

Los Angeles Model Railroad Society

Wiring A Tortoise Switch Machine for the Mainline

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1 Introduction

You are starting a great adventure.

You will be well prepared if you first read these directions in their entirety.

If you use Stan's mount (see later), build the LED module described in Appendix 2.

Build the Power Module, Appendix 3, and then pre-wire the Tortoise connector with Power and Frog connections.

An alternate LED and Power Module are described in Appendices 4 and 5. These are for use with the Tortoise Remote Mount.

1.1 Let's Start

You are replacing an existing mainline switch machine whose electrical connections are proper, but whose mechanical elements are out-of-whack. A mainline machine has several characteristics:

1. It may be operated by a fascia-mounted push button
2. It is addressable by a DT400-402 using the address shown on the fascia
3. It is powered by an SE8C
4. It has a powered frog

Confirm that this is true.

Switch machines in the yard may be replaced by similar techniques, but at present, these machines are powered from a DC power supply. Here, the polarity of the DC to the machine is switched by a panel-mounted DPDT toggle switch. Not all frogs are power switched in yards.

1.1.1 Remove the Existing Switch Master Switch Machine

1.1.1.1 Switch Motor Power

Turn off Track power. Then identify and mark the power leads to the existing Switch Master (black cylinder) machine. These are the two leads (from the SE8C for mainline turnouts) that attach to solder terminals at the bottom of the motor from the SE8C. Usually, there are voltage-dropping resistors in series with one or both of the leads. These resistors are no longer needed.

1.1.1.2 Frog Power

Frog power comes from the stock rails of the turnout (the fixed outside rails). We are going to identify these leads and remove them from the existing motor.

The motor is supported from the layout by two screws, each passes through the motor and a plastic stud. Now, while holding the motor, detach it carefully from the layout. Three leads are still connected to micro-switches at the top of the motor. These leads are used to power the frog. Carefully de-solder or cut these leads at the terminals of the micro-switch. The motor and mounting hardware are no longer needed.

Identify and mark the two leads that from the stock rails, which power the frog, and the lead that goes to the frog itself. These were attached to the two micro-switches. Note, that one of these leads also is attached to the fascia LED. This branch to the LED is no longer needed.

2 Mechanical Mounting

2.1 Mechanical Mounting Options

Tortoise machines may be mounted by many methods and in various configurations. Specifically the voltage polarity (between Tortoise pins 1 and 8) to drive a Tortoise to the through, “t”, (or diverging) route is difficult for me to figure out at this stage of the installation. I play it loose and am prepared to swap the wires.

Similarly, I would not install the LED into the fascia until instructed in paragraph 3.9 (or else be prepared to swap wires here too)

Lastly, be prepared to swap the feed wires that power the frog.

2.2 Turnout Cranks

If new cranks are needed, use 0.032-inch piano wire (K & S part #1143) for the crank and 1/16-inch brass tubing (K & S part #501) for the tubing into which the crank passes vertically from the throw bar to the under-roadbed.

There is a metal form for shaping the crank. ASK FOR IT!

2.3 Mechanical Mounting

Mount the Tortoise machine and hand test it for smoothness of control by slowly moving the mechanism manually (see Tortoise instructions 800-6000, enclosed). I have also included the instructions for the Remote Tortoise Mount (800-6010). In any case, make sure that the points are centered when the Tortoise is in the middle of its throw. Stan has provided various mounting configurations and I have tried his retro-fit design. I can recommend it.

I have also devised an alternate to Stan’s concept that does not require a wooden block. This approach provides less throw than Stan’s because there is no block. Similarly, he throw is also less than the Tortoise-provided concept wherein the actuator rod passes through the roadbed.

I used this alternate during the installation of the four Tortoise machines at Joliet Junction and the throw was sufficient.

2.3.1 Notes for Ira’s Modification to Stan’s Mount

1. Center the points on the turnout. I use tooth picks or blue tape.

2. Bend the under-layout portion of the crank to the vertical. It should be about 1/8-inch below the sub-roadbed.
3. Check for smooth action of the crank
4. I cut the under-layout portion of the crank to about 1.25 inches from the tubing.
5. Build a shepherd's crook (see photo and diagram) from 0.039-inch piano wire (K & S part #497). The top of the crook should reach the top of the Tortoise when the Tortoise is centered in its throw. The top of the crook is about 1/2-inch forward of the lower part of the crook (see second photo). See the bending guide in Appendix 1, Tortoise Wire Bending Guide.
6. The hole above the bright screw needs to be opened with a #60 drill (0.040-inch). The fulcrum hole is just fine.
7. Start with the Tortoise fulcrum near its maximum throw adjustment.
8. Apply heavy duty foam double-sided tape to the top of the Tortoise (red piece in photo). If you clean the sub-roadbed first (sticky tape works well), then you can adjust the machine for best position. The tape allows you to manually or electrically power the Tortoise to test the throw.
9. Adjust the fulcrum as required.
10. Gently screw the Tortoise to the sub-roadbed, leaving the tape in place.
11. Affix the fulcrum with some Blue Tack (gray stuff in the photo) or other removable adhesive when finished.



2.3.2 Ira's Notes for Stan's Mount

Stan's mount is depicted in the following figures.

12. Center the points on the turnout. I use tooth picks or blue tape.
13. The Tortoise with its wooden block must be mounted with the long center line of the block in line with the crank wire that is under the layout. Two positions, each 180° apart satisfy this criterion: one with the crank going into the block and the other away. This affords the flexibility to avoid existing wires and nearby turnouts.
14. You may have to cut down the block to fit tight situations. I had to.



15. Use existing crank, but you may need to cut its length.
16. Use the three existing installations as guides for the position of the shepherd's crook from the crank pivot.
17. Start with the Tortoise fulcrum at its mid-point adjustment.
18. Affix the fulcrum with some Blue Tack or other removable adhesive when finished.

2.3.3 Ira's Notes for the Remote Tortoise Mount:

1. Completely remove the existing crank and 1/16-inch brass tubing.
2. Use a long piece of brass tubing—one that extends about one-inch below the underside of the top. This makes it easier to locate the remote head assembly.
3. Cut a new piece of tubing so it is slightly below the tie tops and extends approximately 1/8 inch below the top. We want the crank to be as close to the tie tops as possible. FYI, I had to cut the tubing to 1.0625" for the Baldwin area.
4. Use 0.032" piano wire, not the 0.025" provided in the kit.

3 Power the Tortoise

3.1 Important Note for Connecting to Tortoise

No leads shall be soldered directly to the Tortoise. Rather, solder to the 8-pin female connectors provided by the club.

All connections to the 8-pin Tortoise connector should be covered with heat shrink to protect the mechanical integrity of the pins.

3.2 Wire Gauge

All wiring shall be 22 gauge stranded wire. I believe that heavier wire needlessly strain the mounting pins.

I use three feet of wire for each lead when I pre-build the wiring harnesses and LED and Power modules. I then cut leads in place. You may want to inspect your site to ascertain a good starting length. Longer is better because I would rather cut than de-solder and re-solder.

3.3 Mark One Side of the Tortoise and Connector

The connector has no key. It can be connected in each of two ways. Therefore place the connector on the machine and mark one side of each with a Sharpie so that reconnection is repeatable. If possible, pick the side that will be visible after installation.

3.4 Pin Numbering

Hold the Tortoise with the connector pointing down and the Tortoise mechanism arm facing you. Pins are numbered 1-8, from left to right.

3.5 Wire Colors

Wiring is color coded as follows (if colored wire is not available use white wire and mark each end of each wire with a Sharpie of proper color).

Pin	Lead Color	Function
1:	Yellow	Power from SE8C
2:	Red	Stock Rail "A"
3:	Black	Stock Rail "B"
4:	Orange	Frog
5:	Orange (normally not used)	Frog
6:	Black (normally not used)	Stock Rail "B"
7:	Red (normally not used)	Stock Rail "A"
8:	Blue	Power from SE8C

3.6 Bring Power from SE8C to Tortoise

Connect Tortoise Pins 1 and 8 to power from the SE8C. Again, verify that all voltage-dropping resistors have been removed.

The Tortoise may be tested by repeatedly pressing the push button. The voltage across the Tortoise should be approximately 10 VDC.

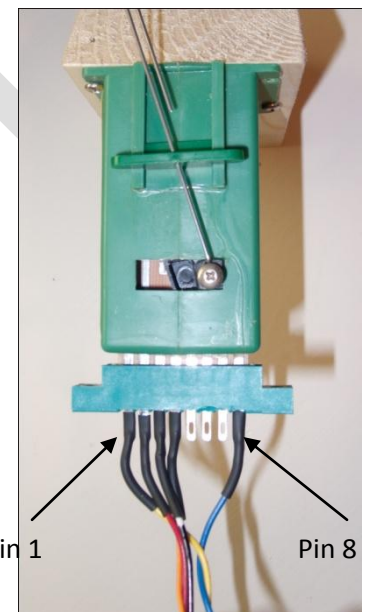
3.7 Test the Pin 1 and 8 Polarity

This is really important!

Now switch the turnout using a DT400. First send the "c" command. The turnout should be set for the through path.

Next, send the thrown, "t", command. The turnout should be set for the diverging route.

If this not the case, then reverse SE8C leads to pins 1 and 8 at the European connector of the Power Module.



3.8 LED Module

3.8.1 Insert the Pre-Built LED Module (Appendix 2) across the SE8C

The LED module is inserted (schematically) across the SE8C; it is physically connected to the Power Module.

This module provides maximum voltage to the Tortoise.

The installer will note that one LED lights when the turnout is set for mainline and the other lights when the turnout is set for diverging.

Now, the voltage across the Tortoise will be of the order of 10 VDC.

3.8.2 Insert the Pre-Built Alternate LED Module (Appendix 4) into either Power Lead

The LED module may be inserted into either the pin 1 or the pin 8 lead. This is at the installer's convenience. This module implicitly monitors the current through the Tortoise motor

The installer will note that one LED lights when the turnout is set for mainline and the other lights when the turnout is set for diverging.

Now, the voltage across the Tortoise will be of the order of 6VDC, which may be insufficient for full throw of the points (depending on overall lead length and SE8C performance).

3.9 Installation of LED into Fascia

Insert the LED that lights for the diverging route into the fascia. Carefully tuck the other LED back from the back side of the fascia so it may be seen from underneath the layout to confirm that power is reaching the Tortoise from the SE8C.

3.10 Wire the Frog

3.10.1 Powered Frogs

All mainline frogs are powered at LAMRS. Frogs from heritage DC days might be quite long—say one foot. Recently built turnouts may have very short frogs, only an inch. In all instances, the frogs are powered.

Frog power comes from the stock rails of the turnout (the fixed outside rails). By wiring from these rails we are assured that we are not causing problems with the PM42 gaps.

The frog must receive track power from either the "A" rail or the "B" rail depending upon how the turnout is thrown. The stock rails provide the "A" and "B" rail sources. The frog is switched from one to the other by a switch that is built right in the Tortoise machine. In fact, the Tortoise has two such switches. Pins 2, 3, and 4 form one and pins 5, 6, and 7 the other.

3.10.2 Wiring Protocol

The frog and power are normally wired to terminals 2, 3, and 4.

At times, when one Tortoise and one Switch Master are used for a crossover, the installer will also use Terminals 5, 6, and 7, to power the second frog, if necessary. In this situation the Tortoise powers both frogs, leaving the Switch Master for motive power alone. Note that the Switch Master and the Tortoise are powered from the same SE8C, but only the Switch Master will have resistors in its circuitry.

I have found that some Switch Masters have had their resistors removed. This will make difficult the implementation of an LED that indicates the diverging route.

I recommend that any Switch Master have a 330-ohm, ½ watt resistor in series, with the combination across the SE8C.

This is important!

The frog itself must be connected to either terminal 4 or to terminal 5! These are the output terminals.

The other two terminals (2 and 3 or 6 and 7) provide power from the stock rails of the turnout. These are switched by the Tortoise.

3.11 Check the Frog Wiring

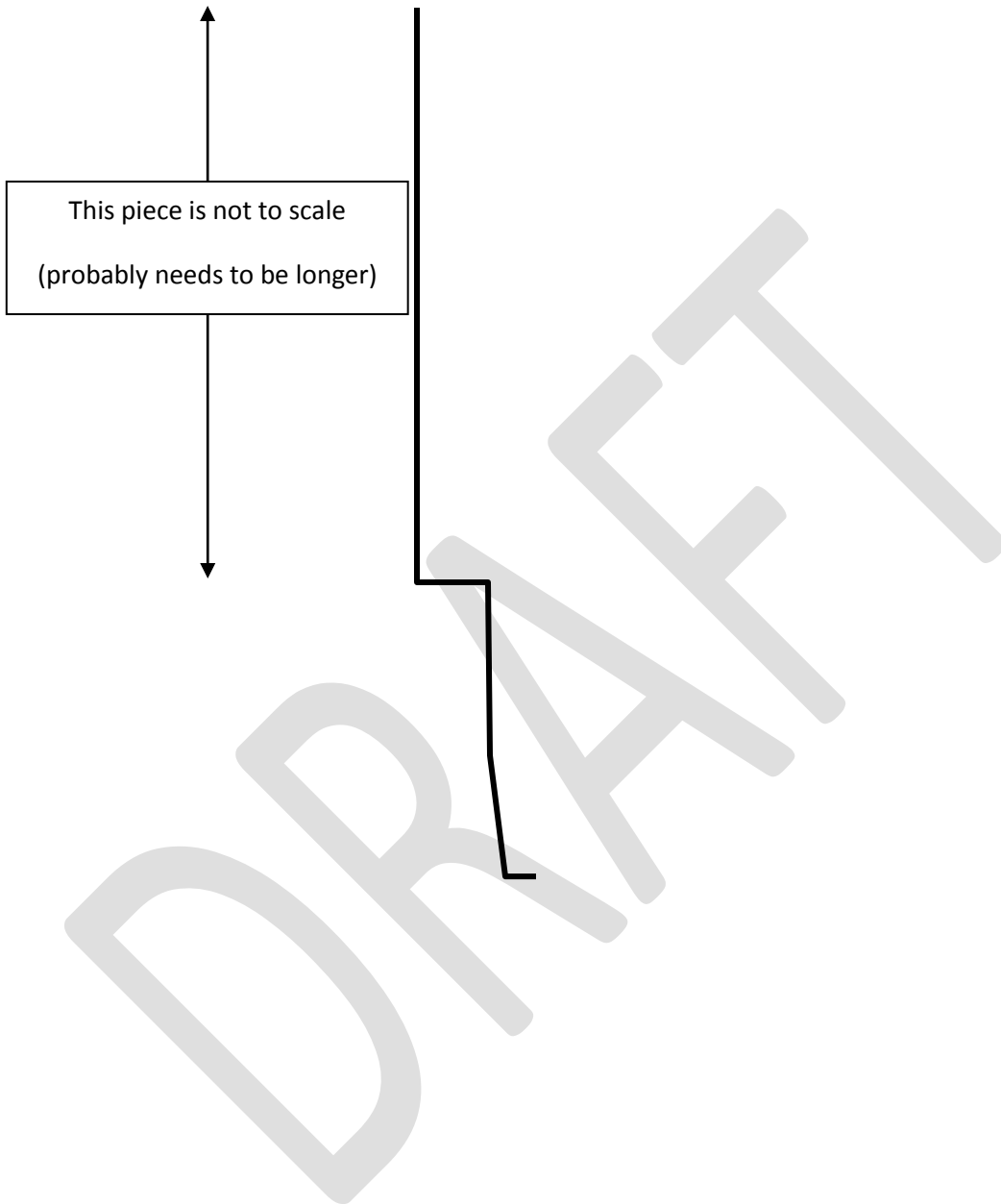
3.11.1 Ramp Meter Testing

1. Turn the Ramp Meter to *ON*. Test it on known working track.
2. Set the turnout to the closed, “c”, position. The turnout will be set for the main. Then use the Ramp Meter to measure voltage between the frog and the fixed outer rail for that path. It should indicate DCC voltage.
3. *Do not switch the machine.*
4. Next, measure voltage between the frog and the fixed rail for the through, “t”, position. There should be no reading.
5. Set the turnout to the through, “t”, position. The turnout will be set for diverging. Then use the Ramp Meter to measure voltage between the frog and the fixed outer rail for that path. It should indicate DCC voltage.
6. *Do not switch the machine.*
7. Finally, measure voltage between the frog and the fixed rail for the closed, “c”, position. There should be no reading.

3.12 Final Test

Finally, run some locomotives and cars through the turnout. Use all possible paths.

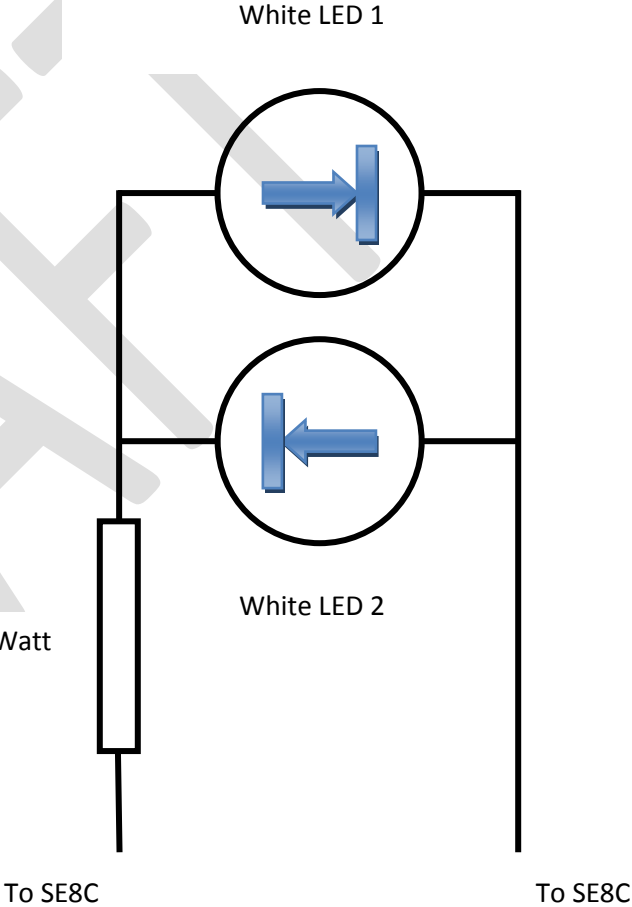
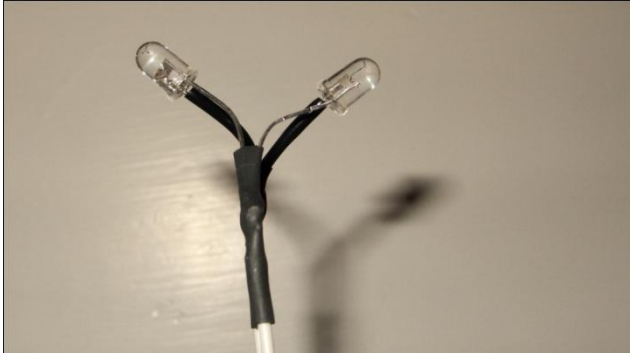
Appendix 1, Tortoise Wire Bending Guide



Appendix 2, Primary LED Module

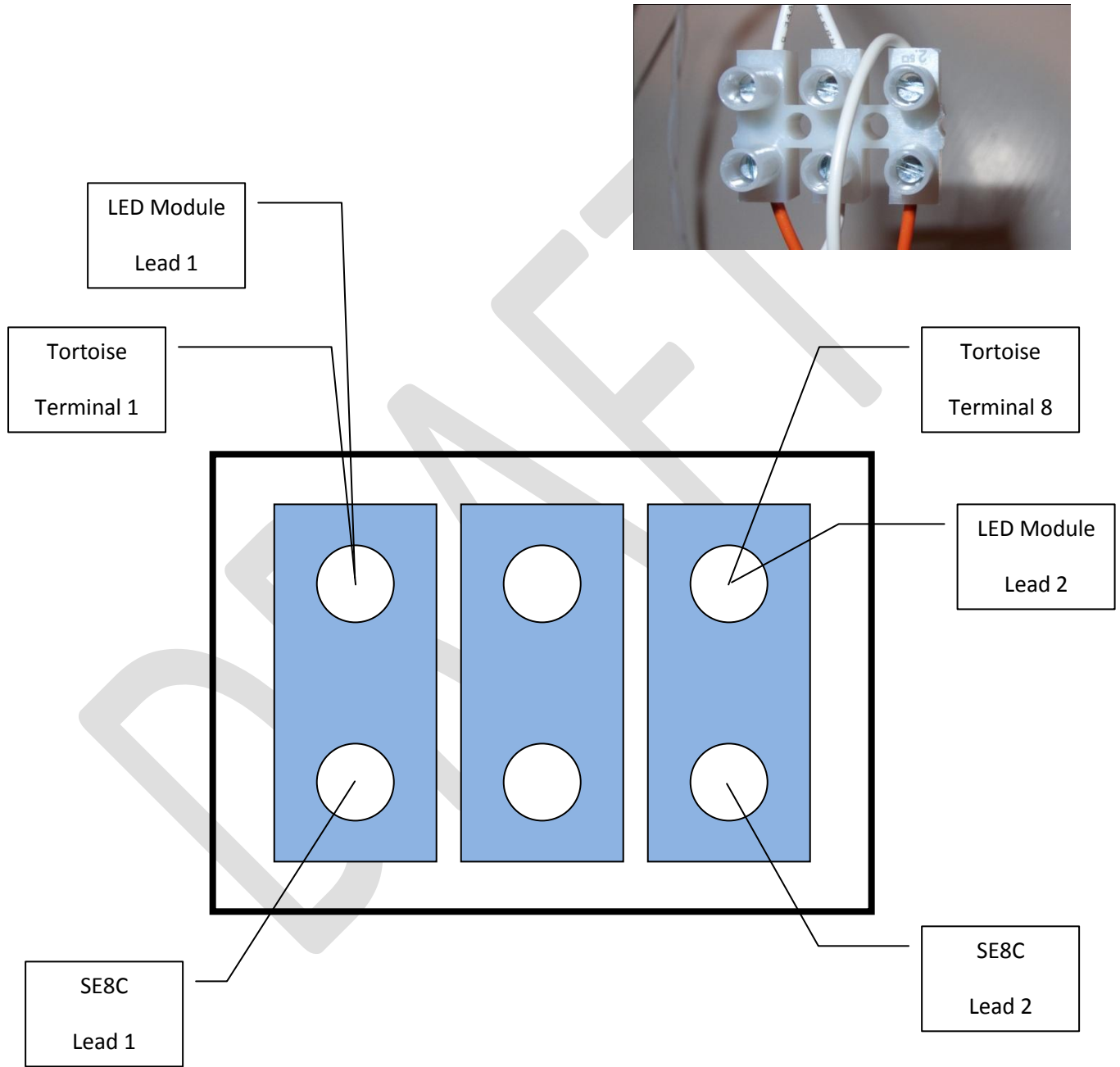
These are the photo and diagram for wiring the LED pair. I used Radio Shack 5mm High Brightness White LEDs, P/N: 276-0017. These come in packages of 2

Make sure that one side of the assembly is insulated with spaghetti or shrink wrap (see photo).



Appendix 3, Power Module

These are the photo and wiring diagram for powering the Tortoise.

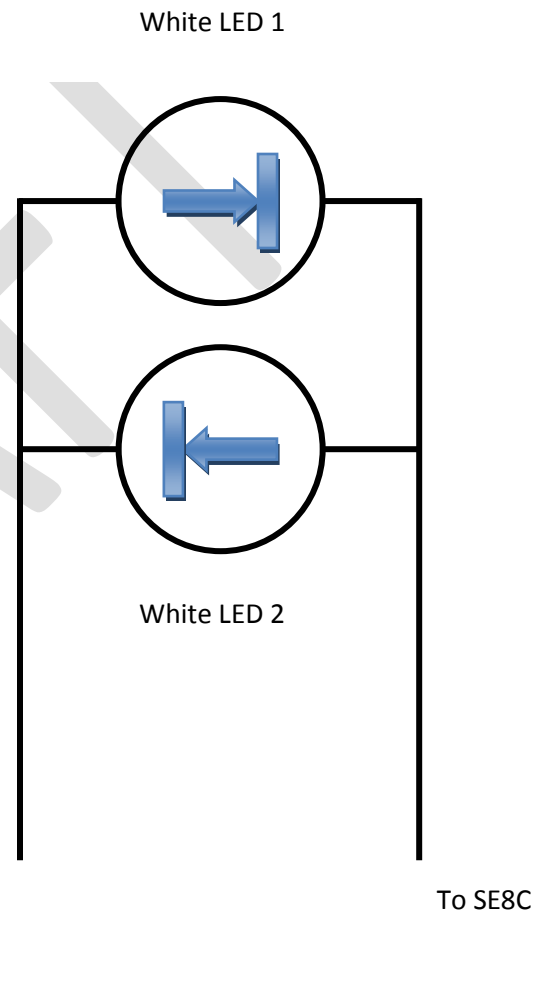
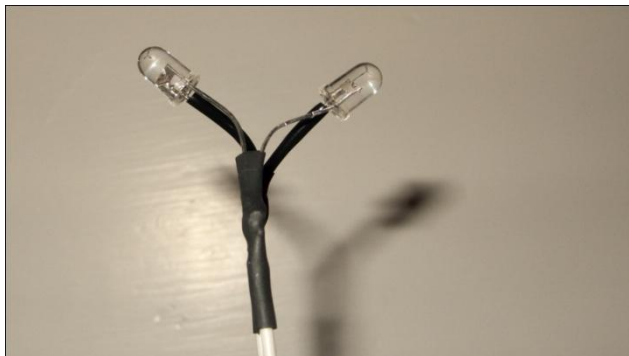


Three Section Terminal Block

Appendix 4, Alternate LED Module

These are the photo and diagram for wiring the LED pair. I used Radio Shack 5mm High Brightness White LEDs, P/N: 276-0017. These come in packages of 2

Make sure that one side of the assembly is insulated with spaghetti or shrink wrap (see photo).



Appendix 5, Alternate Power Module

