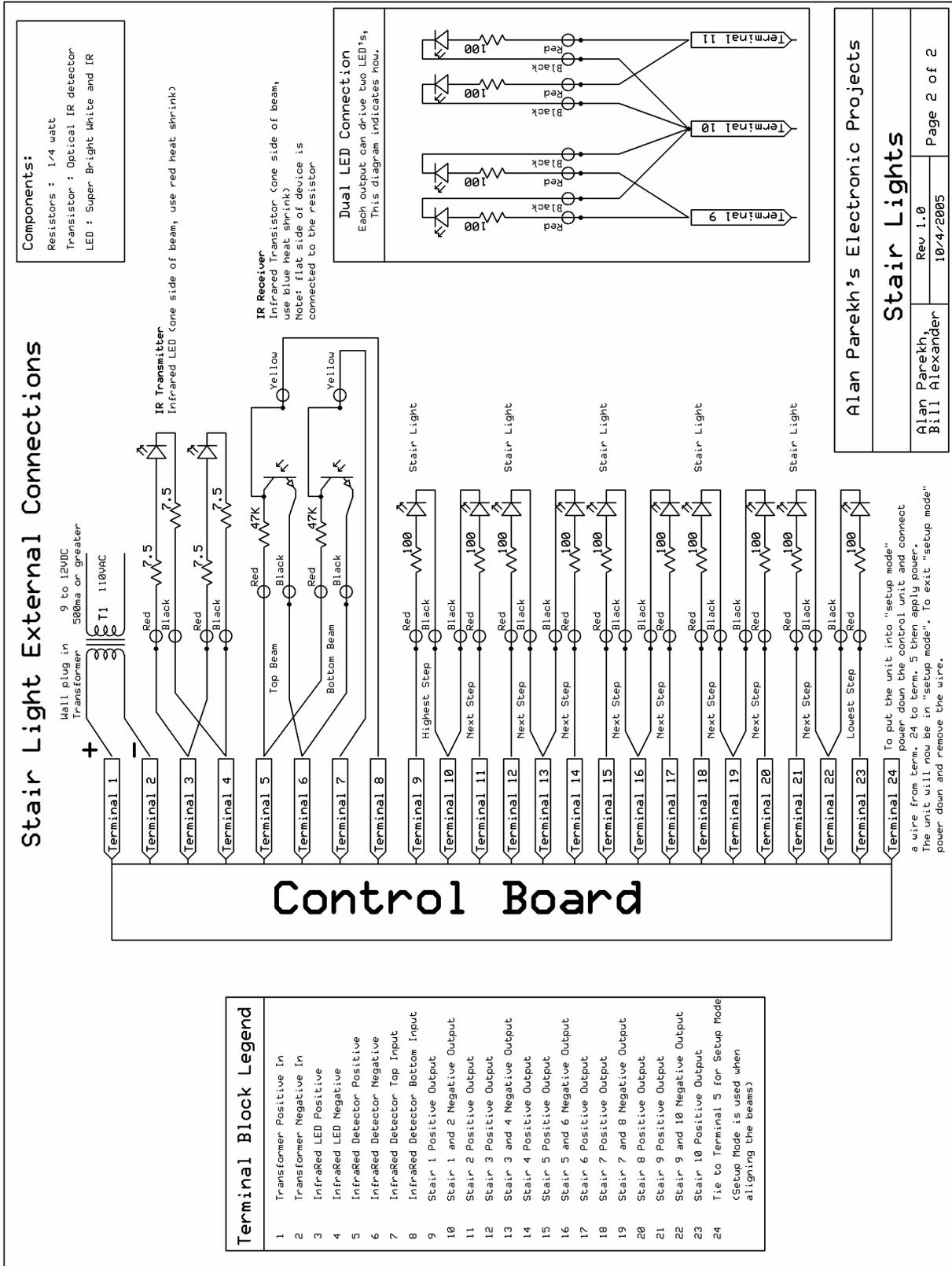
## Stair Lights Installation Guide

<b>Device Location</b>	<b>Cable Distance</b>
Top IR Transmitter	
Top IR Receiver	
Bottom IR Transmitter	
Bottom IR Receiver	
Power Supply Extension	
Stair 1 & 2	
Stair 3 & 4	
Stair 5 & 6	
Stair 7 & 8	
Stair 9 & 10	
Stair 11 & 12	
Stair 13 & 14	
Stair 15 & 16	
Stair 17 & 18	
Stair 19 & 20	
<b>Total Cable Required</b>	

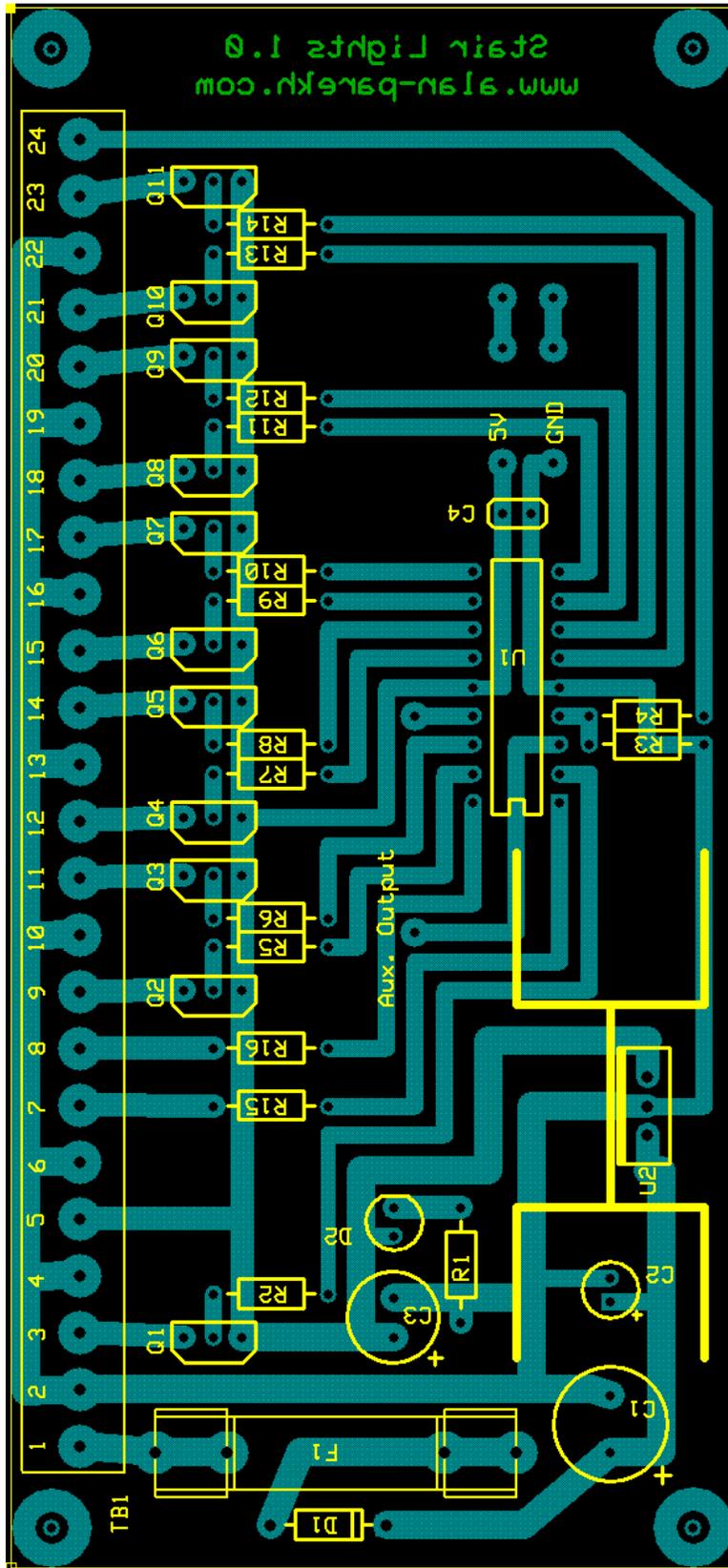
For more information about the cable check out the online store, there are pictures and a description.



## 11.2 Stair Light External Connections



### 11.3 Circuit Board Layout Diagram



**11.4 Circuit Board Component Photo**

