Section 11—U_BLD_M Plans for Single-Track Experimenter's Block

This last part of the Bulletin includes complete plans for the Model 146b Single-Track Experimenter's Block:

Drawing Sheets vs. Pages

These instructions include the following drawing::

page 35, Sheet 3 Schematic Drawings (Phases 1, 2, and 3)

page 36, Parts List for Model 146 Single-Track Experimenter's Block

page 37, Sheet 9 Control Unit

page 38, Sheet 4 Automatic Block Track Unit Assembly

Please do not confuse sheet numbers (of the drawings) with the page numbers in this bulletin.

Note: *This section contains reduced size (8-1/2 x 11) drawings which you can use to build this block. You can also order Item 4 Drawings for Single-Track Experimenter's Block, which includes the same drawings, but colored and 11" x 17" full size, plus the construction template made from the bottom half of page 37—full size, in color, laminated and ready to use.*

11.1 Introduction

ABSTRACT: This set of instructions documents the steps to construct, in four phases; and then operate a G-scale model railroad control device, referred to as an "Model 146b Automatic Block". This Automatic Block automatically controls two trains (sometimes more) on the same track, by keeping them separated from each other by maintaining a predetermined spacing.

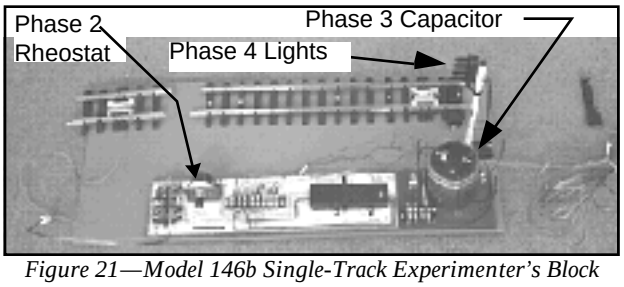


Figure 21—Model 146b Single-Track Experimenter's Block

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

A standard LGB switch motor and relay, activated by standard LGB track contacts, controls the switching on and off the DC track power.

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

This Automatic Block is essentially "plug and play" when used as a portable control unit and track unit combination. You just hook up the AC power, and attach the one remote track contact 'T2'.

This unit has the capability to control a minimum of 2 trains on a single mainline. You can also completely depower it so it acts *inert*—that is, acts just like a section of ordinary straight track.

Videotape Demonstrations

The videotape "Video Textbook for G Scale Automatic Display Ideas" (Item 2, Basic Videotapes 1 & 2V9202) demonstrates how an automatic block operates, using an earlier Model 944 unit.

I suggest you watch the videotapes to "get a feel" for how it operates. This bulletin contains a list on page 21 of people who have at least one of the videotapes.

Objectives

This Automatic Block is intended to be an "experimenter's block", to get you familiar with automatic block operation. After constructing and operating this single-track Automatic Block, you may want to use the other available plans to build a two-track Automatic Switching Block, a 4-track Zellner Yard, or custom configurations of your own design.

You can use this completed block to operate an additional train with the either the 2-track or 4-track switching blocks.

However, if you instead decide not to proceed any further with the automatic controls, the parts used to build this Automatic Block are easily "recyclable" to other model railroad uses.

Skills Required To Construct

As long as you can cut a wire, strip the insulation off the end, and connect it to a screw terminal following explicit diagrams, you can probably build this block. All the construction is done by screwing things together, except 2 solder connections to the rheostat.

The Four Construction Phases

You can construct this block in 4 separate phases as follows.

4. Phase 1—Starter version without slowdown block

   You can construct a simple-as-possible "Starter version" to get familiar with how this block works. On *page 35, Sheet 3 Phase 1—Starter Circuit without Slowdown*, shows the schematic. On *page 37, Sheet 9 Phase 1 Control Unit—Starter Version* shows the actual control unit layout.

5. Phase 2—Standard Version With Slowdown Block

   Later you can later add a rheostat and a few wires to expand the control to add a "Slowdown Block". Now trains will approach a red block at a reduced speed, and also start-up at a reduced speed when the block changes from red to green. On *page 35, Sheet 3 Phase 2—Standard Circuit with Slowdown* shows the schematic. On *page 37, Sheet 9 Phase 2 Control Unit—Standard Version w/Slowdown* shows the actual control unit layout.

6. Phase 3—Standard Version Plus Capacitor (OPTIONAL)

   As of Oct 96, I was still experimenting with the capacitor circuit—it seems to work well with some trains & layouts, and on others I have observed some jerking as the engines enters the stop block. So you may want to skip this step unless it sounds really appealing.

You can add a capacitor wired in parallel with the locomotive motor. On *page 35, Sheet 3 Phase 3—Circuit With Slowdown Plus Capacitor* shows the schematic. On *page 38, Sheet 4 Automatic Block Track Unit Assembly* shows the wiring—you add wires 7B, 7C, plus the capacitor.

When the block changes from Red to Green to start up the locomotive stopped on the block, the uncharged capacitor will drain some of the current away from the locomotive as it charges up, and thus result in a smoother locomotive start. When the next locomotive enters the stop block, the charged capacitor will discharge its energy back into the block, and thus cause the locomotive to drift to a smoother stop.

7. Phase 4—Adding Signal Lights

   You can add red and green signal lights to the block, that will indicate the "state" of the block. On *page 37, Sheet 9 Phase 2 Control Unit—Standard Version w/Slowdown* shows the wiring—you connect the lights to terminals 2, 15, and 16.

AC Current And DC Current

This block uses both AC and DC current.

The AC current is what powers the controls of the block, and the signal lights. The block gets its AC current from the two wires connected to the knife switch K0, which are connected to the AC output of the transformer. The AC wiring is standard LGB circuitry, just like you use to wire your track switches, except we use the track contracts activate the switch motor, instead of the orange 5175 momentary switch control box where your finger pushes the button.

The DC current is the track current that the block controls by switching it off and on, to stop and start the locomotives. The block gets the DC current from the left (+) rail of the mainline just in front of the block, and returns it to the left rail of the stop block and the slowdown block.

AC Control Voltage

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 (rectified to DC) is what powers the switch motor 'M3' that operates the relay.

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 occasions when I have been demonstrating my units at shows, where my 110v ac power connection has been at 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

I have observed that increasing the voltage to 20 or 22 or 24 volts, appears to 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 discontinued version of a San-Val pack that supplies 22 volts AC.

A 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.

Voltage Recommendation

I recommend you use the minimum voltage you can, starting with the "stock" 18 volts, to get reliable operation of the switch motors. At 24 volts, I believe the track contacts may wear out a bit sooner. By "wear out", I mean they start to frequently stick in the closed position—see *page 34, Sticking Track Contacts* for discussion.

The Shiloh Signals searchlight signals with LED s can be ordered to handle up to 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.

BOOSTER: The LGB 52750 Booster is designed to provide more positive operation of switch motors. However, per LGB catalog 02996 "Lights may not be connected to the EPL Booster", but should be on a separate circuit. For this reason, I do not use the Booster with these controls, although you could if you modified the circuits to keep the lighting circuits separate from the circuits that actuate the switch motors.

Wiring Color Code

To make it easier to follow the paths of the circuits on the templates, all the wires are color-coded, as per the following Figure 22.

Each drawing has the wire numbers and colors listed. If you are using the black and white drawings in this bulletin, I recommend you use a colored pencil to color the wires. The circuits are 10 times easier to follow after the wires are colored.

Wiring Color Codes

Where Used	Color	Prefix
Positive (+) *uninterrupted* AC	Red	R
Negative (-) *uninterrupted* AC going *to* the 1700 track contacts	Yellow	Y
Negative (-) *intermittent* AC coming *from* the 1700 track contacts	Green	G
Positive (+) *uninterrupted* DC coming from the positive left rail	Blue	B
Positive (+) *interrupted* DC controlled by switch motors M2 and M3	Black	L
Switched AC (+) to target signal	Gray	A

Figure 22—Wiring Color Codes

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 list on page 36 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.

11.2 The Laminated, Modular Design

What's A "Laminated Template"?

The control unit for this block is built on, what I refer to, as a "laminated template", as shown in the following Figure 23.

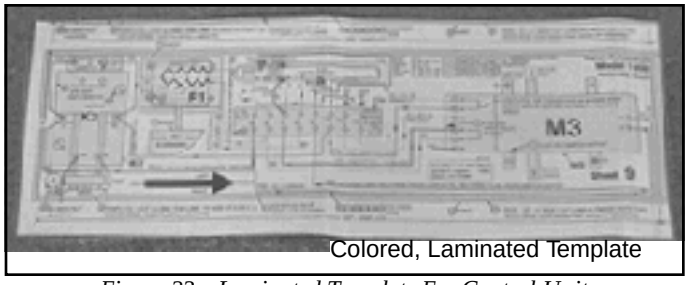


Figure 23—Laminated Template For Control Unit

The laminated template is a full size drawing, with all the wires shown in the proper color, that has been plastic laminated. You glue the laminated template to the wood base, and then attach the parts right on top of the template.

Using the template has the following advantages:

- Assembly is easier, since you just attach parts and wires right on top of the outline on the template. There is no measuring or wondering where anything fits—it's almost like a child's "connect the dots" coloring book.
- More importantly, you have built-in documentation showing where every wire belongs and connects. The small diagram just above terminal block TB4 shows, in icon form, exactly how every wire connects to the track.

What's A "Modular Design"?

This unit uses a "modular design"—that is, the control unit is build on a separate base from the track unit. Having the control unit separate from the track gives you flexibility. You can move the control unit to a location away from the track unit, such as in your control panel, or to a different track unit, or swap-out one control unit for another one having different components or logic.

What If I Skip The Template And The Modular Design?

You could save some steps by omitting the template and mounting parts directly on the track unit, but I would advise against this. The documentation of the template is always helpful., and having the control unit detachable from the track gives you flexibility.

Section 12—Construction Steps

12.1 Making Template and Bases

1. Procure all parts per the parts list on page 36.

Note: *You do not need the first 3 items on the list for the Phase 1 version.*

Making The Template

Drawing Ref. for following steps: page 37 **(Sheet 09)**

2. Enlarge the BOTTOM half of page 37 (*Sheet 9 Phase 2 Control Unit—Standard Version w/Slowdown*) on a copier by a multiplication of about 1.54.

   Note the 1-inch square box on the left side, that you can use as a check that the size is correct.

   Explanation: the original 11" x 17" drawing was reduced to 65% size to shrink it down to 8-1/2 x 11, so enlarging it 154% (1/0.65 = 1.538) should restore it to full size).

Note: *If you are using Item 4 Drawing Set for Automatic Block, you do not need to do Steps 2 through 5, since the template is already full-size, colored, and laminated, and ready to go.*

3. Identify the border of Item 13 the template, where you see the note "... cut along this line". This template border should be 3-3/4" wide and 15" long after enlargement to full size.

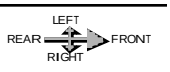
Note: *Double check that you are using the bottom of half of page 37, and not the drawing on the top.*

4. Use blue, green, red, and yellow colored pencils to color the wires on the enlarged Phase 2. The note above motor M3 "Wiring Color Code" defines the color of each wire.
5. Plastic laminate this 3-3/4" wide by 15" long colored sheet. 'Office Depot' type copy stores can do this laminating. Or you can buy do-it-yourself laminating sheets (such as C-Line #65001 Clear-Adheer Do-It-Yourself Laminating Sheets) from Sam's Club or office stores.

Base Assembly

6. Cut a piece of 1/2 inch thick plywood 4" wide x 21" long for the base of the control unit (Item 27).
7. Cut a piece of 1/2 inch thick plywood 12" wide x 26" long for the base of the track unit (Item 62).
8. Sandpaper the bases to remove all rough spots.
9. Paint the base using Ace 35A-1A Beechtree (Item 19, brown) or color of your choice.
10. Glue the laminated template (Item 13) to the rear end of the wood base, using the adhesive (Item 17). There should be about 1/8" border on 3 sides, with about 5-7/8" on the front—refer to *page 38, Sheet 4 Automatic Block Track Unit Assembly* as a check.

Note: *The directions left, right, front, rear; are as per coordinates shown on the drawings.*



The base is now ready to attach parts.

12.2 Attaching Parts - Control Unit

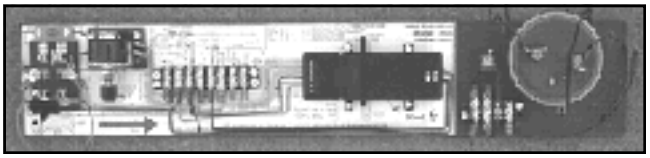


Figure 24—Model 146b Control Unit

Preparing Switch Motor M3

11. **Preparing Switch Motor And Relay:** 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 motor. Pry this cover plate off using a screwdriver, and then snap the relay points into the end of the switch motor.
12. Ream the holes in left-rear and front-right feet of the switch motor with a 7/64" drill.

> **Note:** *As an alternate to screwing down the switch motor, if you don't want disturb the threads in the plastic feet, you can drill 9/64" holes in the wood base, and use wire to tie the plastic feet to the base.*

Drilling Holes and Attaching Parts

13. Drill 5/64 pilot holes in the wood control unit base, for the knife switch, light bulb base, terminal block, and switch motor.

> **Note:** *You can later disconnect the light bulb, or omit it entirely, if you are planning to add signal lights.*

The purpose of the light bulb is to verify the control is receiving AC power. The signal lights will verify presence of power also.

14. Screw these parts to the wood base by using #4 x 5/8" long wood screws (Item 29).
15. **Holes for Wing Nuts and Screws:** 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 the wing nut hole location at the right-rear end of the base.

    Refer to *page 38, Sheet 4 Automatic Block Track Unit Assembly* for the location of the left-front hole, since it is off the template.

12.3 Connect Wires - Control Unit—Phase 1

Note that we are using the template we made using the Phase 2 diagram. But we are using the Phase 1 diagram as a guide for the following steps.

In Phase 1 we will build a "bare bones" basic unit. Thus we will not use all the wires for Phase 1. Later we can add the rheostat and additional wires to make the Phases 2, 3, and 4.

Construction Notes

- You can strip about 1/4" of insulation off the ends of wires that connect to switch motors and relay points.—that is, where you are sliding the end of the wire into the small hole.
- When stripping insulation off the ends of wires that connect to terminals, you can strip off about 1/2".
- When connecting wires to terminals, you can use the spade connectors (Item 51) to make a neater attachment.
- You might want to experiment with the procedure of hooking up one end of the wire, then using pliers to bend sharp corners to follow the path on the template fairly exactly to achieve a neat installation—depending on how fussy you want to be.

Attaching the Wires

Use *page 37, Sheet 9 Phase 1 Control Unit—Starter Version* as a guide for the following steps—don't look at Phase 2 yet.

16. **Black Wires:** Connect BLACK wire L3 (prefix L=BLACK) using 18 gauge solid wire (Item 20).

    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.)

17. **Blue Wires:** Connect BLUE wires B2 and B99 (prefix B=BLUE) using 18 gauge solid wire (Item 21).

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

18. **Green Wires:** Connect GREEN wire G2 (prefix G=GREEN) using 18 gauge solid wire (Item 23).

    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.

19. **Red Wires:** Connect RED wires R2 and R11 (prefix R=RED) using 18 gauge solid wire (Item 24).

    Note wire R3 is the wire coming from the light, Item 82. For this wire, you can just shorten the wire that comes attached to the light and use that.

    Red wire is used for AC - (common).

20. **Yellow Wires:** Connect YELLOW wires Y1 and Y16 (prefix Y=YELLOW) using 18 gauge solid wire (Item 25).

    Note wire Y3 is the wire coming from the light, Item 82. For this wire, you can just shorten the wire that comes attached to the light and use that.

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

Conclusion: At this point, the Phase 1 assembly of the control unit should be complete.

12.4 Assembly Steps - Track Unit

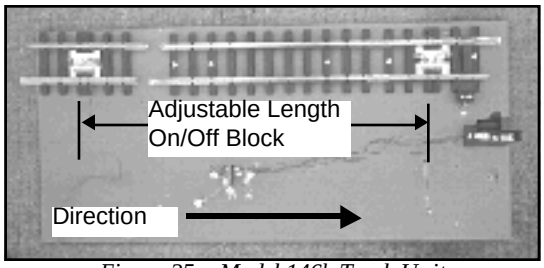


Figure 25—Model 146b Track Unit

Attach Track To Base

Drawing Ref. for following steps: page 38 **(Sheet 4)**

Refer to *page 38, Sheet 4 Automatic Block Track Unit Assembly* for the following steps.

21. Position the loose track on top of the wood base.

22. Verify for both 10153's (Item 48), the gap is in the left rail Verify you have not forgotten track contact T1.
23. With the track in position, use a 5/64" drill to drill holes through the plastic ties and into the wood base.
24. Attach the frontmost 2 pieces of track using #4 x 5/8" long wood screws (Item 29).

    Leave the rear 10153 single isolating track unattached. This can disconnected, moved to the rear, and more track inserted in-between, to make the length of the stop block as long as necessary.

Attach Control Unit to Track Unit

25. Position the control unit on the corner of the track unit, and drill two 3/16 holes to match the holes in the control unit.
26. Using the 2 wing nuts and screws (Item 28), attach the control unit to the track unit.

Connecting Wires On Track Unit

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

27. **Black Wires:** Connect BLACK wire 7.

> **Note:** *Black wire 3 does not get attached until later when you add the slowdown circuitry in Phase 2.*

28. **Blue Wires:** Connect BLUE wire 8.
29. **Green Wires:** Connect GREEN wires 9 and (after reading below) 12.
30. **Yellow Wires:** Connect YELLOW wires 10 and (after reading below) wire 11.

Option: Use Stranded Wire For Wires 11 & 12

On Sheet 04 "Track Unit Layout", the two wires 11 and 12 are shown as yellow and green respectively. If T2 is going to be permanently located in one place, then use the solid yellow and green wire as described in the previous two steps, so you have the color coding.

However, if you plan to move track contact T2 a lot, you may want to use the stranded wire instead of solid wire. If you want to use stranded wire, substitute the following 2 steps for the previous 2 steps.

31. Using the double-conductor 18 gauge stranded wire (such as Radio Shack 278-1301 or similar), attach the darker conductor (substituting for green) to terminal 12 on the terminal block. Connect the other end to the front-most terminal of track contact T2.
32. Using the same double-conductor wire as the previous step, attach the lighter conductor (substituting for yellow) to terminal 11 on the terminal block. Connect the other end to the center terminal of track contact T2 as shown.

Connecting AC Power

Make sure you read the comments about voltage in *Increasing AC Control Voltage* on page 26.

The power input is via terminals 17 and 18 on the center of the knife switch. Connect these to the AC terminals on your power pack.

OPTION: You can connect input power using a female RCA phono plug for a quick connection. This is shown in Figure 26"—Using Phono Jack Wire For Input AC Power".

You can use a Radio Shack #42-2449 or similar; and cut it into a piece about 1 foot long and a 2nd piece about 11 foot long. You can put spade terminals on the cut end of the 11-foot piece to connect to the transformer. The other end has a male phono plug, with a connector, will quickly connect to the male phono plug of the 1-foot piece connected to the control unit.

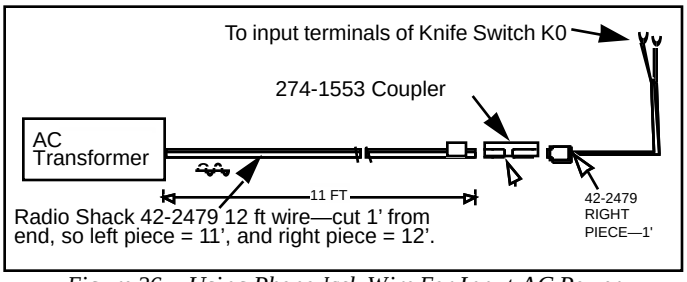


Figure 26—Using Phono Jack Wire For Input AC Power

What To Do Next

At this point, you have completed the assembly of the bare-bones Phase1 block. I suggest you skip ahead to *Section 13.1Operating Phase 1 Starter Version*, on page 31, to get familiar with operating the block, then return to this spot for the Phase 2 assembly.

12.5 Phase 2—Add Rheostat & Slowdown Section

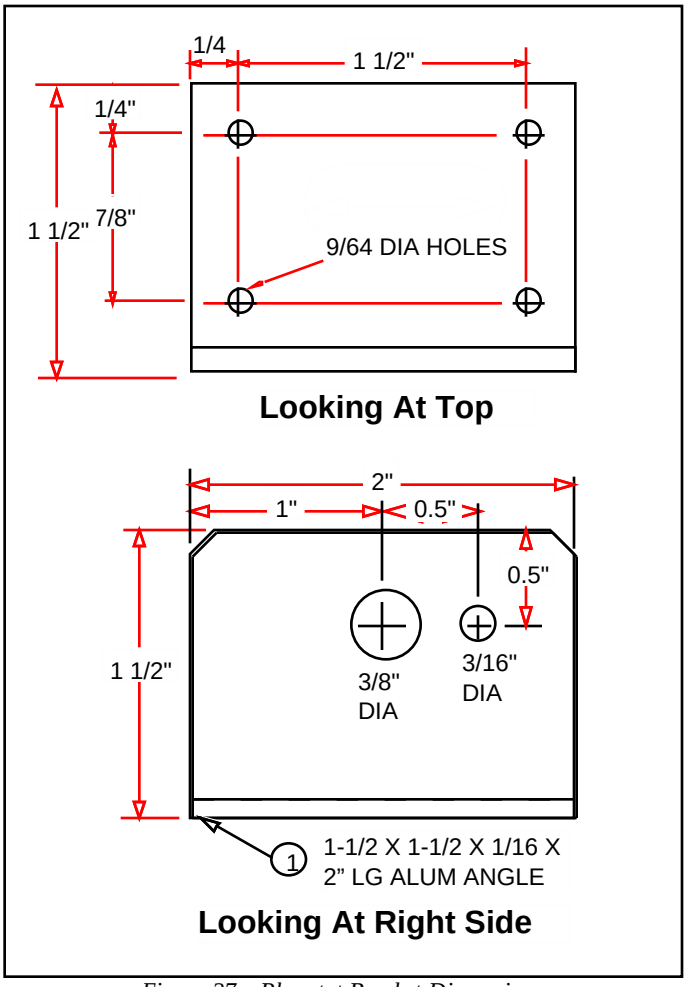


Figure 27—Rheostat Bracket Dimensions

Phase 2 adds the rheostat and the slowdown section in the track. This allows locomotives to enter the block area at reduced speed,

before they stop, and then start up at reduced speed for a smoother start.

Rheostat Bracket

Drawing Ref. for following steps: page 38 **(Sheet 4)**

33. Using *Figure 27—Rheostat Bracket Dimensions*, on page 29 as a guide, cut a 2 inch long piece of 1-1/2" x 1-1/2" aluminum angle.
34. OPTION: To avoid doing any measuring, you can copy this Figure 27, and rubber cement the copy of the drawing onto the piece of aluminum. Then you can use a hammer and center punch, and punch a starter indentation where the holes are shown on the paper.
35. Drill the 6 holes as shown.
36. Screw the rheostat bracket to the wood base.
37. Attach the rheostat and rheostat knob.

Wires

Refer to *page 37, Sheet 9 Phase 2 Control Unit—Standard Version w/Slowdown* as a guide for the following steps.

38. Remove BLUE wire B99 (this is a temporary jumper wire for Phase 1 that is not needed for Phase 2).
39. Solder BLUE wire B1 to the TOP tap of the rheostat, and connect to terminal 8 on terminal block TB4.
40. Solder BLUE wire B5 to the CENTER tap of the rheostat, and connect to terminal 3 on the terminal block.

Note: *Do not connect wires A1, A2, and Y16 yet. These are for the signal lights, which are not connected until Phase 4.*

Adding Slowdown Track

Drawing Ref. for following steps: page 38 **(Sheet 4)**

41. Add the second 10153 isolating track to define the rear end of the slowdown block.

    LENGTH: You might start with a slowdown section about 4 feet long, then experiment with different lengths.
42. Connect BLACK wire 3 to the rear 10153 isolating track on the track unit base, as shown on *page 38, Sheet 4 Automatic Block Track Unit Assembly*. Make this wire about 48" long so you can slide the isolating track back to the rear if necessary to increase the length of the block.
43. Double check that this wire 3 is connected to the left rail in the slowdown block, and not improperly connected to the mainline, and not improperly connected to the stop block.

What To Do Next

At this point, you have completed the assembly the of the Phase 2 block. I suggest you skip ahead to Section *13.2Operating Phase 2 Version With Rheostat*, on page 32, to get familiar with operating the block, then return to this spot for the Phase 3 assembly.

12.6 Phase 3—Add Capacitor

What's The Capacitor Good For?

Phase 3 adds the capacitor. This allows locomotives to start up with a gentler start when the block changes from RED to GREEN. This gentler start happens, because when the block changes to GREEN, the discharged capacitor, as it charges up, will "steal" part of the current away from the locomotive.

Please note that this phase is OPTIONAL. I am still evaluating it's usefulness—sometimes it seems to work well, but not always. Adding the rheostat (Phase 2) produces the most benefit for smoothing out the start up.

Make sure you have the rheostat R1, from Phase 2, installed ahead of (in series with) the capacitor. You have to have some resistance in series with the capacitor, or it does not work well at all.

Obtaining The Capacitor

The best place to find a capacitor with the large enough amount of capacitance at a reasonable price, is probably a surplus electronics store.

You want capacitor sized somewhere in the ballpark, and I emphasize the word ballpark, of 40,000 microfarads, with a working voltage DC (WVDC) of around 25 volts. You sometimes see this capacitance size written also as 40,000 M farads, or 40,000 µ farads. (A micro farad, or µ farad, is 1 millionth of a farad, or 1 x 10^{-6} farads.)

The biggest size capacitor Radio Shack handles is 4700 microfarads, so this is too small.

I have one capacitor that is 40,000 microfarads and 25 WVDC, and the size is about 3-1/2 inches high by about 3 inches diameter.

You will probably get positive results with anything sized between 15,000 microfarads and 80,000 microfarads. The 40,000 microfarads is plenty large for my starter engines.

Note that you can also put several smaller capacitors together by wiring them in parallel with each other. The total capacitance will the sum of the individual capacitances.

You can also use a capacitor of higher working voltage than 25 WVDC. The unit, however, will be larger in size for a given capacitance.

You can think of the capacitor as a very short-term battery, or the electrical equivalent of a rubber band, or the electrical equivalent of a spring. Charging the capacitor up when the block changes to GREEN, is equivalent to stretching out the rubber band, or stretching the spring—while it's stretching (charging up), it's "stealing" current from the locomotive which takes the jerk out of the locomotives start-up.

Hooking Up The Capacitor

Drawing Ref. for following steps: page 38 **(Sheet 4)**

On *page 38, Sheet 4 Automatic Block Track Unit Assembly* shows the capacitor sitting on the front end of the control unit. The location is not critical, is long as you ensure you get it wired in parallel with the locomotive.

This means the current must flow from terminal 7 on terminal block TB4, to the (+) terminal of the capacitor, then from the "-" terminal of the capacitor to the "-" right track rail.

Note: *Make sure you do not reverse the (+) and "-" terminals of the capacitor—this could ruin the capacitor.*

---

44. Attach black wire 7B from terminal 7 to terminal block TB5.
45. This step, installing switch K3 is OPTIONAL, but I recommend it. When the switch is closed, the capacitor will be "in the circuit". When you open the switch, the capacitor will

be “out of the circuit”. Thus by turning this switch on and off, you can easily compare the operation with and without the capacitor.

Install toggle switch K3—use a Radio Shack 275-612 SPST toggle switch or anything similar. Install it so that when the handle is forward, the switch is closed.

The easiest way to install it is to solder two stiff wires about 2" long onto the switch, put spade terminals on the other ends, then just slide screw it to terminal block TB5.

46. Attach remaining wires 7B2, 7C, and 7C2.

    Make sure wire 7C2 connects to the right (-) rail.

What To Do Next

At this point, you have completed the assembly the of the Phase 3 block. I suggest you skip ahead to *13.3Operating Phase 3 Version With Capacitor*, on page 32, to get familiar with operating the block, then return to this spot for the Phase 4 assembly.

12.7 Phase 4—Add Signal Lights

The signal lights do not affect the function of the block, but I strongly recommend them, as they add to the visual interest when the block operates.

The template shows the wiring for lighted signal, such as the Shiloh two-light #GS2S units, or the Model Power #990 two-light units. The Model Power units are cheaper, but they use bulbs, and seem to me to be disturbingly fragile. The Shiloh units are probably preferable—they are sturdier, plus the high intensity LEDS should last longer than bulbs.

You can also hook up semaphore units such as the LGB 5092 through 5095 series, although this is slightly more complicated, as you are adding a second motor to the system.

Hooking Up Signal Lights

Drawing Ref. for following steps: page 38 **(Sheet 4)**

Refer to *page 37, Sheet 9 Phase 2 Control Unit—Standard Version w/Slowdown* for the following steps.

47. Hook up yellow wire Y16, and gray wires A1 and A2 as shown.

    The gray color indicates wires that carry switched AC to power the lights.

48. Position the light on the track unit. Note that Sheet 4 shows a suggested location for the signal light on the front of the track unit.

49. Hook up terminals 15 and 16 of terminal block TB4 to the red and green lights.

50. Hook up the common (-, ground) wire from the lights to terminal 2 of TB4 as shown.

Checking Signal Lights

Operation will be the same as Phases 2 and 3. The following steps will verify the lights are working properly.

51. Push the arm of motor M3 to the left (RED) position. Verify the red signal light is lit.

52. Push the arm of motor M3 to the right (GREEN) position. Verify the green signal light is lit.

Alternate 1—Using LGB Semaphore Signal For Lights

Note this is an ALTERNATE to using the signal lights. You would probably want to mount the motor on the front of the block where the capacitor is shown, and locate the capacitor somewhere else.

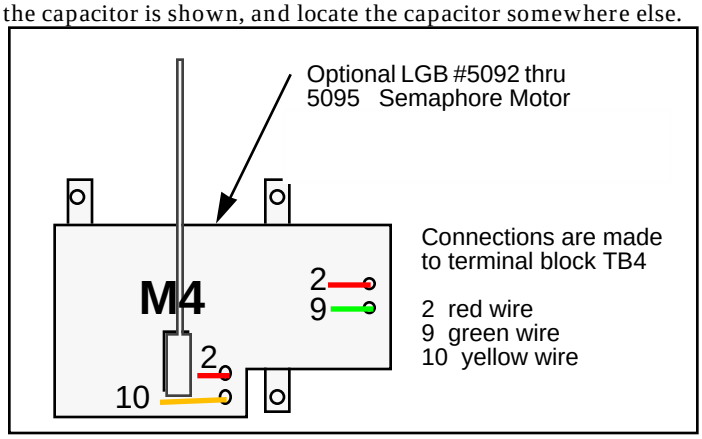


Figure 28—Wiring Alternate Semaphore Motor

Figure 28—Wiring Alternate Semaphore Motor, on page 31 shows the wiring for the semaphore.

Alternate 2—Using LGB Semaphore For Lights & Relay

As you probably know, the LGB 5092 through 5095 series signals include relay points on the same motors that operate the semaphores.

Because this system uses 1 motor to power 2 mechanical items (relay and semaphore arm), it has in the past seemed to be less reliable. Since 1988, to improve reliability, I have been using 1 motor for relay points only, and a separate motor for operating mechanical semaphore arms (if one is used).

Therefore, based on my past experience, I do NOT recommend using 1 motor for both relay and semaphore arm, but you may want to experiment. If you use the Booster or higher voltages, you may be able to get reliable operation of both mechanisms from one motor.

Section 13—Operating The Automatic Block

13.1 Operating Phase 1 Starter Version

53. Verify you have completed Phase 1 construction steps in Section *12.3Connect Wires - Control Unit—Phase 1*, on page 28 through Section *12.4Assembly Steps - Track Unit*, on page 28.

Check Out Steps

54. Connect AC control power to the knife switch.

55. Verify the light bulb lights when the knife switch is closed by pushing the handle down to the right.

56. Verify the arm of motor M3 moves to the left (RED) when a magnet is held over track contact T1.

57. Verify the arm of motor M3 moves to the right (GREEN) when a magnet is held over track contact T2.

Operating Instructions

The following *Figure 29 —Initial Conditions—Phase 1* gives suggestions for starting the automatic block.

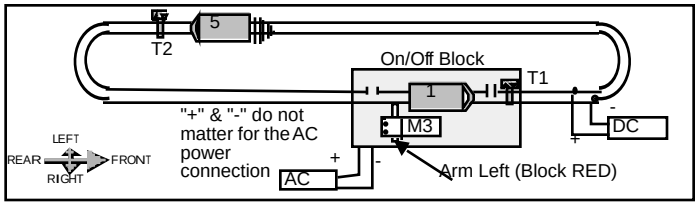


Figure 29—Initial Conditions—Phase 1

You may want to try to duplicate some of the steps shown on Module 4D of Video V9202, Tape #2:

58. Initial Conditions 1:
    - AC power to block: OFF.
    - Block in GREEN position (arm to right).
    - Position a single train as shown by engine 5 in Figure 29. Engine 1 is removed from the track.

    Action: Run 1 train around the loop to verify that trains will pass over the depowered block.

59. Initial Conditions 2:
    - AC power to block: ON.
    - Block in RED position (arm to left).
    - Put a magnet on bottom of engine 5.
    - Position a single train as shown by engine 5 in Figure 29. Engine 1 is removed from the track.

    Action: Run engine 5 around the loop and verify it will change the block from red to green back to red as it passes around the loop.

60. Initial Conditions 3:
    - AC power to block: ON
    - Block in RED position (arm to left).
    - Put magnet on bottom of 2 engines. Position 2 engines as shown in Figure 29.

    Action: Run trains around the loop and verify the block will keep them separated.

61. Do this step only if one of your two engines is consistently faster than the other one.

    Initial Conditions 4:
    - AC power to block: ON.
    - Block in RED position (arm to left).
    - Put magnet on bottom of slower engine, no magnet on bottom of faster engine.
    - Position 2 engines as shown in Figure 29, with the slower engine being the position shown by engine 5.

    Action: Run trains around the loop and verify the block will keep them separated. Slower engine 5 with the only magnet should always have a green block and never stop.

62. Do this step only if you have 3 engines that run approximately the same speed.

    Initial Conditions 5:
    - AC power to block: ON.
    - Block in RED position (arm to left).
    - Put magnet on bottom all 3 engines.
    - Position 2 engines as shown in Figure 29, and the 3rd engine in between those two. You may have to move track contact T2 clockwise around the loop (closer to contact T1). (The best reference for this is to watch Module 4D (Living Room Demo) on videotape #2, where I demonstrate operating 3 and then 4 trains on the same loop with one block.)

    Action: Run these 3 trains around the loop and verify the block will keep them separated.

    Note that if one of these 3 engines is consistently faster than the other two, you can remove the magnet from it.

13.2 Operating Phase 2 Version With Rheostat

63. Verify you have completed Phase 2 construction steps in Section *12.5Phase 2—Add Rheostat & Slowdown Section*, on page 29.

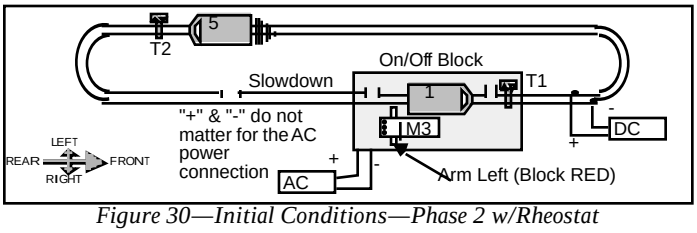


Figure 30—Initial Conditions—Phase 2 w/Rheostat

64. Turn the knob of the rheostat all the forward (CW). This will set the resistance to zero, that is, no slowdown. Operate the block in this setting to verify trains are travelling across the slowdown section ok.

    With zero resistance, the block should operate the same as it did in Phase 1.

65. Begin experimenting with turning the rheostat know CCW, which increases the resistance. This should start slowing trains down as they enter the slowdown section, and starting them up more gently when the block changes from RED to GREEN.

13.3 Operating Phase 3 Version With Capacitor

66. Verify you have completed Phase 3 construction steps in Section *12.6Phase 3—Add Capacitor*, on page 30.
67. Set toggle switch K3 to the rear, which should disconnect the capacitor. Then verify the block operates exactly the same as it did for the Phase 2 version.
68. Set toggle switch K3 to the front to connect the capacitor. Adjust the rheostat about in the middle.

Note: *Do not set the rheostat all the way forward (zero resistance) when using the capacitor.*

Without resistance in the circuit, the capacitor "sucks up" current too quickly, and drops the voltage when the block changes to GREEN, as it acts like a short circuit when it first starts charging.

This momentary short-circuit effect and resulting voltage drop will jerk the engine on the mainline, and may make your transformer unhappy.

Making sure there is some resistance in series with the capacitor, prevents the short-circuit effect.

69. Experiment with the capacitor, by varying the rheostat setting.

Section 14—Track Planning For Best Visual Effect

You may want to give some thought to the "visual effectiveness" of the track plan you use with this block. The reason I mention this is, the effects of a single-track block operating on a simple oval loop can be subtle—that is, with a train on one side of the loop and another train on the other side, a casual observer may never realize there is more than 1 train running.

A way to emphasize the fact that there are two trains on the same loop, is to configure the track plan so the viewer's eye is forced to see both trains at once. You can do this by using an elevated crossing, or a crossover, or a dogbone—set them up so, at some point, one train passes close by the other, and the observer cannot fail to notice that there are 2 trains on the loop.

Figure 31 and Figure 32 show examples of a dogbone and elevated Figure 8, configured so the viewer sees both trains in the same scene. In fact, as the viewer observes engine 5 passing by on the mainline as it travels over Contact T2, engine 1 on the stop block will start up, for "added drama".

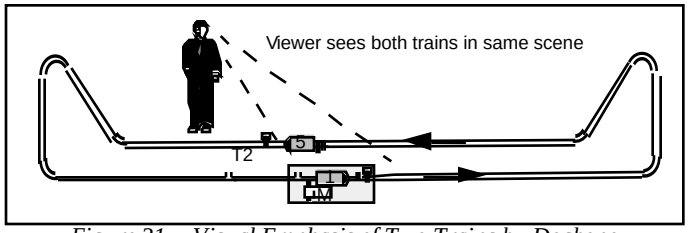


Figure 31—Visual Emphasis of Two Trains by Dogbone

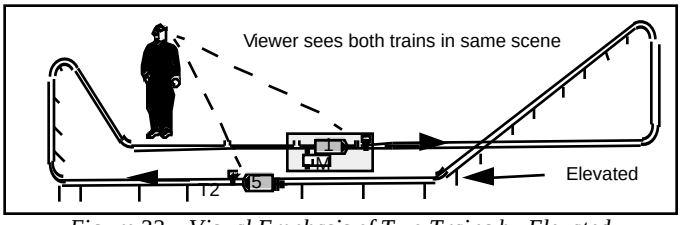


Figure 32—Visual Emphasis of Two Trains by Elevated

Section 15—Troubleshooting

Possible Malfunctions

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

- Engine stalls or slows down, upsetting the timing
- Rolling stock uncouples or derails
- AC Control Voltage is too low—see *AC Control Voltage* on page 26
- Relay motor M3 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:

15.1 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 position of the arm of the motor M3 on the control unit. Verify that the arm is 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 the arm is not stuck in the middle—that is, if the motor arm is throwing completely, perform the checks in the next section *15.2Sticking Track Contacts*, on page 34.
- If the arm is stuck in the middle, reposition it per Figure 29"—Initial Conditions—Phase 1" 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 usually 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 from the end of the motor.
- 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.
- Find the little "tab" on the pinion. This little tab 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 the pinion so it does stick straight up.
- Now re-center the arm, by carefully lifting the arm straight up off the pinion, being careful to keep the pinion centered.

  Note that you can move the arm with 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 centered.
- Replace the cover and the 4 screws.
- Replace the 1203 relay points.

Checking Voltage Across Switch Motor Terminals

If you suspect that you may be getting a voltage drop to the switch motor, 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.

- 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 33.

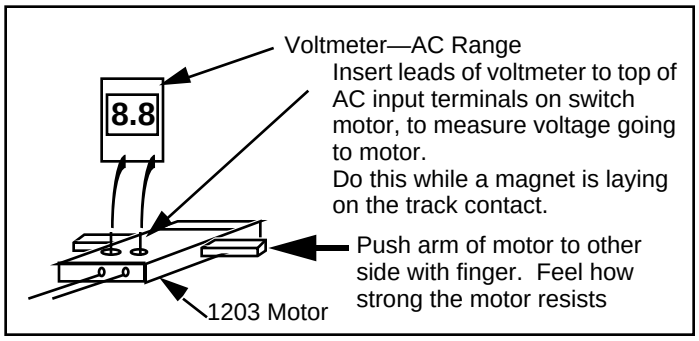


Figure 33 —Measuring Voltage Drop Across Switch Motors

- 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 (if you have others connected to track contacts).
- Notice if the motor 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 rectified signal. The main value should be that you can compare the values produced by different track contact relative 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 to the 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.

15.2 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 the motor M3 to the other position, then return it to the original position. If a track contact is stuck, the motor 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.

  For this single-track block, a sticking T1 contact will jam motor M3 in the left (RED) position. A sticking T2 contact will jam motor M3 in the right (GREEN) position.
- 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.

Feedback Form

Name: _____

Home Phone: _____ - _____

Street: _____

City: _____

State:_____ Zip: _____

Date: _____

Please feel free to use this section for any feedback or comments you might wish to make — just mail it to the address on the bottom of the page. You can also send it **anonymously** if you prefer.

Existing Products

Any changes in the existing line of "products" you would like to see:

_____

_____

_____

_____

New Products

Any new Ingram Autocontrols non-electronic template-type "products" you would like to see: (such as possible Reverse Loop control template, Automatic Route Selection template, etc)

_____

_____

_____

_____

_____