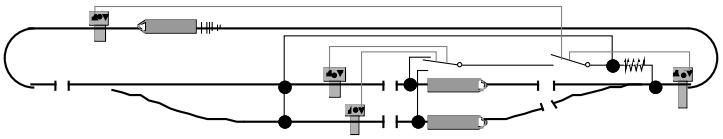
# Model 165

## Automatic Switching Block

## Publication P165

## Assembly and Operating Instructions

**(for use with D8811-165, 11” x 17” drawing set)**



***— Ingram Autocontrols —***

***‘U_BLD_M’ Drawing Series***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## Version Notice

Revisions made to this document are listed below in chronological order.

| Revision | Release Date | Description |
|---|---|---|
| A | 8/94 | Operating Instructions Only |
| B | 9/94 | Operating Instructions Only |
| C | 9/95 | First Full Drawing Release |

## Contents

# Chapter 0 Introduction

## 0.1 Overview

ABSTRACT: This set of instructions (this booklet plus the package of approximately fourteen 11” x17” drawings) documents the steps to construct and operate a G-scale model railroad control device, referred to as an “Automatic Switching Block”, that automatically controls multiple trains on the same track, by switching them between the main line and a siding, slowing them down, stopping them, plus controlling a 4-light searchlight signal.

I have been offering this Model 165 control unit in assembled form since May 1994. Now, with these new drawings—as I tell people at shows when demonstrating the assembled units—if you don’t like my prices or my delivery or my attitude as a vendor for the assembled units; you now have the alternative to to build your own units, using the drawings and following the 117 easy steps in this booklet

I have been fortunate to be able to build about nine of these units for people during the past year, and in the process of doing so, have been able to “tweak” and refine the drawings to bring them up to what I hope is a reasonably refined state as you see them now.

- **Synopsis**

The first part of these instructions describe how to construct an automatic switching block. The second part describes how to operate one.

This unit, as with previous Ingram designs, uses all electromechanical components—no electronics. The parts are all readily available from Shiloh Signals, LGB, Radio Shack, and Newark Electronics.

You can use any good-running, properly-geared locomotives (this excludes some brands) right out of the box, with no modifications except adding a magnet to the bottom to activate the track contacts.

This switching block is essentially “plug and play” when used as a portable control unit and track unit combination as shown in Figure 2c on Sheet 2. You just hook up the AC power, rear switch and siding track, and attach the one remote track contact ‘T2’.

This unit has the capability to control a minimum of 3 trains on a single mainline. You can also operate it with either one of the two functions turned off, or you can completely depower it so it acts *inert*—that is, acts just like a section of ordinary straight track. Refer to the logic diagrams on Sheet 12 for more detail.

The drawing set for this Model 165 unit is unique in that it includes a full size, color-coded, plastic-laminated template made from Sheet 9. You glue this template onto a wood base, attach parts directly on top of their outlines, and finally connect the colored wires following the color coded paths. This laminated Sheet 9 then becomes a permanent part of your final assembly, containing documentation of all wiring connections.

- **Phone Support**

  I will be most happy to offer my opinion on any questions you may have concerning operation of these control units. My only request is that I be allowed to return long distance calls collect (negative cashflow=tight budget ). My phone number is at the bottom of each page.

- **Videotape Demonstrations**

  The videotape "Video Textbook for G Scale Automatic Display Ideas" (V9202, tape 1 or tape 5) demonstrates how an automatic switching block operates, using the original Model 163 unit.

  Tape 1 demonstrates the normal automatic switching block operation, plus "reduced mode" automatic block operation. Tape 5 demonstrates automatic switching block operation, plus "reduced modes" of operation as an automatic block, automatic passing siding, and as a piece of straight track.

  If you have not yet seen one of these units in operation, I suggest you watch one of the videotapes to "get a feel" for how it operates. Ingram Autocontrols' Bulletin #B9507 (July 1995) contains a list of people who have at least one of the videotapes.

- **Using These Block Controls With Digital Command Controls**

  To the best of my knowledge, you can use these block controls with the digital command controls that conform to the NMRA standard, such as LGB's soon-to-be-available multi-train mouse controls. You should be able to run trains with any combination of the command control activated or deactivated (with command control deactivated the engines operate like standard engines), or with the block systems either activated or deactivated.

  The "highest form" of operation would be achieved by using the digital command control to synchronize the speeds of the engines, and using the automatic switching block to control the switching, slowing down, stopping, starting, and the signal lights.

  For controlling three trains on one loop, the switching block can handle any three engines of widely differering speeds. The logic, as per Figure 12e on Sheet 12) is to hold two engines stopped on the siding until the third engine gets about two-thirds of the way around the loop.

  For engines that run similar speeds, which you could accomplish by "tuning" them with the command control, you could space the trains closer together than two-thirds a a loop apart, and thus you could likely control four or five trains on the same track. The demonstrations on Videotapes 1 and 5 show the automatic switching block controlling five similar-speed engines.

- **Previous Instruction Sets**

  This set of drawings for the Model 165 automatic switching block, supersedes previous 'U_BLD_M' drawing sets for the Model 163, 164, and 164b automatic switching blocks (and Model 942 (P8811), 944, and 945 automatic blocks).

  All four of these automatic switching block designs operate in a similar manner—the differences are in the way the parts are laid out.

  Incidently, the previous Model 164b is still a viable design to use. It is not as compact, and does not have the 4 wires to drive a searchlight signal. But is somewhat easier to assemble, as it is laid out more flat, as it uses knift switches and bulbs that mount on the board, instead of toggle switches and the LED that mount on the control bracket.

- **Number of Drawings**

  Please do not let the number of drawings included here intimidate you into thinking that the control unit is more complicated than it really is. You could construct one from Sheet 9 alone. After all, I built the first several units using early versions of Sheet 9 (the control unit) and Sheet 4 (layout and wiring for the track unit).

  You really don't need all the drawings (various drawings are for indoors, outdoors, testing, enclosures, schematic reference, operating steps). I have included them all because I think you will find it more efficient to use or start-with dimensions I have developed, rather than "reinventing the wheel" and developing them yourself from scratch.

- **As Ignored By The Press**

  You may notice, when you think about it, you have never seen a in-depth review of an Ingram Autocontrols' drawing set, assembled control unit, or videotape in any of the magazines. It is not because I have not tried, but rather because I cannot get the editors to review them.

  In 1992 I sent the drawings and tapes to all magazines at that time involved in G scale; The Big Train Operator, Classic Toy Trains, Garden Railways, LGB Telegram, TCA Quarterly, andTrain Yard. The Big Train Operator has been kind enough to do a couple of brief reviews (90 & 92), but otherwise these controls have been ignored by the press.

  The obstacle, I think, is that the magazine editors correctly assume that only a small portion of the reading audience is interested in these automatic controls. Although these controls generate a lot of interest at shows when people see them on my displays controlling five and six trains on the same track, probably only about one one-hundreth of one percent of railroaders are interested in actually building or purchasing one of these units.

  So, in the magazines, you get to read product reviews month-after-month of the "all new" flat cars and "all new" box cars—that really have been around in various gauges for more than fifty years. I get somewhat frustrated when I spend, over the years, thousands of hours developing concepts and drawings that really are new—controlling multiple trains on the same track with simple off-the-shelf parts, beginning in 1988 (Publication P8811)—and the press ignores it.

  But when viewed in terms of sales and dollar volume and consumer interest, the flat cars and box cars are going to be sold by the thousands; while in a year and a half I have managed to sell only about nine of the Model 165 control units.

  However, if you like, you can gather opinions about my built-up units by talking to previous purchasers. Ingram Autocontrols' Bulletin #B9507 (July 1995) contains a list of people who purchased the built-up controls, as well as a list of those who have the earlier drawings (164b) that were shipped with the videotape sets.

## 0.0 AC Control Voltage

This subject of voltages is where I have been most negligent in passing on good information. Probably the most important factor in getting reliable operation of these control units, is supplying it with a good "healthy" source of AC control voltage. This AC control voltage is what "throws" the switch motors that operate the relays and also the rear track switch.

LGB's "standard" control voltage is 18 volts AC. LGB transformers AC output measures 18 volts. This works fairly well for indoor operation where everything is clean, but I think that there is not much margin of error.

There have been occassions when I have been demonstrating my units at shows, where my 110v ac power connection has been on the end of a series of long extension cords, and have I watched in dismay and frustration as the switch motors on my control unit repeatedly failed to reliably change. And this was indoors—with no dirt to contend with.

- **Increasing AC Control Voltage**

  Increasing the voltage to 20 or 22 or 24 volts, I believe, will improve the reliability of the operation of the switch motors. Blue Streak transformers, which a lot of people seem to have, produce about 20 volts AC. Thus Blue Streaks are a good source of AC power. I currently use a not-very-good-otherwise discontinued version of a San-Val pack that supplies 22 volts AC.

  Another way you can increase the voltage to 24 volts, is to get one of the little plastic lawn-sprinker transformers you can buy in hardware stores.

  The Shiloh Signals searchlight signal is designed to handle 24 volts. But you have to be careful about overheating any bulbs that may be in the circuit (such as you have if you use the LGB signals 5092, 5094, 5095, etc).

  If you use 24 volts and fail to use the resistors to reduce the voltage to the bulbs, you may burn them out and melt the plastic housings.

  Byron Fenton (who has built several of these units with Ed Zellner) cautions that if you use 24 volts, you must use a 220 ohm 1/2 watt resistor in series in the wire powering a two bulb unit—such as the semaphore arm. Byron advises you use a 100 ohm 1/2 watt resistor in series in a wire powering a one bulb unit, such as the 3030 indicator light—the 220 ohm resistor will also work.

- **LGB's 5275 Booster**

  LGB's 5275 EPL booster unit, I believe, uses capacitive-discharge electronic circuitry to increase the AC voltage from 18 volts to some higher voltage. Because LGB's instruction sheet for the 5275 states "Lights may not be connected to the EPL booster", I cannot not advise using the booster.

  In other words, LGB does not want the booster powering any loads that draw constant current—such as lights or LEDs. They want only momementary loads, such as switch motors. This Model 165 design has 3 LEDs—one on the rheostat bracket, and two in the target signal.

  So you always have three LED's drawing current. My guestimate is that these LED's draw about 20 ma each, for a total of 60 ma. The booster unit may tolerate this small current drain without damage, but I do not know. For this reason, at this time I recomend increasing the voltage (if necessary) rather than using the booster.

# 0.0 Wiring Color Code

To make it easier to understand how the circuits work, all the wires are color-coded, as per the following Figure 30.

| Wiring Color Codes | | | |
|---|---|---|---|
| **Where Used** | **Wire Color** | **Prefix** | **Examples** |
| Positive (+) *uninterrupted* AC | Red | R | (Block) R2, (Switch) R11, R12, (Bracket) R25, R26 |
| Negative (-) *uninterrupted* AC going *to* the 1700 track contacts | Yellow | Y | (Block) Y1, Y16, (Switch) Y11, Y17, (Bracket) Y21, Y22, Y23, Y24, Y26, Y27 |
| Negative (-) *intermittent* AC coming *from* the 1700 track contacts | Green | G | (Block) G2, G912, (Switch) G12, G105 |
| Positive (+) *uninterrupted* DC coming from the positive left rail | Blue | B | (Block) B1, B2, B5, B7, B8, (Switch) None |
| Positive (+) *interrupted* DC controlled by switch motors M2 and M3 | Black | L | (Block) L3, (Switch) L13, L14 |
| Switched AC (+) to target signal | Gray | A | A1, A2, A3, A4 |

Figure 30 Wiring Color Codes

Note that the color code is also shown on Sheet 09 "Full Size Template for Control Unit", just next to the outline of motor M2, and also on Sheet 4 and several other sheets.

## 0.0.1 Obtaining Colored Wire

I recommend using solid, 18 gauge colored wire to construct the control unit. Some people use stranded wire and non-colored wire for the control unit, but I advise taking this shortcut. The solid wire you can shape better to follow the paths, and the colors make it much easier to understand how the circuits work.

I also prefer the solid wire because it easily screws to the 17000 track contacts and 10153 isolating track terminals, versus having to put the 50131 press cable connectors on the ends of the stranded wire.

You can get the 18 ga solid black, green, and red wire from Radio Shack. The 18 gauge solid blue, yellow, and gray colors is not available from Radio Shack, but is still considered a common product. Two manufacturers that make these colors are Carol Cable and Apex wire. See parts lists Sheets 7 & 8 for the part numbers.

You might be able to find a distributor close to you by calling these wire companies' headquarters. Carol Cable has several numbers, in Manchester NH at 800-424-5666, and on the west coast 800-372-6374. Apex Wire is in Hauppauge, New York, and their phone number is 516-273-3322.

A distributor here in Denver named Cashway Electric at 303-623-0151 (use the All-Wire part number) handles the Apex wire, and they told me they can ship it to out-of-town customers.

For "runs" of longer than 30 feet (connecting to the track), you may want to consider using a heavier wire. Also, Sheet 15 has some notes about using sheathed cables.

## 0.0 Browsing the Drawings

**Note that Sheet 9—the full size template—is the key sheet in this drawing set.** For that reason, let's start with it first. Remaining drawings will be discussed in numerical order.

- **Sheet 09 "Full Size Template for Control Unit"**

  Note that the drawing set contains two copies of this Sheet 9. The copy is in the drawing set is colored, but not laminated. The copy at the end of the stack is both colored and plastic-laminated.

  You cut the laminated copy down to size to make the template. You then glue this template onto a wood base, attach parts directly on top of their outlines, and finally connect the colored wires following the color coded paths. This Sheet 9 then becomes a permanent part of your final assembly, containing documentation of all wiring connections.

  Note that the small sketch in the left rear corner shows in "icon" form how wires 1-12 connect to the track, and how wires 13-16 connect to the searchlight signal.

- **Sheet 01 "Cover Sheet"**

  Note this shows the list of drawings that make up this drawing set.

- **Sheet 02 "Photographs"**

  Figure 2a in the upper left shows the Model 165 Control Unit. If you look closely, you can see the colored template (sheet 9) and how it shows the wiring paths.

  Figure 2b shows the track unit (sheet 4).

  Figure 2c shows the track unit with the control unit mounted on top of it. This model 165 control unit is modular, so you can mount it directly on a track unit as shown, or you can remote mount it and use a cable to connect it to the track.

  Figure 2d shows a track unit with an enclosure. Figure 2e shows the Shiloh Signals 4-light searchlight signal. The 4-light signal indicates all states of the control unit, and has no moving parts, only high-intensity LEDs.

  The remaining photos show some of the previous designs of control units.

- **Sheet 04 "Track Unit Dimensions"**

  Sheet 4 shows some suggested dimensions for laying out the track. You would most likely use this type of modular track unit for an indoor display, although you could use it outside.

  Note that the length of the on/off "stop" blocks is about 40 inches. This is adequate to stop any single LGB engine. A length of 60" will stop double-headed White Pass type diesels. See "Determining Correct Lengths of Blocks", on page 37 for more comments.

  The previous design Model 164b had this unit built in two pieces instead of one piece—the idea being that you could add extra track between the two pieces to make the stop blocks as long as necessary. For these drawings, I changed back to the one-piece design to keep things simpler.

- **Sheet 05 "Track Unit Wiring"**

  This shows how to wire up the track unit after you have done everything on Sheet 4.

- **Sheet 07 "Parts List & Costs-Control Unit, Sheet 08 "Parts List & Costs-Track Unit"**

  Sheet 7 shows parts for the control unit, and sheet 8 shows parts for the track unit.

  The two hardest-to-find components are part 6 the rheostat and parts 16 (& 42) the 16-position terminal block. But using the phone numbers and part number I list, you can get Newark Electronics to ship these to your doorstep with a phone call and a credit card.

- **Sheet 12 "Schematic and Logic Diagram"**

  Figure 12e is the *logic diagram* that shows the logic of how the automatic switching block works, although you can probably get a much better idea from viewing the video demonstration.

  Note that the key concept is to hold two of the engines (shown as engines B and C stopped on the on/off stop blocks) until the third engine (shown as A) gets about 1/2 to 2/3 of the way around the loop.

  Figures 12a and 12c show the *logic diagrams* for the two possible "reduced mode" types of operation.

  •• Figure 12g Schematic

  Figure 12g is the schematic, that shows the wiring in the simplest manner.

  The Red and Green states are defined by the position of the motor M3. When the block is the Green state, the arm of motor M3 is in the forward position, and the connection is made from wire B2 to wire L3 so that one of the two legs of the siding is powered.

  When the block is in the Red state, the arm of motor M3 is in the rear position, and no connection is made between wires B2 and L3, and neither leg of the siding is powered.

  At all times the slowdown blocks are powered at reduced voltage. The path of the DC current to the slowdown block is: In from the mainline on wire 8, through rheostat R1 to drop the voltage, then out wire 3 to the slowdown blocks.

  The DC current path to the on-off blocks is: In from the mainline on wire 8, through rheostat R1 to drop the voltage, then out wire B2 to relay M3. Assuming relay M3 is green, current travels on wire L3 to relay M2 which controls the side-to-side switching. Then, depending on position of M2, current travels out either wire L13 or L14 to one of the on/off blocks.

- **Sheet 13 "Test Wiring"**

  This sheet shows some tests with which you can verify the operation of the control unit—either before or after you have track installed.

- **Sheet 14 "Track Preparation"**

  This sheet shows how you can make the track layout for a permanent or an outdoor layout. Note that this is similar to Sheet 4, except Sheet 4 is for a portable, modular unit.

  •• Using a Jumper in Place of the Control Unit

  The wiring shown shows how you can jumper wires 3, 4, 7, and 8 together to operate the layout without the control unit. Jumpering these four wires connects all the blocks to the main line. Using this jumper technique, you could construct the trackwork for the automatic switching block before you build the control unit.

- **Sheet 15 "Control Unit Cable Connections"**

  This sheet shows how to hook up the control unit to the track unit using a cable, in the case where you want to mount the control unit remotely from the track unit.

  From the point of view of minimizing the length of wires for both simplicity and miminizing voltage drop, it is better to have the control unit mounted right next-to or on the track unit, if possible.

  However, for outdoor installations, people sometimes mount the control unit next to their transformer in a weather-resistant box on the porch. In this case the cable can be used.

- **Sheet 16 "Initial Conditions"**

  This sheet shows to position everything for start up. Figure 16e shows you how to operate in "full mode" (normal) operation. The other figures show various forms of "reduced-mode" operation you can experiment with.

- **Sheet 21 "Searchlight Signal Spec Sheet"**

  This sheet shows specifications for the 4-light Shiloh Signals searchlight signal. You can send this sheet directly to Shiloh Signals to order one.

  The addition or lack of this signal does not affect the operation of the control unit.

  However, I highly recommend the use of it because you can better tell what the control unit is doing. The 4 lights on the signal show all 4 states of the control unit.

  The red and green lights indicate the position of the relay motor M3 that controls the on/off blocks. If M3 is depowered (blocking off), both these lights will be dark.

  The two yellow lights indicate the position of the relay motor M2 that controls the side-to-side switching. If M3 is depowered (switching off), both these lights will be dark.

- **Sheet 22 "Building Dimensions"**

  This sheet shows dimensions to build a small shed that will conceal the control unit. It will look similar to the shed shown in Figure 2d, except it will be slightly smaller (the shed in the picture was built to conceal a slightly larger unit).

  If you do not want to build your own shed or have someone readily available who can, you can possibly contact Peter Kenneman (303-750-9417) or Jim Siedleman (303-693-8977) here in Denver—they sometimes make custom buildings.

## 1.4 Control Unit Location for Outdoor Use

When using the control unit outdoors, you have basically two choices as where to locate it:

1. locate it next to the track and protect from weather
2. locate it next to the transformer, and connect to trackage with a cable.

**Next to Track:** The advantages of locating the control unit next to the track:

- you can easier verify its properly operating by holding a magnet over a certain track contact, and observing that the proper relay motor operates in the proper direction.

The disadvantage of locating it next to the track is:

- you should keep it protected from the weather to keep the relays operating reliably.

**Next to Transformer:** The advantage of locating the control unit next to the transformer (which is usually on a porch or in a shed) is:

- the control unit is generally better protected from the weather
- you can adjust the slowdown rheostat R1 while you are standing at the transformer.

The disadvantage of locating it this way, away from the track, is

- you need two people to verity its proper operation—one to activate the track contact by holding a magnet over it, and a 2nd person to watch the control unit to see that the proper relay actuates
- you need to use a cable to connect the control unit to the trackage.

**My Recommendation:** My recommendation is that you mount the control unit next to the track. The reason I recommend this: I think the ability to stand next to the block area, hold a magnet next to a given track contact, and easily see that the proper switch relay motor is doing what it should; is the most important consideration.

**Layout Drawings:**

If you locate the control unit next to the track, your arrangement might look similar to Sheet 4, which shows the control unit located next to the converging switch S2.

If you locate the control unit remotely from the track, your arrangement might look similar to Sheet 15, which depicts the control unit connected to the trackage by a 15-wire Carol cable (Carol Part #C2423).

# Chapter 0 Assembly Steps - Control Unit

**Note:** Item numbers for the control unit refer to Sheet 07 "Parts List & Costs-Control Unit.

Before starting assembly, you will probably want to procure parts shown on Sheet 07 "Parts List & Costs-Control Unit. The laminated template of Sheet 9 (Item 13) and the laminated rheostat mounting bracket label (Item 14) are included as part of this instruction package.

## 0.1 Base Assembly

0. Per Sheet 09 "Laminated Template for Control Unit", cut a piece of 1/2 inch thick plywood 6-1/4” x 12-7/8” long for the base (Item 27).
1. Sandpaper the base to remove all rough spots.
2. Paint the base using Ace 35A-1A Beechtree (Item 19, brown) or color of your choice.
3. Using scissors and Sheet 9 (make sure you use the plastic-laminated one), trim the template to the 6” x 12-5/8” size. The template shows these dimensions—verify them before you cut.
4. Glue the laminated template Sheet 9 (Item 13) to the wood base, using the adhesive (Item 17).

   The base is now ready to attach parts, as shown in the following figure.

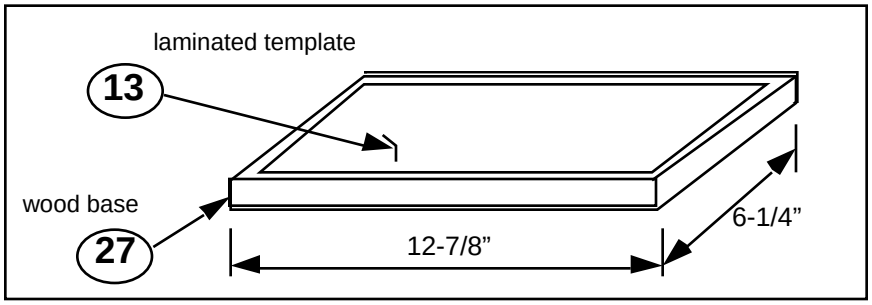
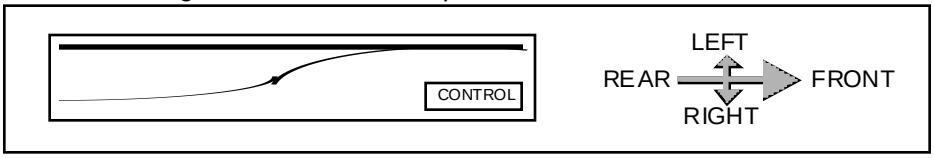



Figure 0 Wood Base With Laminated TemplateAttached

## 0.2 Upper Control Unit—Rheostat Bracket Assembly, Items 1-9

**Note:** The directions left, right, front, rear; are as per coordinates shown on Sheet 09 and below.



## 0.0.0 Drilling Holes and Attaching Parts

The following figure contains the top view and side view templates for punching holes in the rheostat mounting bracket. (You can cut-out the duplicate copy that is included at the end, Figure 44 on page 39). By using these templates, you will not have to measure any hole locations.

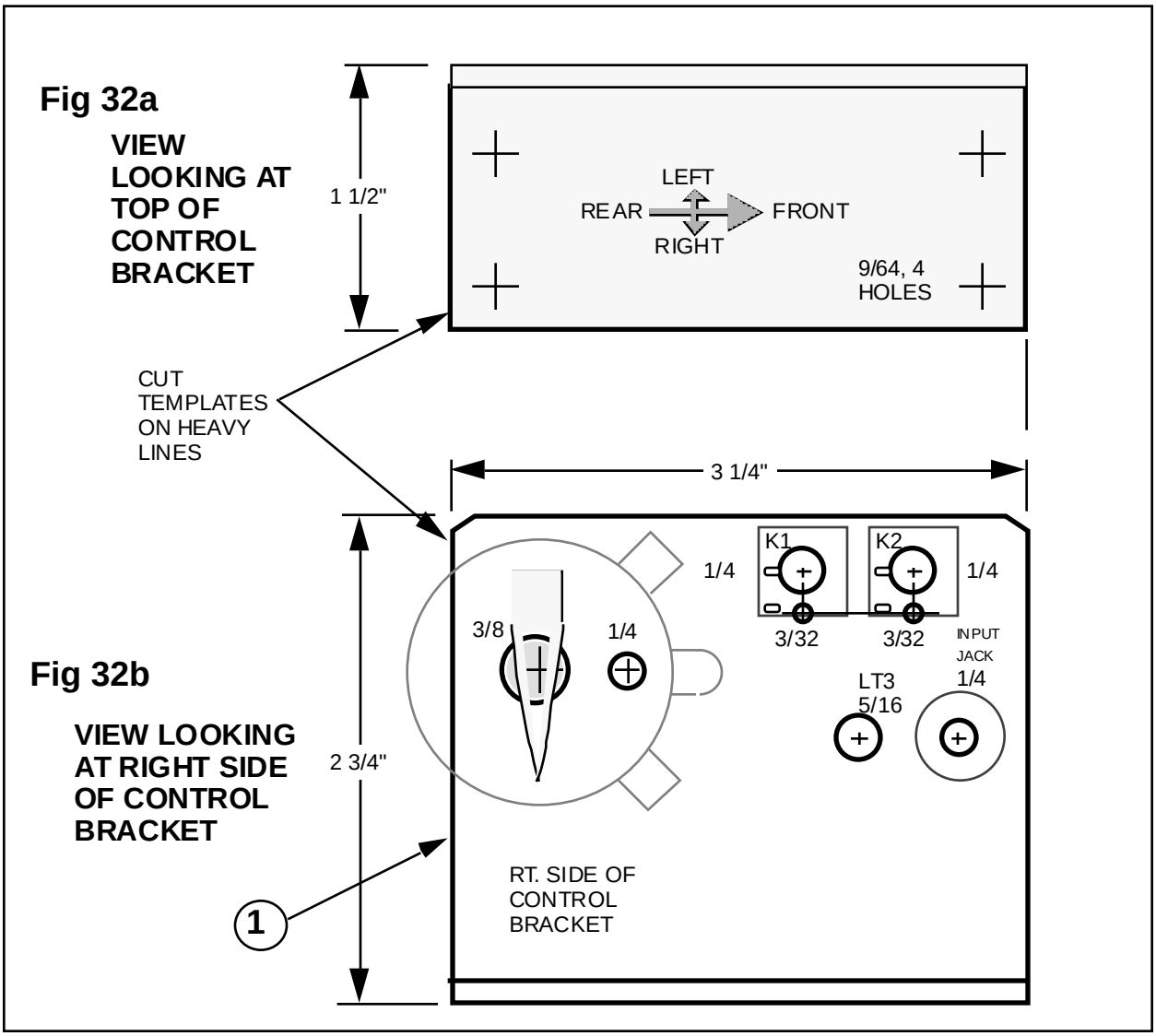



Figure 0 Templates for Locating Holes in Rheostat Mounting Bracket

0. Using scissors, trim the two drawings. Trim Figure 32a the top view to 1-1/2" x 3-3/4". Trim Figure 32b the right side view to 2-3/4" x 3-1/4".
1. Cut a 3-1/4" long piece of the aluminum angle (Item 1).
2. Using rubber cement (Item 18), rubber cement the top view drawing to the top of the horizontal "foot" of the angle. Rubber cement the right side view template to the right side of the rheostat mounting bracket.

The bracket is now ready to be punched, as shown in the following figure.

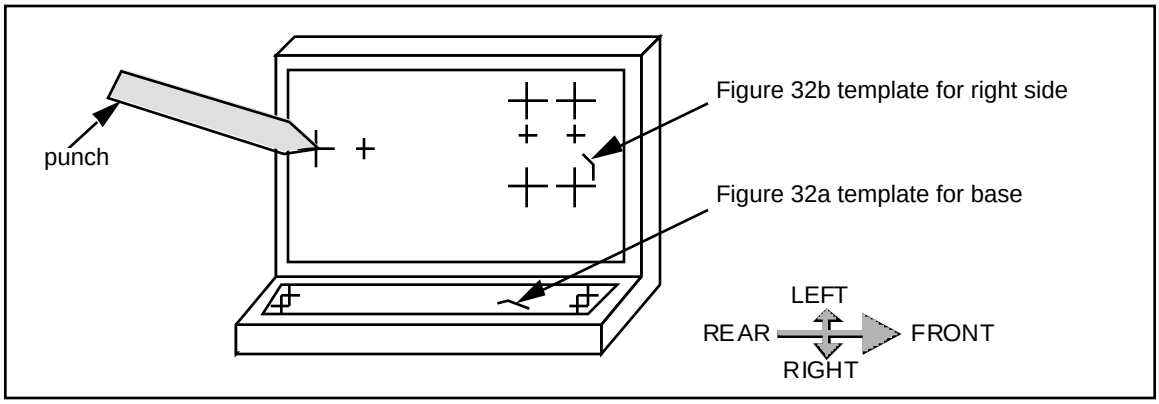



Figure 0 Bracket With Templates for Punching Holes

0. Using a hammer and a punch, punch 8 indentations (for drilling holes for parts) on the right side of the bracket, as per the locations on the template. Punch 4 indentations (for holes for screws) on the top side of the horizontal foot.
1. Following the template, drill the following holes on the vertical right side of the bracket:
   - 3/32 hole for bottom alignment tab of toggle switch K1 (Item 8)
   - 3/32 hole for bottom alignment tab of toggle switch K2 (Item 8)
   - 1/4” hole for shaft of toggle switch K1 (Item 8)
   - 1/4” hole for shaft of toggle switch K2 (Item 8)
   - 1/4” hole for input jack (Item 4)
   - 1/4” hole for alignment tab of rheostat (Item 6)
   - 5/16” hole for LED holder (Item 3)
   - 3/8” hole for shaft of rheostat (Item 6)
2. Following the template, drill four 9/64 holes in the base of the bracket (to later attach the bracket to the wood base).
3. Scrape the two templates off the rheostat mounting bracket and discard them.
4. Position the bracket on the right front corner of the wood base as shown in Sheet 09 "Full Size Template for Control Unit". Using the four holes you drilled in the previous step as guides, drill four 5/16 pilot holes in the wood base.

   The four “crosshairs on the base show the approximate position.
5. Use four screws #4 x 1/2” long (Item 29) to attach the bracket to the wood base.

**Note:** As you attach electrical components in the following steps, orient the components on the bracket so the switches and handles face “out” to the right.

6. Screw on the two toggle switches K1 and K2 (Item 8).
7. Screw on the input jack (Item 4).

0. Screw on the rheostat (Item 6).
1. Insert the LED (Item 2) into the LED holder (Item 3).

   This step was not clear to me, until Byron Fenton showed me how to do it. The following sketch (hopefully) clarifies how these two parts are assembled

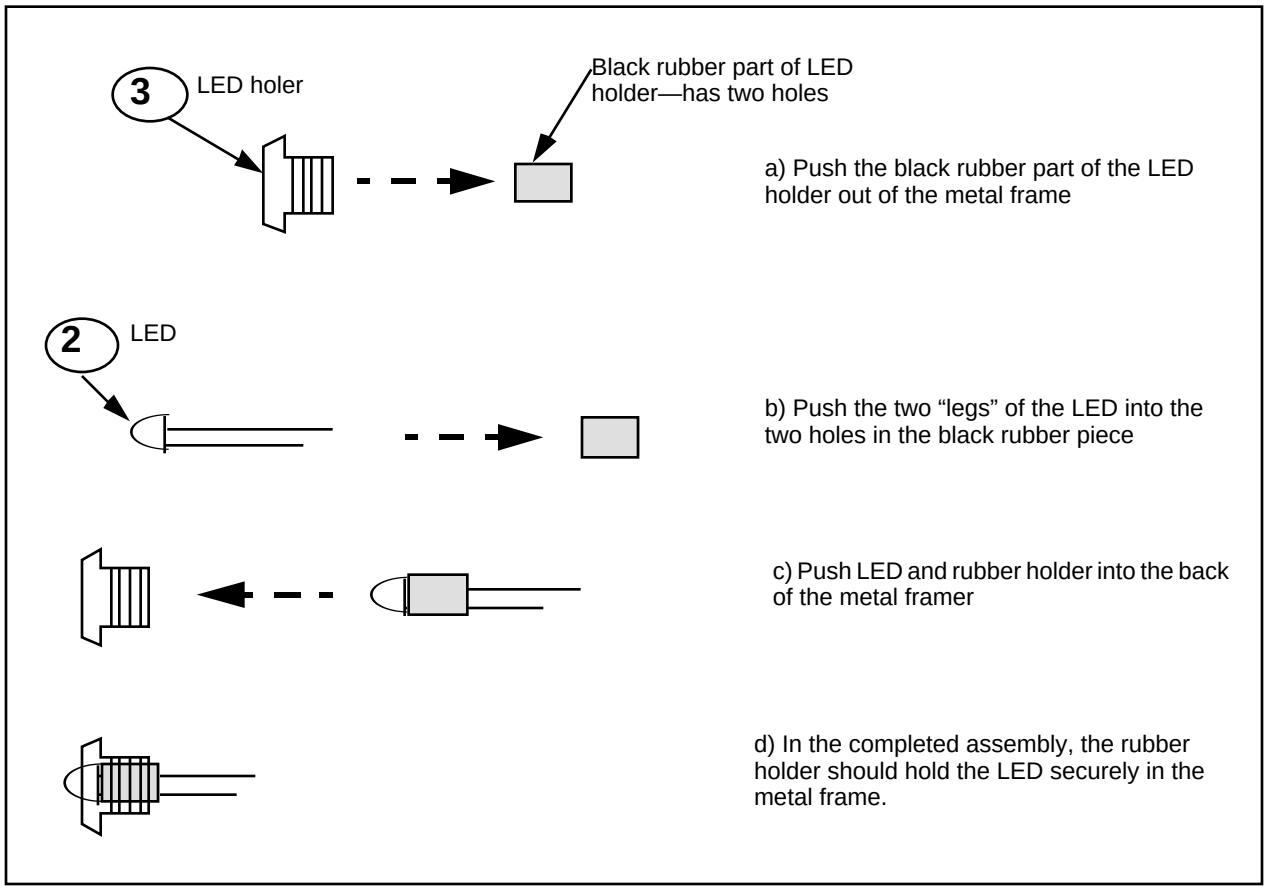



Figure 0 Assembling LED into LED holder

2. Screw the LED/LED holder assembly to the bracket.

The bracket now has all parts attached, as shown in the following figure.

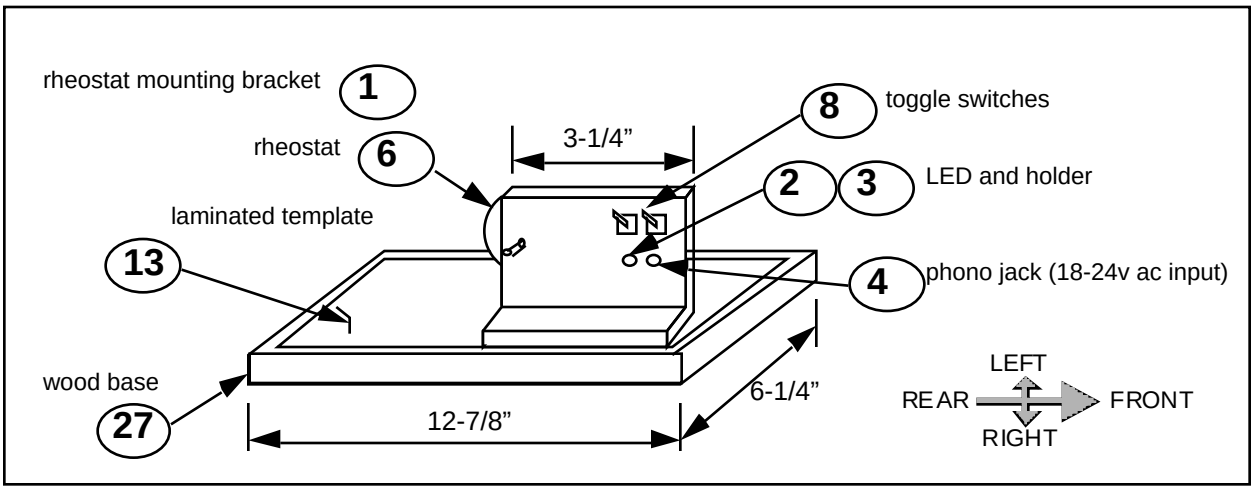



Figure 0 Rheostat Mounting Bracket and Parts Mounted

**Terminal Block TB4**

0. Drill two 5/64 pilot holes in the wood base for the 6-position terminal block (Item 15) in the locations shown on the template Sheet 9.

   The four "crosshairs on the base show the approximate position.

1. Screw the 6-position terminal block TB4 (Item 15) to the wood base by using four screws #4 x 1/2" long (Item 29).

## 0.0.0 Wiring The Rheostat Bracket—LED And Input Jack

Wiring the rheostat mounting bracket (Item 1) is probably the most tedious part of the whole assembly process for this unit, due to the working space being somewhat cramped.

**Note:** For these upcoming steps of wiring the control bracket, refer to Figure 9c left side view of the control bracket on Sheet 09.

The following schematic Figure 36, "Schematic Representation for Fig 9b Rheostat Mounting Bracket"can also be used as a reference for the wiring on the rheostat mounting bracket (Item 1).

Note that this figure shows the same wires as Figures 9b and 9c on Sheet 9. When you are making the connections, you want to refer to Figure 9c, the view of the left side of the bracket, since that is the side you will be looking at as you connect the wires.

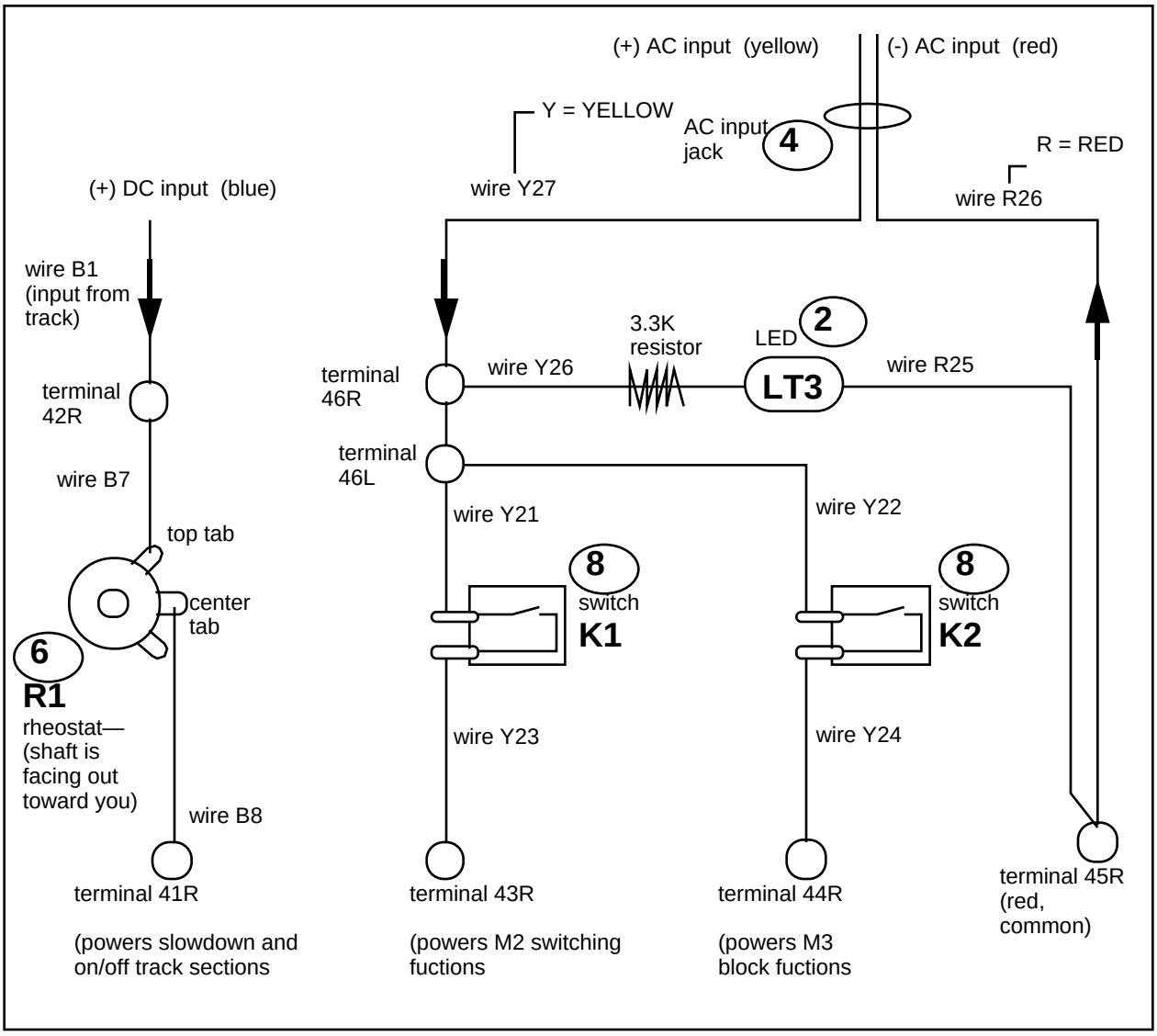



Figure 0 Schematic Representation for Fig 9b Rheostat Mounting Bracket

**LED (LT3)**

0. Solder one end of the resistor (Item 5) to longer of the two ends of the LED.
1. Cut a 4" piece of yellow wire (Item 24), to use as wire Y26, and solder it to the other end of the resistor.
2. Cut a piece of yellow shrink wrap tubing (Item 9) long enough to cover the resistor and both soldered connections, and slide it over the end of the wire so it covers all the soldered connections so as to prevent shorting.

**Note:** In the following steps, some terminals have more than one wire connected to them.

0. Screw the other end of the yellow wire Y26 to terminal 46R on terminal block TB4. Attach it loosely since a second wire will be added to this terminal later.

   Verify the position of terminal 46R (46 right) using the top view (main view) of Sheet 9.

1. Solder one end of red wire R25 to the other end of the LED. Slide a small piece of shrink wrap (red if you have some) over the bare wire to protect from shorting. Screw the other end of the red wire to terminal 45R. Do not tighten the screw yet, since a second wire will be added to this terminal later.
2. Heat the shrink wrap tubing until it contracts tightly around the wires. (For a heat source, I crudely use the tip of the soldering iron. You can also use a small torch or cigarette lighter or hair dryer.)

#### Input Jack

3. Solder one end of red wire R26 to the longer connection of the input jack (Item 4). By the longer connection, I mean the "outer" connection that touches the bracket (since red is the AC ground).
   Screw the other end of this wire to terminal 45R. Note this terminal now has two red wires connected to it.
4. Solder one end of yellow wire Y27 to the shorter "inside" connnection of the input jack (Item 4).
   Screw the other end to terminal 46R. Note this terminal now has two yellow wires connected to it.

## 0.0.0 Wiring The Rheostat Bracket—Toggle Switches & Rheostat

#### Toggle Switch K1

5. Solder the upper end of yellow wire Y23 to the lower tab of toggle switch K1 (Item 8). Screw the lower end to terminal 43R.
6. Solder the upper end of yellow wire Y21 to the upper tab of toggle switch K1 (Item 8). Screw the lower end to terminal 46L. Do not tighten the screw yet, as a second wire will be added to this terminal later.

#### Toggle Switch K2

7. Solder the upper end of yellow wire Y24 to the lower tab of toggle switch K2 (Item 8). Screw the lower end to terminal 44R.
8. Solder the upper end of yellow wire Y22 to the upper tab of toggle switch K2 (Item 8), Screw the lower end to terminal 46L. Note this terminal now has two yellow wires connected to it.

#### Rheostat R1

9. Solder the upper end of blue wire B8 (Item 21) to the center tab of rheostat R1 (Item 6).
   Screw the lower end to terminal 41R.

0. Solder the upper end of blue wire B7 to the upper tab of rheostat R1. Screw the lower end to terminal 42R.

# 0.0 Lower Control Unit, Items 10-29

## 0.0.1 Attaching Parts On The Lower Control Unit

#### 16-Position Terminal Block TB3

1. Drill four 5/64 pilot holes for 16-position terminal block TB3. The two "crosshairs" on the template show the approximate position. Use the terminal block as a template for drilling the other two holes.
2. Screw the 16-position terminal block (Item 16) to the wood base by using four screws #4 x 1/2" long (Item 29).

#### Preparing Switch Motors And Relays

Note that switch 'S2' has no motor on it—it just slides in whichever direction the engines push it as they pass through. Thus you can remove the switch motor from switch 'S2' and use it on the control unit.

3. The 12030 relay points (Item 12) snap into the end of the 12010 switch motors (Item 11). There is a plastic cover plate on the end of the motors. Pry this cover plate off using a screwdriver, and then snap the relay points into the end of the switch motors.

#### Attaching Switch Motor M2

4. Drill four 9/64" holes to attach switch motor M2. Note there are two crosshairs at the upper left "foot" of the motor, and two crosshairs at the lower right foot. (I suggest using wire, hence two holes for each foot.)
5. Using two pieces of black 18 gauge solid wire, run the wire through the two holes and twist it at the top,so as to hold the plastic foot of the motor to the wood base, as shown in the following figure.

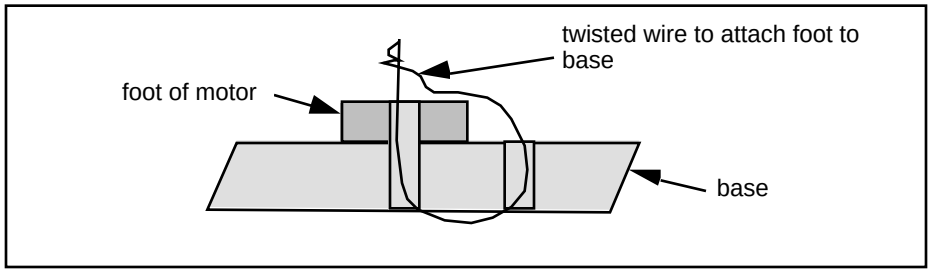



Figure 0 Using Twisted Wire to Attach Foot of Switch Motor to Wood Base

Note you could also screw the foot to the base, which is neater, but I prefer to use the wire since that does not damage the threads in the plastic foot.

#### Attaching Switch Motor M3

6. Drill four 9/64" holes to attach switch motor M3. Note there are two crosshairs at the upper right foot of the motor, and two crosshairs at the lower left foot.

0. Use two pieces of black 18 gauge solid wire to attach two of the plastic feet to the base, as shown in Figure 37, "Using Twisted Wire to Attach Foot of Switch Motor to Wood Base".

#### Holes for Wing Nuts and Screws

1. Drill two 3/16” holes in the base. These holes are for the screws and wing nuts used to attach the base to the track unit. Note the template shows you a set of crosshairs for each wing nut hole location near the end of the base (11-3/4” apart).

## 0.0.0 Attaching Wires on Lower Control Unit

2. Cut a two-terminal-long piece of the jumper (Item 10), in the shape as shown on *Sheet 09* on TB3 at terminals 10 and 11. After cutting it, attach it to the terminal block between terminals 10 and 11. Do not tighten the screws yet.

**Note:** When stripping insulation off the ends of wires that connect to terminals, you can strip off about 1/2”.
You can strip about 1/4” of insulation off the ends of wires that connect to switch motors and relay points.

#### Black Wires

Attach the following BLACK wires (prefix L=BLACK) using 18 gauge solid wire (Item 20):

3. Attach L3, from terminal 24 on motor M2, to terminal 36 on motor M3)
4. Attach L13, from terminal 7 on terminal block TB3, to terminal 25 on motor M2)
5. Attach L14, from terminal 4 on terminal block TB3, to terminal 23 on motor M2)

Black wire is used for DC + that is “switched”—that is, sometimes the power is on, and sometimes the power is off. (DC - on the right rail is not connected to the control unit at all)

#### Blue Wires

Attach the following BLUE wires (prefix B=BLUE) using 18 gauge solid wire (Item 21):

6. Attach B1, from terminal 8 on terminal block TB3, to terminal 42L on terminal block TB4)
7. Attach B2, from terminal 37 on motor M3, to terminal 41L on terminal block TB4. Do not tighten the screw yet, as a second wire will be added to terminal 41L later.
8. Attach B5, from terminal 3 on terminal block TB3, to terminal 41L on terminal block TB4. Note terminal 41L now has 2 wires.

Blue wire is used for DC + that is “unswitched”—that is, the power is always on.

#### Green Wires

Attach the following GREEN wires (prefix G=GREEN) using 18 gauge solid wire (Item 23):

0. Attach G2, from terminal 12 on terminal block TB3, to terminal 32 on motor M3)
1. Attach G12, from terminal 5 on terminal block TB3, to terminal 21 on motor M2)
2. Attach G105, jumper between terminals 1 and 5 on terminal block TB3)
3. Attach G912, jumper between terminals 9 and 12 on terminal block TB3)

Green wire is used for AC + that is "switched"—that is, the power is momentarily on if the corresponding track contact is activated, but is normally off.

#### Red Wires

Attach the following RED wires (prefix R=RED) using 18 gauge solid wire (Item 24):

4. Attach R2, from terminal 31 on motor M3, to terminal 45L on terminal block TB4. Do not tighten the screw to terminal 45L yet, as a second wire will be added later.
5. Attach R11, from terminal 2 on terminal block TB3, to terminal 45L on terminal block TB4—note terminal 45L now has 2 wires. Do not tighten the screw to terminal 2 yet, as a second wire will be added later.
6. Attach R12, from terminal 2 on terminal block TB3, to terminal 22 on motor M2. Note terminal 2 now has 2 wires connected to it.

Red wire is used for AC - (common).

#### Yellow Wires

Attach the following YELLOW wires (prefix Y=YELLOW) using 18 gauge solid wire (Item 25):

7. Attach Y1, from terminal 11 on terminal block TB3, to terminal 44L on terminal block TB4)
8. Attach Y11, from terminal 6 on terminal block TB3, to terminal 43L on terminal block TB4. Note a second wire will be added to terminal 6 later.
9. Attach Y16, from terminal 10 on terminal block TB3, to terminal 34 on motor M3)
10. Attach Y17, from terminal 6 on terminal block TB3, to terminal 27 on motor M2. Note terminal 6 now has 2 wires connected to it.

Yellow wire is used for AC + that is "unswitched"—that is, the power is always on.

#### Gray Wires

Attach the following GRAY wires (prefix A=GRAY) using 18 gauge solid wire (Item 22):

11. Attach A1, from terminal 15 on terminal block TB3, to terminal 35 on motor M3)
12. Attach A2, from (terminal 16 on terminal block TB3, to terminal 33 on motor M3)
13. Attach A3, from terminal 14 on terminal block TB3, to terminal 26 on motor M2)
14. Attach A4, from terminal 13 on terminal block TB3, to terminal 28 on motor M2)

Gray wire is used for AC + that is “switched” that powers the lights of the searchlight signal.

Note that terminal 38 on motor M3 has no wires connected to it.

### Rheostat Mounting Bracket Label

The following Figure 38 shows a copy of the rheostat mounting bracket label. Use this copy for reference only. A yellow, plastic-laminated label (Item 14) is supplied to glue to the bracket.

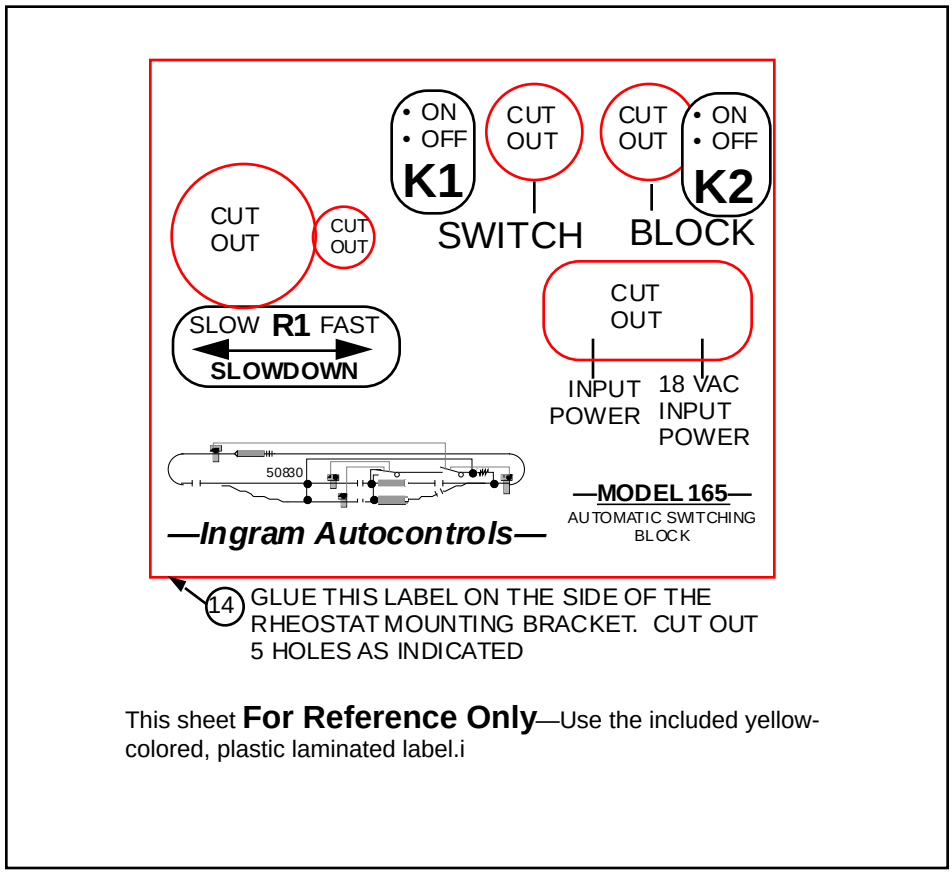



Figure 0 Copy of Laminated Rheostat Mounting Bracket Label

0. Trim the yellow laminated rheostat mounting bracket label (Item 14) to fit the right side of the bracket. Cut out the five holes to fit over the handles of the controls.
1. Using rubber cement. or Fun Tak, attach the label to the rheostat mounting bracket.
2. Attach the plastic rheostat control knob (Item 7) to the shaft of the rheostat, using the provided set screw.

### Conclusion

At this point, the assembly of the control unit should be complete.

If you are going to build a track unit, proceed to Chapter 3, "Assembly Steps - Track Unit", on page 23.

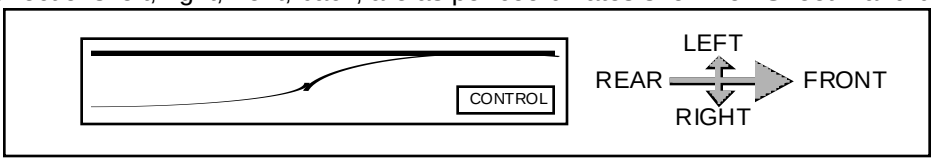
If you are going to hook the control unit up to existing trackwork, proceed to Section 4.2, "Connecting the Control Unit to Existing Trackage", on page 30

If you want to test the control unit before you hook it up to any trackage, see Section 5.1, "Check Out Steps", on page 33.

# Chapter 0 Assembly Steps - Track Unit

**Note:** Item numbers for the track unit refer to Sheet 08 "Parts List & Costs-Track Unit".

**Note:** The directions left, right, front, back; are as per coordinates shown on Sheet 4 and below.




**Note:** Use Sheet 04 “Track Unit Dimensions” for the following steps.

**Base (Item 62)**

0. Per Sheet 04 “Track Unit Dimensions”, cut a piece of plywood, 3/8 to 1/2 inch thick 17” wide x 65-1/2”” long for the base (Item 62).
1. Sandpaper the base to remove all rough spots.
2. Paint the base using Ace 35A-1A Beechtree (Item 19, brown) or color of your choice.

   The base is now ready to attach parts.
3. Attach terminal block TB8 (Item 42) to the right front corner of the base as shown, using four #4 x 1/2” long wood screws (Item 54).

## 0.1 Preparing Special Track Pieces

**Cutting 3” Special Track Length (Item 45b)**

4. From one of the one-foot long straight sections of track (Item 45), use a razor saw or hack saw to cut a piece 3” long This is the piece (Item 45b) that goes immediately to the front of the switch.

   Note that you cannot use a standard 6” long 1015 track, as would seem more logical at first glance, because the tie spacing is too close to fit in the track contact.
5. File the rear of the right rail as necessary to smooth the edges from the cutting.
6. Slide a brass rail joiner (Item 40) onto this rail. You will have to bend the small vertical tab from the vertical up to horizontal to do this.

**Cutting 1-3/4” Special Track Length (Item 45c)**

Referring to Sheet 04 “Track Unit Dimensions”, locate the 1-3/4” piece (Item 45c) just to the rear of the switch.

The reason for the special 46 mm length, is that when you use a 1600 switch on the other end to complete the siding, all the track in-between can be standard lengths. See Figure 4c at the top of Sheet 4—each switch makes an offset that make the curved leg 23mm longer than the straight leg. So adding 46 mm to the straight leg compensates for the two 23mm offsets from the two switches.

0. From the other end of the cut-up piece used in the previous step, cut a piece 1-3/4" long. If you have a metric ruler, instead of measuring 1-3/4", cut the right rail 46 mm long, and the left rail 44-1/2 mm long.

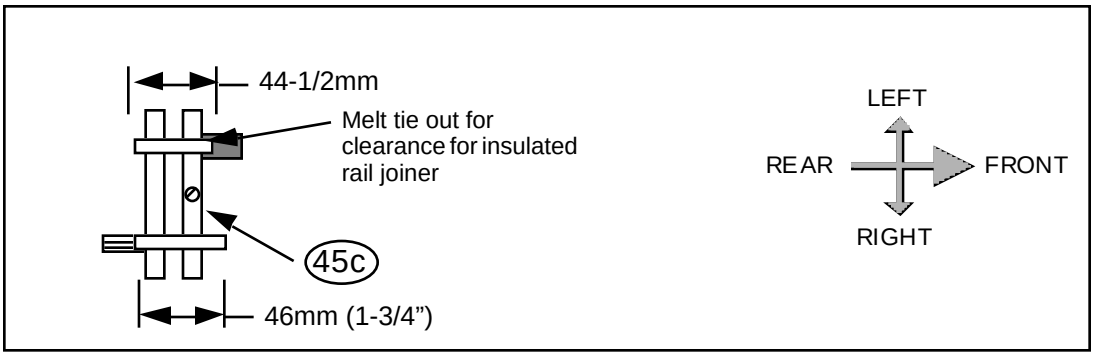



Figure 0 Special 46mm Long Track Piece Item 45c

The reason for the 1-1/2 mm shorter length for the left rail, is to allow space for the plastic rail joiner. Note that the brass rail joiner should be on the right rear corner of the track.

1. You want to attach the plastic insulated rail joiner (Item 41) onto the front of the left rail. However there is not clearance between the front tie and the rail. So use a soldering iron to melt space under the rail, so that you can slide the plastic rail joiner on, as shown in the following figure.

   Another option is to just remove that tie, but I think this piece looks better having both ties.

**Curved Track**

2. From the curved track (Item 14), remove the brass rail joiner from the front end as per orientation of Sheet 4. Slide on one of the plastic insulating rail joiners (Item 41) where you removed the brass one.

**Attaching Track To Base**

At this point, you have prepared all the special pieces of track, except for soldering a wire on the end of the 3" piece, which we will do later.

3. Lay the pieces loose on top of the wood base.
   Verify the following per Sheet 4:
   - The straight section assembly is about 1" in from the front of the base, and about 1-1/8" in from the rear of the base
   - The rear end of the curved leg is offset from rear of the straight leg by about 23 mm (0.91") as shown.
   - For both 10153's (Item 48), the gap is in the left rail
   - You have not forgotten track contacts T3 and T4. Don't worry about T1 yet, because the front piece of track (Item 45b) you will later remove.
4. Use a 7/64" drill to drill pilot holes in the plastic ties where the screws will go. In most cases you can use the holes already in the ties.

0. Use a 5/64” drill to drill pilot holes in the wood for the screws, under the holes in the ties.
1. Use a #4 x 5/8 long wood screw (Item 55) to attach the track ties to the wood base.

   You will probably want to attach the three ends of the track assembly first, to get everything held in proper position, then attach the other pieces. The 3” piece on the front end (Item 45b) you will remove after the rest of the track is attached.

## 0.0 Attaching Wires

**Note:** Use Sheet 05 “Track Unit Wiring” for the following steps.

**Attaching Special Wire Number 8 to 3” Track**

This wire 8 brings input DC track power from the mainline into the control unit.

2. Remove the 3” track section (Item 45b) that is on the front end.
3. Get the 3” long piece of straight track that you removed, and get a piece of the blue wire (Item 57). You will solder the blue wire to the tab on the underside of the brass rail joiner, on the left front of this track, as shown in the following figure.

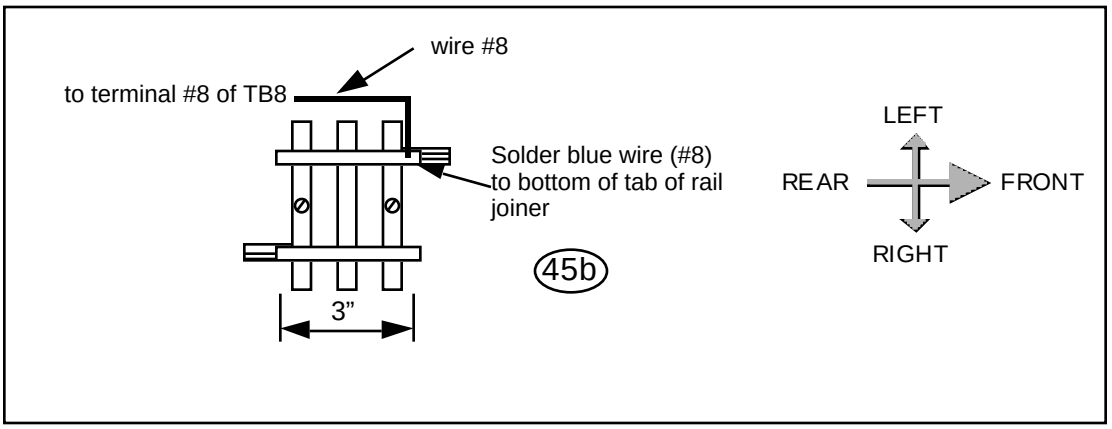



Figure 0 Soldering Blue Wire to Bottom Tab of Rail Joiner

4. Cut this piece of the blue wire (Item 57) to a length that is long enough to attach to the bottom of the brass rail joiner, go through a hole in the base, under the base, and connect to terminal 8 of terminal block TB8.
5. Solder the blue wire (wire 8) to the tab on the bottom of the brass rail joiner.
6. After the wire is soldered, drill a 9/64” hole in the base, located directly under where the blue wire connects to the rail joiner.
7. Reattach the 3” track to the base, with the blue wire going down through the hole to the underside of the base.
8. Drill a 9/64” hole about 1/4” to the left of terminal 8 on TB8.
9. Attach the other end of the blue wire (wire 8) to terminal 8 of TB8.

### Attaching Other Wires

For the following steps, use a 9/64 drill to drill holes as required, in order to run the wires underneath the wood base.

#### Black Wires

Attach the following BLACK wires using 18 gauge solid wire (Item 56):

0. Wire 4 (terminal 4 on terminal block TB8 to the 5th terminal from the rear of the rightmost 10153 (Item 43)
1. Wire 7 (terminal 7 on terminal block TB8 to the 5th terminal from the rear of the leftmost 10153 (Item 43)

Black wire is used for DC '+' that is "switched"—that is, sometimes the power is on, and sometimes the power is off.

DC '-' on the right rail is not connected to the control unit at all. Note that there are no gaps or block in the '-' right rail.

#### Blue Wires

Attach the following BLUE wires using 18 gauge solid wire (Item 57):

2. Wire 3 (terminal 3 on terminal block TB8 to the 3nd terminal from the rear of the leftmost 10153 (Item 43)
3. Wire 3B (the 2nd terminal from the rear of the rightmost 10153, to the 2nd terminal from the rear of the leftmost 10153 (Item 43)

Blue wire is used for DC + that is "unswitched"—that is, the power is always on.

#### Green Wires

Attach the following GREEN wires using 18 gauge solid wire (Item 58):

4. Wire 5A (terminal 5 on terminal block TB8 to the frontmost terminal of track contact T4
5. Wire 5B (terminal 5 on terminal block TB8 to the rearmost terminal of track contact T3
6. Wire 9 (terminal 9 on terminal block TB8 to the rearmost terminal of track contact T1

Green wire is used for AC + that is "switched"—that is, the power is on if the corresponding track contact is activated, but is normally off.

#### Yellow Wires

Attach the following YELLOW wires using 18 gauge solid wire (Item 59):

7. Wire 6A (terminal 6 on terminal block TB8 to the center terminal of track contact T4
8. Wire 6B (terminal 6 on terminal block TB8 to the center terminal of track contact T3
9. Wire 10 (terminal 10 on terminal block TB8 to the center terminal of track contact T1

Yellow wire is used for AC + that is "unswitched"—that is, the power is always on.

**Stranded Wires to Contact T2**

0. Using the double-conductor stranded wire (Item 61), attach the lighter side to terminal 11 on terminal block TB8. Connect the other end to the center terminal of track contact T2.
1. Using the same double-conductor wire as the previous step, attach the darker side to terminal 12 on terminal block TB8. Connect the other end to the frontmost terminal of track contact T2.

Sheet 5 shows these two wires as green and yellow, but you probably want to use the stranded wire so that track contact T2 can be moved around. If T2 is going to be permanently located in one place, then use the solid yellow and green wire so you have the color coding.

**Attaching Searchlight Signal**

Perform these steps if you are using the Shiloh searchlight signal. The use of this signal is optional—it does not affect the operation of the block, but I recommend it because the four lights tell you the "state" of the control unit, plus it is attractive to watch.

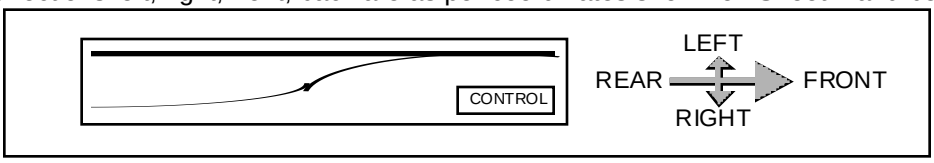
Specifications for this signal are shown on Sheet 21 "Searchlight Signal Spec Sheet". You can order this signal directly from Shiloh Signals.

2. Drill a 1/4" hole for the stem of the signal 3" in from the front of the base, as indicated on Sheet 4.
3. Push the bottom of the signal into the hole, so the wires run underneath.
4. Connect the white Shiloh wire (wire 2B, common) to terminal 2 of terminal block TB8.
5. Connect the yellow Shiloh wire that has the black stripes on it (wire 14) to terminal 14 of terminal block TB8.
6. Connect the yellow Shiloh wire that has NO black stripes on it (wire 13) to terminal 13 of terminal block TB8.
7. Connect the red Shiloh wire (wire 15) to terminal 15 of terminal block TB8.
8. Connect the green Shiloh wire (wire 16) to terminal 16 of terminal block TB8.

--

# Chapter 0 Connecting Control Unit to Track

**Note:** The directions left, right, front, back are as per coordinates shown on Sheet 4 and below.




If you built a modular track unit as described on Sheet 04 “Track Unit Dimensions”, proceed with the steps in the following section 4.1, "Connecting Control Unit to Modular Track Unit".

If you are connecting the control unit to an existing track system, proceed to “Connecting the Control Unit to Existing Trackage” on page 30

## 0.1 Connecting Control Unit to Modular Track Unit

The section describes how to attach the control unit to the portable modular track unit described on Sheet 04 “Track Unit Dimensions”.

**Attach Control Unit to Track Unit**

0. Position the control unit on the corner of the track unit, such that the 16-position terminal block TB3 in the corner of the control unit, lines up with the 16-position terminal block TB8 mounted on the track unit.
1. Using the 2 wing nuts and screws (Item 28), attach the control unit to the track unit.

**Connect Interface Wires**

2. Cut 16 short jumper wires, about 3 inches long, with spade connectors on each end, to connect the two 16-position terminal blocks, as shown in the following Figure 41.

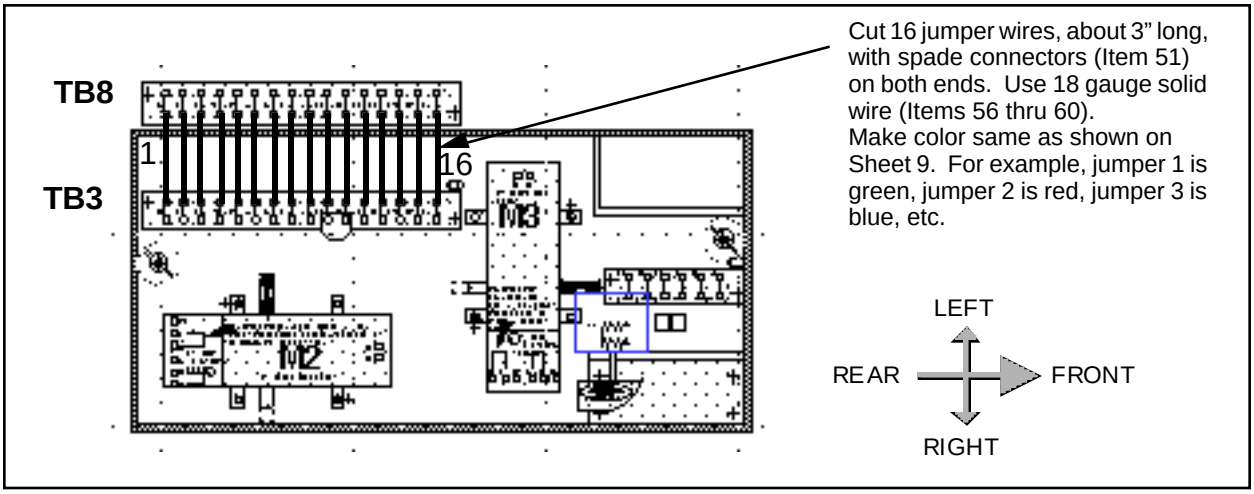



Figure 0 Jumper Wires to Connect Control Unit to Track Unit

0. Connect the 16 jumper wires between the two terminal blocks. Check to verify that you did not accidently cross any wires.

#### Connect Track Switch S1

Note that track switch S1 is supplied by the purchaser. Terminals 1 and 2 connect to track switch S1.

1. Identify terminals 1 and 2 on terminal block TB8 on the track unit.
2. Cut a slot in the wood base, about 1/4" wide by 3/4" long, for the two wires 1 and 2 to come up through from the bottom.
3. Using the double-conductor stranded wire (Item 61), attach the lighter side to terminal 1 on terminal block TB8. Connect the other end to the right terminal of switch motor M1.
4. Using the same double-conductor wire as the previous step, attach the darker side to terminal 2 on terminal block TB8. Connect the other end to the left terminal of switch motor M1.

Sheet 5 shows these two wires as green and red, but you probably want to use the stranded wire so that switch can be moved around. If switch S1 is going to be permanently located in one place, then use the solid red and green wire so you have the color coding.

#### Connecting AC Power

Make sure you read the comments about voltage in "Increasing AC Control Voltage" on page 6.

The power input is via the female RCA phono plug that is located on rheostat mounting bracket, identified with the label "18 VAC INPUT POWER".

To plug into the female RCA phono jack on the control unit, you need a wire that terminates with a male RCA type phono jack. You can use a Radio Shack #42-2449 or similar. This wire has spade terminals on one end to connect to the transformer, and on the other end has a male phono plug that plugs into female jack on the control unit.

## 0.0 Connecting the Control Unit to Existing Trackage

#### Installation Steps

Sheet 14 "Track Preparation" describes how to attach the control unit to existing permanent or outdoor trackage.

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**Important:** *Try to use straight sidings between switches S1 and S2 as shown in Sheet 14 "Track Preparation". Curved sidings will work, but it is more difficult to accurately control the speed of the locomotives in the slowdown blocks when they pulling against the increased frictional resistance of the curves.*

---

**Note:** You can design and install the trackage with the proper gaps and insulators ahead of time, and install the control unit at a later date. You simply jumper all the blocks to connect them to the main line, and thus operate without the control unit. Sheet 14 "Track Preparation" shows the jumper wiring.

**Cables**

Sheet 15 “Control Unit Cable Connections” shows the wiring for connecting the control unit to the trackage (connecting terminal blocks TB3 to TB8). I suggest using a colored-coded, stranded cable for this connection.

Sheet 15 “Control Unit Cable Connections” shows a 15 wire cable, with 13 wires actually used (Carol Cable Part No. C2423).

Note that if you use only a 3 light target signal instead of the special 4 light signal I show, you do not need wire 14. This means you need only 12 wires instead of 13, which means you can use a 12 wire cable instead of a 15 wire cable. The drawing shows some part numbers for 12 wire cables.

--

# Chapter 0 Operating and Troubleshooting

## 0.1 Check Out Steps

**Test Wiring and Check Out**

For testing, you can hook up the control unit with a simple test wiring arrangement, as shown on Sheet 13 “Test Wiring”. Note that this test wiring is a subset of the wiring connections shown in Sheet 15 “Control Unit Cable Connections”.

Note that you can omit hooking up wires 13, 14, 15, and 16 that operate the target lights and the control unit will still operate—you will just not have indicator lights.

Follow the steps on Sheet 13 “Test Wiring” to check out the control unit. Note you can repeat these tests after you have the control unit installed and connected to the layout, as indicated by the steps indicated by the preface “TRACKAGE”.

## 0.2 Operating Instructions

The attached Sheet 16 “Initial Conditions”gives suggestions for starting the automatic switching block.

In normal operation, the control unit is doing both automatic switching (motor M2) and automatic blocking (motor M3). For special operation, you can shut down either part of the control unit—that is, you can deactivate the blocking function, or you can deactivate the switching function. You can also shut the control unit down entirely, so the whole unit acts like a piece of straight track.

With the idea of making things simpler, these steps begin with operating the unit like a piece of straight track, and progress to full automatic switching block operation.

## 0.3 Possible Malfunctions

You may encounter some of the following problems that can cause the automatic switching block system to malfunction:

- Engine stalls or slows down, upsetting the timing
- Rolling stock uncouples or derails
- Switch motor fails to completely throw
- A Track contact sticks in the closed position.

The first two problems are pretty much self explanatory. The last two are described in more detail as follows:

### 0.3.1 Switch Motor Fails to Throw

Mounting the control unit in a clean location is the best way to keep the switch motors working well. Nevertheless, occasionally a switch motor will fail to “throw completely”. By this I mean that the arm fails to move all the way to the other position as it should.

If the system suddenly malfunctions, you can check for an “incomplete throw” by doing the following:

- Stop all trains immediately.

- Examine the positions of the arms of motors M2 and M3 on the control unit, and also M1 on track switch S1. Verify that the arms are completely to one side or the other, and not stuck in the middle.
  You should never see the arm in the middle—it should be either all the way to one side or the other.
- If none of the arms are not stuck in the middle—that is, if all of the motor arms are throwing completely, perform the checks in the next section 5.3.2, "Sticking Track Contacts", on page 36.
- If the arm is stuck in the middle, reposition it per Sheet 16 “Initial Conditions” and restart the trains.
- If the motor starts sticking on a regular basis, check that the AC control power is not dropping significantly below 18 volts.
  Once when I tried to run 2 trains on the gray 1/2 amp starter set pack, I noticed the automatic block I was using started making incomplete throws, apparently because the AC side of the starter pack was dropping in voltage as a result of my loading the DC side of it to the maximum.

You will occasionally encounter this problem of a motor sticking and not throwing entirely. However, if a motor starts doing this repeatedly, try replacing it with a new one.

#### “Tuning” The Switch Motors

The motors work most reliably if the rack is centered on the pinion. Occasionally the factory seems to assemble one that is off by a tooth, which is not as reliable for automatic operation. Most of the motors are used for manual operation where you push a button with your finger until the switch throws, in which case the motor can be a trifle weak and it will still work because you will keep pushing the button until it completes its travel. However for automatic operation where the engine crossing the track contact creates a limited-duration pulse, it is critical the motor be “optimally tuned”.

I check the centering on the motors I put on units I build, but you can double check by performing the following steps:

- Remove the 1203 relay points if the motor has them.
- Remove the 4 screws holding down the top of the motor, being careful to keep not let the top move.
- Center the arm as much as possible, then hold it in that centered position.
- Remove the lid, being careful to keep the arm in place on the pinion.
- Carefully re-center the arm. The motor housing and arm are symmetrical, so you can visually center them.
- Carefully lift the arm straight up off the pinion, being careful not to let the pinion move.
- You should see a little “tab” on the pinion, and it should be sticking straight up if the rack on the arm was centered on the pinion.
- If the tab on the pinion is not sticking straight up, move it so it does stick straight up.

- Now put the arm with the rack down on top of the pinion, being careful to center the arm with the housing and not to disturb the pinion so that it remains centered. Note that you can move the rack to one side or the other a tooth at a time, but carefully letting the teeth slide over the pinion while the position of the pinion remains unchanged.
- Replace the cover and the 4 screws.
- Replace the 1203 relay points if the motor has them.

**Checking Voltage Across Switch Motor Terminals**

If you suspect that you may be getting a voltage drop to one of the switch motors, such that the motor is not throwing as positively as it should be, you can do a voltage test across the terminals of the motor when the track contact is activated.

- Designate one of the motors to test. You can use all three of them: M1, M2, and M3.
- Turn off the AC power to the control unit.
- Lay a magnet across one of the track contacts that actuates the motor.
- With a voltage range set to the AC range, hold the two leads of a digital voltmeter down inside the terminals of the motor, as shown in the following Figure 42.

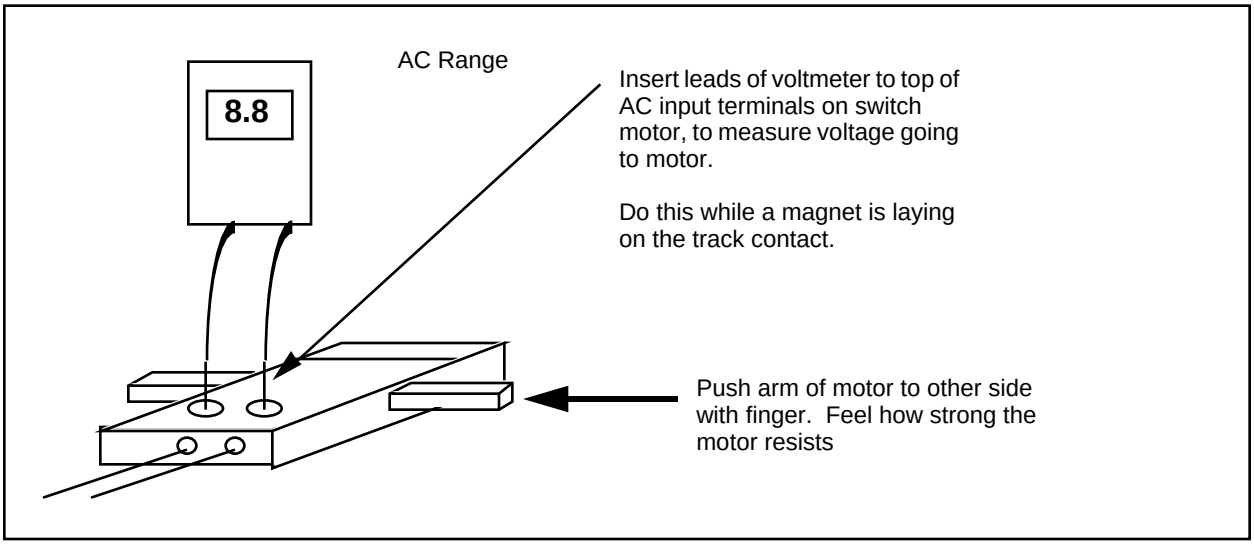


Figure 0 Measuring Voltage Drop Across Switch Motors

- Turn on the AC power.
- Observe and record the AC voltage reading on the meter .
- With your finger, push the arm of the motor to the other side. Feel how strong the resistance is.
  Compare it's strength relative to the other motors. Notice if it catches or has a tendency to hang up anywhere along the length of its travel.
- Turn off the AC power.

Note you can measure the voltage at each motor for each of the two track contacts hooked to it. Expect voltages somewhere in the ballpark around 8.5 volts to 9.6 volts AC for an 18 volt power source.

Note that this voltage measurement you are seeing is not really accurate, as you are measuring a half-wave rectifed signal. The main value should be that you can compare the values produced by four track contact to each other, to see if any of readings are significantly lower than the others.

I would advise against leaving the AC power on for very long when the track contact is in the constantly-closed position due tothe magnet laying on it. LGB claims that you can apply constant AC voltage to the motors without damaging them, but I notice the motors quickly get hot under this condition.

## 0.0.0 Sticking Track Contacts

The 17000 track contact is normally open. It is closed only when a magnet passes over it which causes the contact to momentarily close.

Occasionally a track contact will stick in the closed position, and thus "jam" the system. If the system suddenly malfunctions, you can check for a stuck track contact by doing the following:

- Stop all trains immediately, making sure no engines are parked on top of a track contact.
- Push the arms of motors M2 and M3 to the other position, then return them to the original position. If a track contact is stuck, one of these motors will have power applied to it when it shouldn't, and thus will "fight you" when you try to move it.
- If you find evidence of a sticking track contact, you can identify the sticking track contact as the one that causes the motor to go to the position it is sticking in.
- After identifying the sticking track contact, tap it several times with your finger. This will usually cause it to stop sticking and return to the "open" position.

Often a track contact will stick once in a while, but operate properly for several hundred times before it sticks again. However, you may encounter a track contact that begins to stick repeatedly, in which case you should remove it and replace it with a new one.

# Chapter 0 Reference Notes

## 0.1 Block Lengths

### Determining Correct Lengths of Blocks

If you build one of these units in a new layout, you probably want to calculate the lengths of your slowdown and on/off blocks before you lay the track. Note that Figure 4b on Sheet 4 shows the two slowdown blocks B1 and B3 and the two on/off blocks B2 and B4.

The length of the blocks is defined by the lengths between the 10153 gapped tracks. The length of the on/off block must be sufficiently long to stop a moving engine, or else the engine will skid across the block and keep moving. The following figure may help you estimate your lengths.

**Determining Block Lengths**

| Block | Length |
|---|---|
| B2—Straight On/Off Block | Length of longest engine combination plus *skid* distance of approximately 24 inches |
| B4—Curved On/Off Block | Same as Block B2—due to geometry of the curve track, it will be slightly longer |
| B1—Straight Slowdown block | Length of the longest train—noting that end of the caboose should stop about one foot in front of the switch so a train coming through the switch to the other siding will not hit it |
| B3—Curved Slowdown Block | Same as Block B1—due to geometry of the curve track, it will be slightly longer |

Figure 0 Determining Block Lengths

### Comments About On/Off Block Length

I use the term *skid* distance to refer to the distance the engine will coast or skid after it enters a dead on/off block. An LGB engine with only a couple of cars and running at a slow speed will stop almost on a dime. In this case the *skid* distance is only about 1/4 inch or so. On the other extreme, I have observed an Aristo Craft Alco diesel with about 10 cars moving at a fast pace skid about two feet or so after entering the dead on/off block, since the engine is relatively light and the cars had a lot of momentum.

Therefore, to be on the safe side, you should probably allow a skid distance of about 24 inches if possible.

If you look at drawing Sheet 04 “Track Unit Dimensions”, you see the length of the on/off block is about 40 inches. This length is sufficient to stop all the LGB engines, or a single "A" unit Aristo Craft diesel if the slowdown rheostat R1 is properly adjusted.

If you plan on operating multiple engine trains, you can increase the 40 inch length of the block by the length of the additional engine.

# 0.0 Track Contact Position

### Positioning 1700 Track Contacts T3 and T4

Track Contacts T3 and T4 control the side-to-side power routing for the two legs of the passing siding. Note that Sheet 14 “Track Preparation” shows the track contacts about two inches *to the rear* of the on/off blocks. Make sure you locate these contacts to the rear of the on/off blocks. Do not put these track contacts inside the on/off blocks. The reason why you do not want to put these track contacts inside the on/off blocks is that an engine could stop right on top of the track contact, which will hold the circuit closed and jam the operation of the control unit.

### Positioning 1700 Track Contact T2

The icon view of a track loop on Sheet 09 "Full Size Template for Control Unit" shows Track Contract T2 located about two-thirds of way around the loop, see also Figure 14b on Sheet 14 “Track Preparation”. This is a good location to begin with. For three trains, this will almost always work.

Often you can operate 4 trains or even 5 trains on the same track by moving Track Contact T2 back closer to Track Contact T1—this spaces the trains closer together so as to fit more of them on the same track. Module 4D on Tape 2 of the V9202 video demonstrates these spacing variables for the 944 automatic block—the same principles apply for the automatic switching blocks.

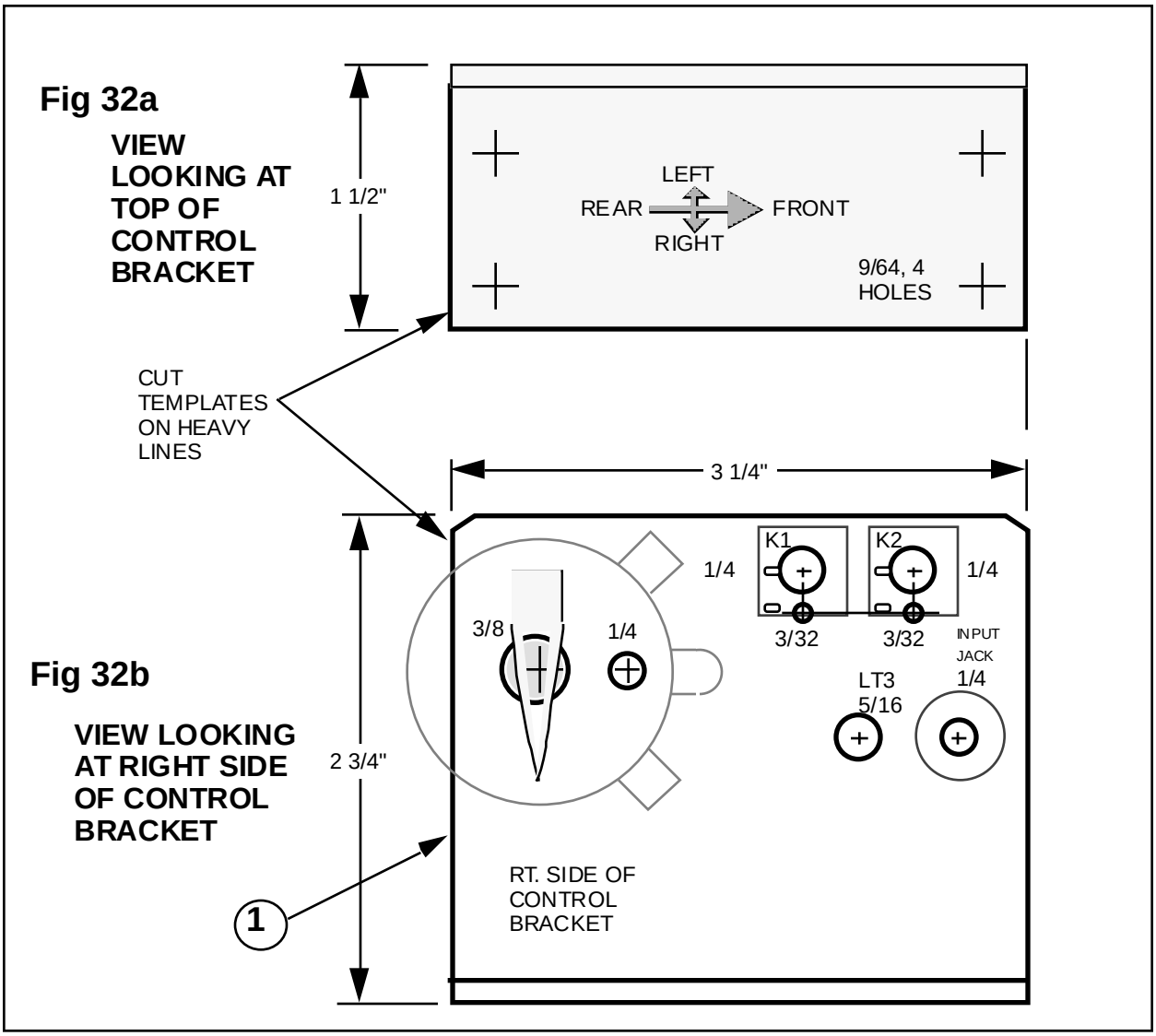


Figure 0 DUPLICATE for cutting of Figure 32, "Templates for Locating Holes in Rheostat Mounting Bracket", on page 12

Cut out the figures on this page to use for the template to punch and drill the rheostat bracket.

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| Revision | Release Date | Description |
|---|---|---|
| A | 8/94 | Operating Instructions Only |
| B | 9/94 | Operating Instructions Only |
| C | 9/95 | First Full Drawing Release |
| C | 5/12/95 | Added 4.1/4.2 Zellner Yard<br>Added 10.1/10.2 Sect 4.2 Control Unit Location for Outdoor Use<br>Added Sh 34 Zellner Yard track layout to drawing set |