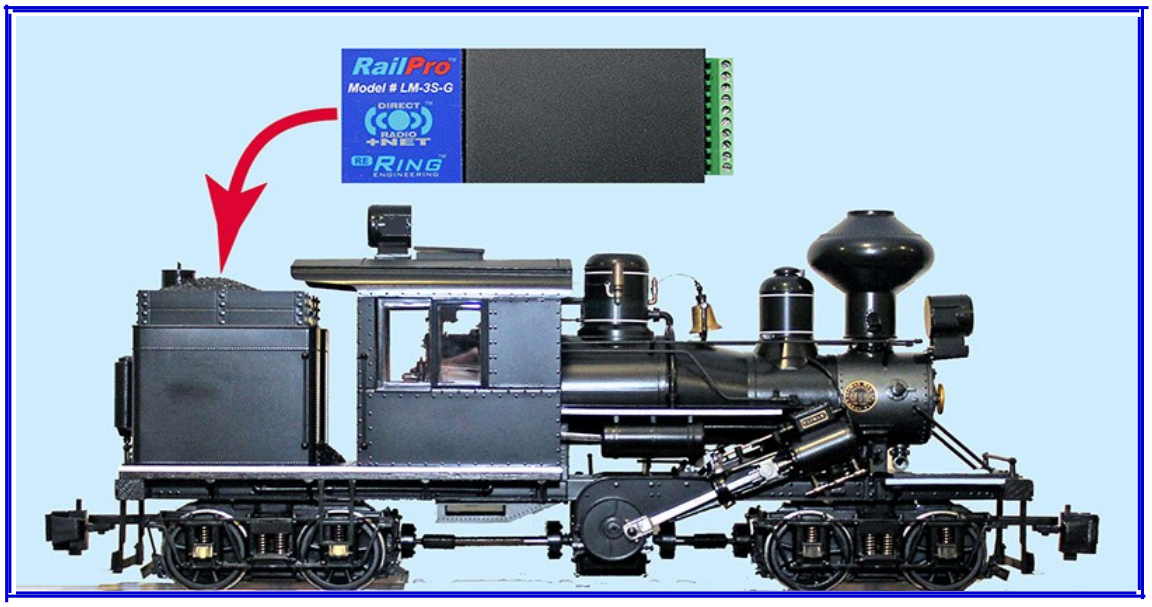
Installing a RailPro LM-3S-G Loco Module in a Bachmann Fn3 Climax Locomotive



by

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INTRODUCTION

Read on to learn how I installed a RailPro (http://www.ringengineering.com/RailPro.htm) LM-3S-G locomotive module with sound in a Bachmann Fn3 scale Climax model locomotive. After several false-starts and dumb mistakes, it turned out to be fairly straightforward. I hope this document helps you perform a smooth installation.

My background

I've been involved in model railroading for a long time, and modeled the Virginian Railway in HO scale (http://virginian.mdodd.com) from 1996 until 2008. I equipped all my locomotives with DCC sound decoders, and held regular operating sessions from 2000 until July, 2008, when the layout was dismantled and given to a friend who regularly attended op sessions.

My wife, Louise, and I moved to a new house in 2011, and I became too busy to begin a new Virginian layout. In 2017 I decided to forgo the Virginian, and model a proto-freelanced West Virginia logging railroad with geared locomotives in large scale. At first I planned to again use DCC to control the engines, but after hearing great things about RailPro, and learning more about the technology it uses, I chose that system instead.

This is my first-ever venture into large scale and Bachmann F scale products. As I understand it, Bachmann produced two or more versions of the Climax and a 3-truck Shay. I believe I have the latest versions of both engines, so the procedures I describe in this document for my Climax might not work for earlier versions.

Bachmann packed a lot of electronics into these engines! This is a blessing because it simplifies installing a loco module. But Bachmann did a poor job of documenting the internal electronics, so I had to do some detective work during my installation.

Fortunately, I have worked with electronics for many years, so figuring out the Climax electronics didn't take long.

FINDING YOUR WAY AROUND THIS DOCUMENT

Throughout this document, "hyperlinks" to figures, tables, and other sections are shown in **bold green.** Click the mouse pointer on a link to go directly to that location. For example, clicking on **Let's go!** takes you to that section on page **4**. So does clicking the green **4**.

You also can click on a heading or page number in the table of contents to jump directly there.

Clickable Internet websites are shown in underlined blue.

You are reading a PDF document. PDF reader programs have various ways to return to the page you were on when you jumped somewhere else. Try holding the **Alt** key and pressing the left-arrow key (←).

Usually you can add a "Back" (also known as "Previous View") button to your PDF reader's toolbar. If you're using *Adobe Reader,* right-click on the toolbar, click **Navigation**, then click **Previous View**. A left-arrow button should appear on the toolbar.

If you use *Foxit Reader,* click the **View** menu, then **UI Options,** then **Customize Toolbars.** Scroll through the list and check the box next to the **Previous View** item in the **View** group. A left-arrow button should appear on the toolbar.

DEFINITIONS

For brevity and clarity, I use certain terms in this document that have the meanings listed here.

- **Climax:** The Bachmann large scale (20.3:1)model of the Climax steam locomotive, in particular, the later version that might differ from earlier versions.
- **Jumper board:** The circuit board that plugs into two rows of sockets on a larger circuit board inside the Climax's fuel bunker. Specifically, after a brief mention of the factory-installed "DC jumper board," I use "jumper board" to refer to the "jumper board with wires," as Bachmann calls it.
- **Feature:** An object on the locomotive such as a light or smoke unit that can be turned on and off with an electronic signal.
- **RailPro:** The radio control system developed by Ring Engineering, inc. (http://www.ringengineering.com/RailPro.htm)
- **Loco module:** The RailPro Locomotive module suitable for this locomotive, model LM-3S-G.
- **9-pin connector:** The white connector with wires supplied with the loco module, and which plugs into a socket on one end of the loco module.
- **Trip-red:** My term for the condition where a PWR-56 power supply shuts off its output and displays a red light if it detects excessive output current.

Are you prepared?

I'll say at the outset that you should possess a few traits, abilities, and tools to successfully install a loco module in a Bachmann Fn3 Climax:

- **Patience.** Nothing is difficult, but the entire procedure has many details to pay attention to.
- **Common sense.** You need to understand at least the basics of each step, and say, "now wait a minute!" if something doesn't seem right. Then you need to figure out what's going on.
- **Basic soldering skill and tools.** Fortunately, all soldering is done on a simple "jumper board" outside the locomotive, so there is no chance of damaging the internal electronics. At minimum, you should be able to solder a wire to a printed circuit board (PCB). You'll also need basic soldering tools. See **Appendix D: About soldering** on page **21** for more information.
- **Basic modeling skill and tools.** If you've ever kitbashed a freight car or put together a structure kit, you probably have the skill needed to install a loco module. You need a well-lighted work space and basic tools like needle-nose pliers, wire cutters, and a small screwdriver. I found it useful to have a set of jeweler's screwdrivers, a set of drills, and a tap to thread a hole.

Acknowledgment

I bought my RailPro system from Don Sweet at RCS of New England (www.rcsofne.com). Don provided valuable information about how a loco module typically is installed in model locomotives, and described the purpose of some of its terminals.

I would have spent much longer figuring out these details without Don's help. ***Thank you, Don!***

Overview

The Bachmann Fn3 Climax can operate with straight DC or with a command control system like RailPro or digital command control (DCC). To accomplish this, internal electronic circuits control lights in response to low-power control signals. In other words, the control signals don't directly turn on lights or the smoke unit – they just command the internal electronics to do those things.

We don't need to wonder if the lights are incandescent lamps or light-emitting diodes (LEDs). We don't need to worry about incandescent lamp voltage or if we must install current-limiting resistors for LEDs. The internal electronics take care of everything – all we need to do is make a simple low-power electrical connection to turn on a light.

Let's go!

Installing a RailPro loco module in a Climax is straightforward. The loco module is installed inside the Climax's fuel bunker, where other electronic connections are made, but all loco module connections are made on a separate "jumper board." You won't do any soldering or modifications inside the bunker or in contact with any electronic components. These are the steps:

1. Remove the stock "DC jumper board" and modify "jumper board with wires" to connect with the loco module.
2. Remove unneeded wires from the jumper board.
3. Choose the Climax features you want to control from the loco module.
4. Remove unused wires from the loco module's 9-pin connector.
5. Solder wires from the loco module's 9-pin connector to pins on the jumper board.
6. Connect six wires from pins on the jumper board to screw terminals on the loco module.
7. Test the installation using your RailPro power supply and handheld controller.
8. Optionally perform a final installation to secure the loco module in the climax.

Step 1: Open the bunker

We will install the loco module inside the fuel bunker behind the cab. Lift off the coal load or oil bunker cap, depending on your model. You will see a "DC jumper PC board," as Bachmann calls it; we'll omit the "PC" and call it simply the "DC jumper board." See **Fig. 1** to the right.

This board contains some simple electronics, and connects the track power to the motors and internal electronics.

The jumper board plugs into two rows of sockets that Bachmann states are "...designed to accommodate aftermarket plug-and-play products." The RailPro LM-3S-G loco module is not

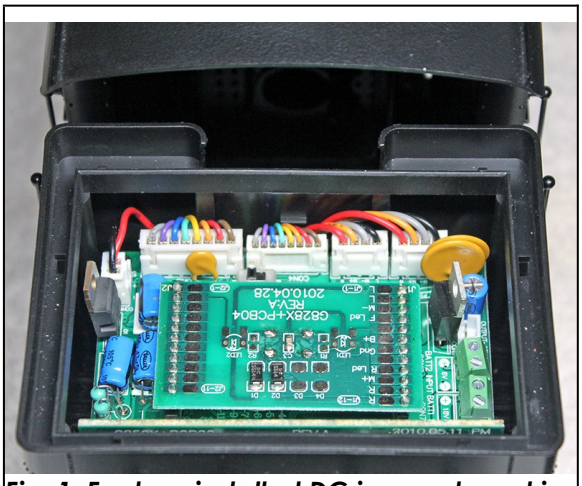

Fig. 1: Factory-installed DC jumper board in the fuel bunker.

such a product, so we must install it on Bachmann's replacement "jumper board with wires" that is included with the locomotive.

The jumper board

Fig. 2 shows the "jumper board with wires" that replaces the stock DC jumper board (**Fig. 1**). Retrieve this jumper board from the extra parts that came with your Climax.

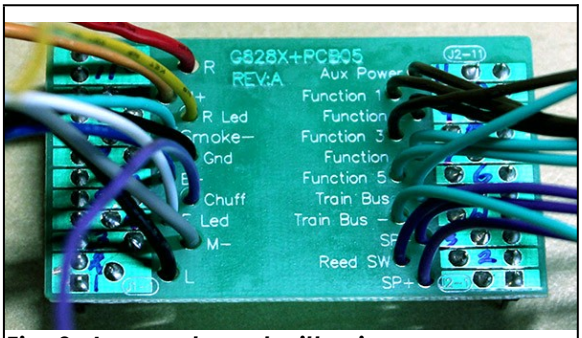

Fig. 2: Jumper board with wires

We will remove many of these wires, then connect the RailPro loco module to this jumper board.

From this point onward I refer to this board simply as the "jumper board," since we will set aside the original DC jumper board, do all our work on this one, and plug it into the fuel bunker sockets when done.

This jumper board has wires connected to the pins that plug into those sockets. Each pin is labeled on the jumper board, and the Climax owner manual has a table that also identifies the purpose of each pin.

But the two don't match. **Table 1 below** correctly identifies the pins.

J1 Pin No.	Purpose	J2 Pin No.	Purpose
12	Rail +	12	Solid key, no pin
11	Rail +	11	Not used
10	Motor +	10	Firebox flicker
9	Rear headlight	9	Not used
8	Smoke unit	8	Cab light
7	Locomotive ground (Gnd)	7	Not used
6	Locomotive positive (B+)	6	Not used
5	Chuff trigger	5	Train bus -
4	Front headlight	4	Train bus +
3	Motor -	3	Speaker -
2	Rail -	2	Not used
1	Rail -	1	Speaker +

Table 1: Jumper board pin identification

Notes about the pin labels

I made these notes while testing and checking the various pins and resulting locomotive behavior.

- J1 pins 1 & 2 and 11 & 12 convey the track power to the jumper board. This is as far as the track power goes; we must connect it on the jumper board to the Locomotive

positive (B+) and Locomotive ground (Gnd) pins to power the Climax's internal electronics. We also must connect it to the loco module's Track screw terminals.

- The motor wires on J1 pins 3 & 10 will be connected to the loco module's motor screw-terminal outputs.
- All locomotive control pins actuate their respective feature (light, firebox flicker, smoke unit) when connected to Gnd, J1 pin 7, the common point for the internal electronics.

  This is the big benefit provided by the internal electronics – the RailPro loco module simply connects a control pin to Gnd to turn on that feature. We never need to worry about adding current-limiting resistors for LEDs or burning out incandescent lamps with too much voltage.

Step 2: Remove unnecessary wires from the jumper board

Carefully unplug the factory-installed DC jumper board from the fuel bunker, and store it with the other extra parts that came with your Climax.

> **Storing parts**
>
> It's important not to lose parts removed from the locomotive and the loco module. I use the RailPro loco module box to store everything I remove.

The replacement jumper board comes with wires soldered to every pin (see **Fig. 2** on page **5**. We don't need many of these, so we'll remove those to reduce clutter and increase space for the loco module.

The wires are soldered on the top side of the jumper board, but on the underside they loop through holes to exit the board on the top side.

Begin by pushing the following wires through their holes to the underside, then grasp each one, apply downward pressure, and apply a hot soldering iron to the pad on the top side. When the solder melts, the wire will pull free.

We will remove all wires except six needed for power and motor connections to the loco module. We remove remove the feature (lights, etc.) control wires because later we'll solder wires from the 9-pin connector in their place.

See **Unsoldering aides** for tips on removing excess solder to clear the holes for possibly soldering wires from the loco module.

Remove these wires from the jumper board:

Jumper Board Pin and Designation	Purpose
J1 pin 4, F LED	Front headlight
J1 pin 5, Chuff	The loco module has no chuff sync input at this time
J1 pin 8, Smoke-	Smoke unit
J1 pin 9, R LED	Rear headlight
J2 pin 1, SP+	Speaker +
J2 pin 2, Reed switch	Unsure if this is associated with Chuff, J1 pin 5, but

	remove it anyway
J2 pin 3, SP-	Speaker -
J2 pin 4, Train Bus –	Don't know what this is for
J2 pin 5, Train Bus +	Don't know what this is for
J2, pin 6, Function 5	Listed as “not used” in owner manual
J2, pin 7, Function 4	Listed as “not used” in owner manual
J2, pin 8, Function 3	Cab light
J2, pin 9, Function 2	Firebox flicker
J2 pin 10, Function 1	Listed as “not used” in owner manual
J2 pin 11, Aux power	Don't know what this is for; listed as “not used” in owner manual

Table 2: Remove these wires from the jumper board

When done, your jumper board should have wires still soldered to these pins:

Jumper Board Pin and Designation	Purpose
J1 pins 1 & 2, L	Left rail power
J1 pin 3, M-	Motor -
J1 pin 6, B+	Internal electronics power +
J1 pin 7, Gnd	Internal electronics power -
J1 pin 10, M+	Motor+
J1 pins 11 & 12, R	Right rail power

Table 3: Keep these wires on the jumper board

Basic loco module hookup

In the next steps we will connect the RailPro loco module to pins on the Climax's jumper board. This section gives a brief introduction to what to expect.

The loco module has two connectors – a 10-position terminal block with screws on one end, and a 9-pin connector with a mating plug and wires on the opposite end. The screw terminals are where the power and motor connections are made; we'll use six of these. The 9-pin connector contains outputs to control up to six locomotive functions, and send audio signals to the locomotive speaker. The number of wires used on this connector depends on the locomotive features you choose to control with the loco module.

Step 3: Choose locomotive features to control with the loco module

As you can see in **Table 1**, the Climax lets you control the two headlights, cab light, firebox flicker, and smoke unit, and send sound to the built-in speaker. Identify the features you want to control, and which outputs on the loco module will control them.

I chose to control them all. **Table 4 below** lists the Climax features and the loco module outputs I assigned to them. There is space for you to write your own assignments. Leave an assignment blank if you choose not to control that feature.

Feature	Jumper Board Pin, Label	My 9-pin Assignment	Your 9-pin Assignment
Front headlight	J1 pin 4, F LED	Output 1 (orange)	
Rear headlight	J1 pin 9, R LED	Output 2 (blue)	
Smoke unit	J1 pin 8, Smoke -	Output 3 (white)	
Cab light	J2 pin 8, Function 3	Output 4 (yellow)	
Firebox flicker	J2 pin 10, Function 1	Output 5 (gray)	
Speaker +	J2 pin 1, SP +	Speaker (red)	
Speaker -	J2 pin 3, SP -	Speaker (green)	

Table 4: Engine feature pin assignments to loco module pins

Step 4: Remove unused wires from the 9-pin connector

The LM-3S-G loco module user manual states, *"You can remove any unused wires from the nine pin connector by lifting the keeper on the connector and sliding the wire out of the connector."* Here is how I did this.

In **Table 4** I chose to use five of the six available outputs plus the two speaker connections, so I removed the Output 6 (purple) wire and the Input (black) wire.

The bit about "lifting the keeper" is more involved that you might think. The plug housing is made of slippery plastic, and there is little space to fit a tool under the keeper to lift it.

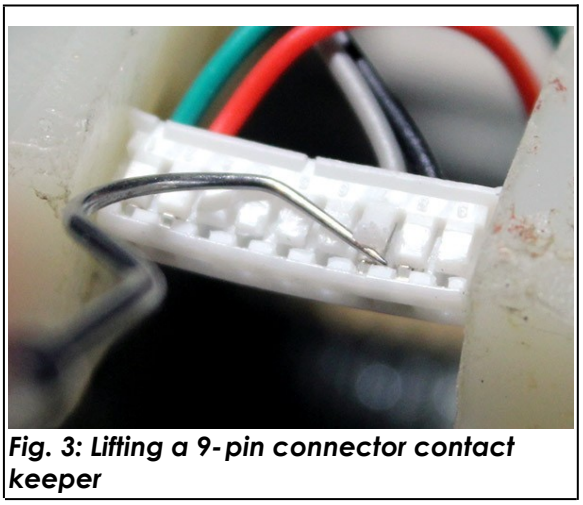

Fig. 3: Lifting a 9-pin connector contact keeper

After trying a small flat-blade screwdriver, I got better results with a dentist's pick. This fine-point tool was small enough to to slide under the keeper, and strong enough to lift it slightly to free the metal contact. Note in **Fig. 3** how the pick is lifting the keeper.

A very small jeweler's screwdriver ought to work as well. (Later (page **Error: Reference source not found**) you will need such a small screwdriver to secure wires to the loco module's screw terminals.)

While the keeper tab is lifted, gently pull the wire to remove the metal contact. Keep the wires in case you want to reinstall them in the plug. To reinstall, orient the contact so the tiny tab on its back faces the side of the plug with the keepers.

Push the contact into the square hold in the back of the plug until you hear a faint click, indicating the keeper has locked behind the tab. You can use a small screwdriver to push the contact all the way into the hole.

Step 5: Solder 9-pin connector wires to the jumper board

By now, you have chosen the Climax features you want the loco module to control, and removed the unused wires from the 9-pin connector. Now we'll solder the remaining wires to the associated jumper board pins.

Refer to **Table 1 above** with your assignments of Climax features to pins on the 9-pin connector. Do the following for each assigned feature:

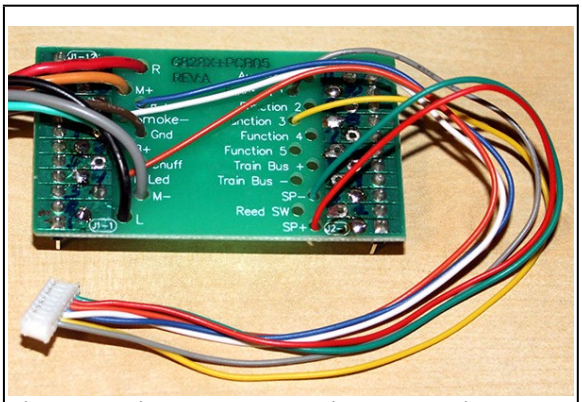

Fig. 4: 9-pin connector wires to the jumper board

- Insert the 9-pin connector wire into the large hole adjacent to the associated J1 or J2 pin pm the jumper board.
- On the underside of the jumper board, insert the bare end of the wire into the hole through the solder pad.
- On the top side of the jumper board, solder the wire to the solder pad. It helps if you bend the wire flat against the pad and clip off any excess wire before soldering.

Fig. 4 shows the 9-pin connector wires I used in my installation.

Step 6: Identify power and motor connections

Table 5 lists the required power and motor connections between the jumper board and the loco module's screw terminals. Unlike the feature controls, you must make all these connections.

The first column shows the designations printed on the jumper board followed in parentheses by the corresponding designations in the owner manual.

- The R pins send rail power to the loco module.
- The M+ and M- pins send power from the loco module to the Climax's motors.
- The B+ and Gnd pins provide operating voltage from the loco module to the Climax's internal electronics, which in turn send it to lights and the smoke unit as needed.

Power / Motor Connection	Jumper Board Pin	Loco Module Screw Terminal
R (Rail +)	J1 pin 11 & 12	TRK (either of the 2 terminals)
L (Rail -)	J1 pin 1 & 2	TRK (remaining of the 2 terminals)
M+ (Motor +)	J1 pin 10	M1 +
M- (Motor -)	J1 pin 3	M1 -
B+ (Locomotive Positive)	J1 pin 6	+V
Gnd (Locomotive Ground)	J1 pin 7	COM

Table 5: Climax power and motor connections to loco module's screw terminals

Step 7: Connect power and motor wires to the loco module

We don't use the 5-volt connection

Page 7 in the LM-3S-G owner manual shows a wire from the +5 volts screw terminal to locomotive lights, and current-limiting resistors between the lights and the 9-pin connector. It also issues warnings about damaging LEDs with incorrect current-limiting resistors.

We do not need +5 volts or resistors because the Climax's internal electronics take care of that for us. *The loco module needs only to connect a control pin to the Gnd pin turn on a feature.*

About the loco module screw terminals

The screws in the terminal block are tiny. My smallest flat-blade screwdriver wouldn't fit into the hole. Time to break out the set of jeweler's screwdrivers! Even then, I had to use the third-smallest blade to reach the screws.

Using **Table 5** as a guide, connect the six power and motor wires still soldered to J1 pins to the associated screw terminal on the loco module.

On my Climax, the insulation on these wires was not stripped far enough for terminal screws to reliably hold the bare wire; sometimes they would fall loose.

I clipped the end, stripped about 1/8" of insulation, and "tinned" the wire with solder. Then the screw terminals held the wire securely.

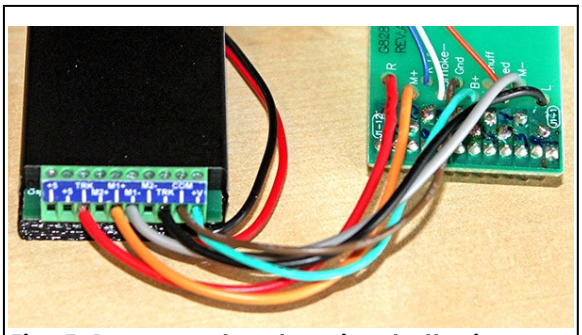

Fig. 5: Power and motor wires to the jumper board

Step 8: Set the Climax's configuration switches

There are four switches hidden behind the sand boxes on the rear wall of the fuel bunker, and one behind the smoke box door on the front of the engine.

The rear switches configure the engine's power source, motor and lights. The front switch sets how the smoke unit is powered.

Fuel bunker switches

The metal sand boxes are held in place with plastic hooks. To remove a sand box, push it toward one side and pull the opposite side away from the bunker wall.

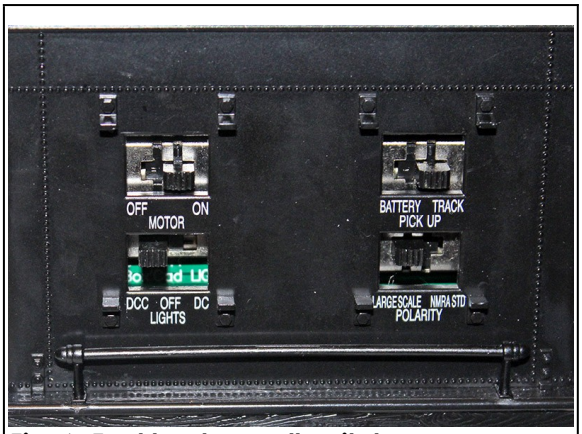

Fig. 6: Fuel bunker wall switches

Set the switches like this:

- **Motor on/off:** On.
- **Pickup:** Track, unless you are using battery power, which is not covered in this document.
- **Lights:** DCC. This allows all lights to be controlled by the loco module. If set to the DC position, all lights will be on as long as the engine is sitting on powered track.
- **Polarity:** To match how your track is wired. "Large scale" expects the left (fireman's side) rail to be positive, while NMRA expects the right (engineer's side) rail to be positive. See **About track polarity below** for more information.

Smoke box switch

A switch behind the smoke box door controls how the smoke unit is powered. In the DC position, the smoke unit is on whenever voltage is present on the Locomotive + pin.

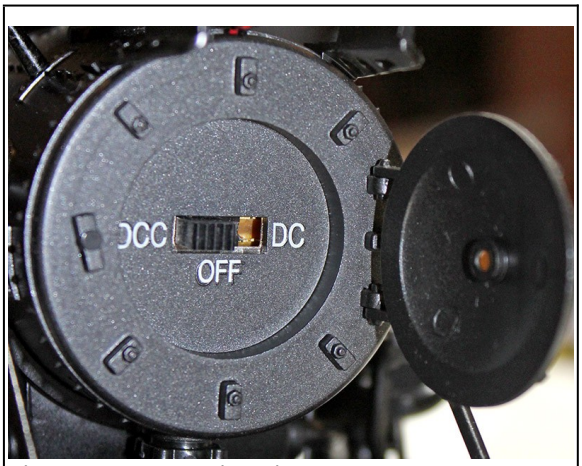

Fig. 7: Smoke unit switch

Set this switch to DCC to turn the smoke unit on and off with a loco module function.

Remember, even after wiring to install the loco module, *if the switch is set to the DC position, the smoke unit will be on whenever the Climax is sitting on powered track.*

About track polarity

Track polarity doesn't matter for our purpose because the loco module accepts either polarity and generates the correct polarity motor voltage to run forward or backward as needed. The The loco module also produces a positive voltage on its +V and COM screw terminals to power the Climax's internal electronics, regardless of track polarity.

Step 9: Test the loco module

Wiring the loco module to the jumper board is complete. Now we test it with a RailPro power supply and hand controller to verify that it controls the Climax properly. Do the following:

- ☐ Insert the 9-pin connector into its mating socket on one end of the loco module.
- ☐ Plug the jumper board into the two rows of sockets inside the fuel bunker. Be sure the J1 pins are on the engineer's (right) side, and the J2 pins are on the fireman's (left) side.

- ☐ Be sure all the pins mate with a socket, and the jumper board is not offset fore or aft. The J2 socket row has solid blocks at each end to ensure correct positioning, but the J1 row does not. It's best to partially insert the J2 pins first; this will position the J1 end correctly. When all pins are started in their sockets, press down gently to seat the jumper board.

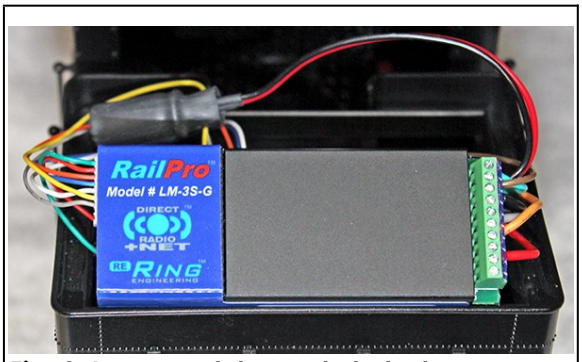

Fig. 8: Loco module ready to test

- ☐ Gently bend the wires under the loco module enough to allow setting it in the fuel bunker; see **Fig. 8**. Allow one side of the loco module to rest on the bunker's rear ledge; the other side will be supported by the wires.
- ☐ Connect your RailPro PWR-56 power supply to the track as directed in step 6 on page 4 of the LM 3S-G loco module user manual: "*Connect the power source....*"
- ☐ Skip to step 8, "*Power-up the module,*" then continue with steps 9 – 12. Be sure to perform the "Motor Full Current" calibration; the engine will not run until this is done.
- ☐ Check the locomotive features listed in **Table 4** that you connected with wires from the 9-pin connector.
- ☐ Also check one or more sounds to confirm the built-in speaker is connected to the loco module.
- ☐ If everything operates as expected, ***congratulations!*** You have successfully installed a loco module in a Bachmann Climax. All that remains is to make the installation permanent; continue with **Step 10: Test-fit the assembly in the fuel bunker**.
- ☐ If something doesn't work, check the following:
  - ◊ Nothing works – Check that the **Pickup** switch on the bunker rear wall is set to **track.**
  - ◊ Still nothing works – Check the track power wires on the loco module TRK terminals, and on J1 pins 1&2 and 11&12.
  - ◊ Motor doesn't run – Check that the **Motor on/off** switch on the bunker rear wall is set to **on.**
  - ◊ Motor still doesn't run – Did you perform the "Motor Full Current" calibration?
  - ◊ Motor still doesn't run – Check the motor wires on the loco module M1+ and M1- terminals, and J1 pins 3 and 10 on he jumper board.
  - ◊ Lights are always on – Check that the **Lights** switch on the bunker rear wall is set to **DCC.**
  - ◊ Smoke unit is always on – Check that the switch behind the smoke box door is set to **DCC.**
  - ◊ One or more locomotive features don't work:
    - ▫ Check that the wires from the 9-pin connector to the jumper board are soldered to the correct pins, as listed in **Table 4**.
    - ▫ Use the handheld controller to check which handheld controller buttons control which outputs. Reassign these if necessary.

Step 10: Test-fit the assembly in the fuel bunker

- ☐ The loco module's screw terminals should be on the engineer's side of the bunker. Gently fold the wires soldered to J1 on the jumper board inward toward the center. Likewise, gently fold the six wires attached to the loco module's screw terminals down and under the module; see **Fig. 9**.

  The folded wires allow the loco module to be pressed downward into the space above the jumper board

- ☐ Also fold the red and black wires attached to the capacitor alongside the module.

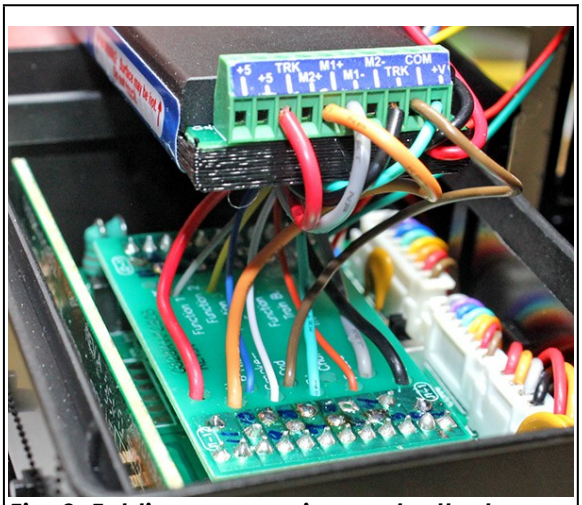

Fig. 9: Folding power wires under the loco module

- ☐ Finally, press the loco module into the space above the jumper board. You may need to bend the wires on both ends sharply to get it to fit.

  For now, set the capacitor with the red and black wires alongside the loco module, toward the front of the fuel bunker. This can be tucked anywhere during final installation.

  Fig. 10 shows the loco module test-fit inside the fuel bunker. Note the tight spaces for the wires on both ends.

  If you wish, you could call it done here, but read **Step 11: Final installation** before you decide.

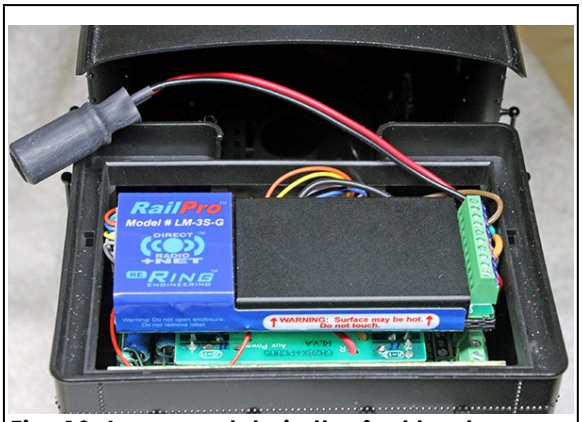

Fig. 10: Loco module in the fuel bunker

Step 11: Final installation

The test-fit in the preceding step could bed your final installation – the loco module fits comfortably in the space, with the required ⅛" minimum space around and below it. When the bunker cap is set back in place, there will be more than the required ½" space above it.

I wanted a spacer that would hold the loco module securely, but still be removable for access to the soldered wires, in the event changes are needed. This is what I did; see the photos on the next page for details.

- Cut a section of ⅝" round Delrin about ⅜" long to act as a spacer. A wood dowel would work as well as Delrin.
- Drilled and tapped a hole for a 6-32 screw through the center of this round spacer.
- Drilled a clearance hole for the 6-32 screw in the center of the jumper board.
- Screwed the spacer to the jumper board.
- Plugged the jumper board into the fuel bunker sockets.

- Folded the wires on both ends of the loco module under it, and a bit off to one side, so they wouldn't run across the spacer.
- Applied a thin coat of "Amazing" Goop* adhesive (http://eclecticproducts.com/products/amazing-goop.html) to the top of the spacer, then set the loco module on that, placed a scrap of ½" wood on top, and stretched a length of masking tape across the fuel bunker to hold the loco module in place until the Goop dried. **Fig. 11** - **Fig. 14** show the spacer and the loco module glued to it.

* There are many varieties of Goop, but frankly, I haven't found much difference among them. I find "Plumber's Goop" but no other variety at Lowe's.

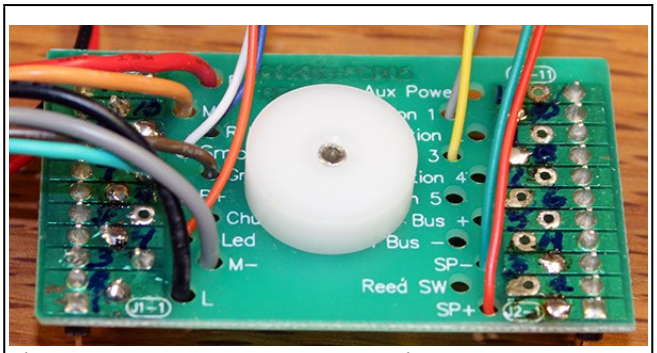

Fig. 11: Spacer screwed to the jumper board

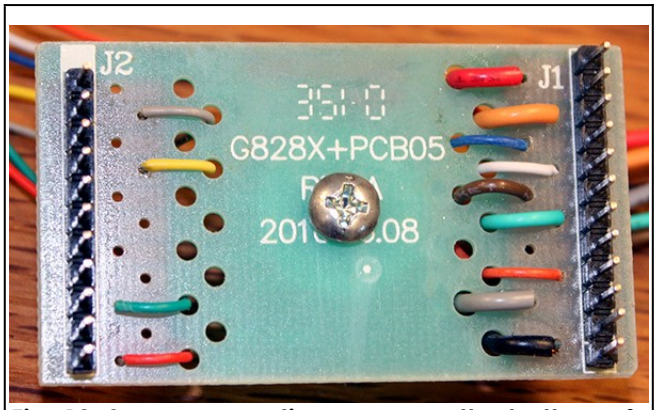

Fig. 12: Spacer mounting screw on the bottom of the jumper board

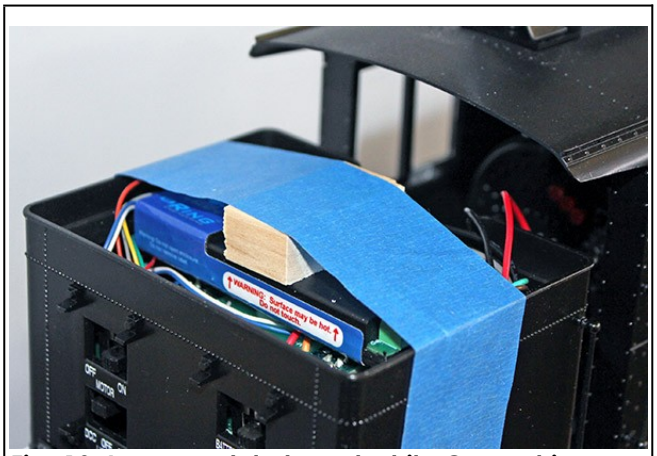

Fig. 13: Loco module taped while Goop dries

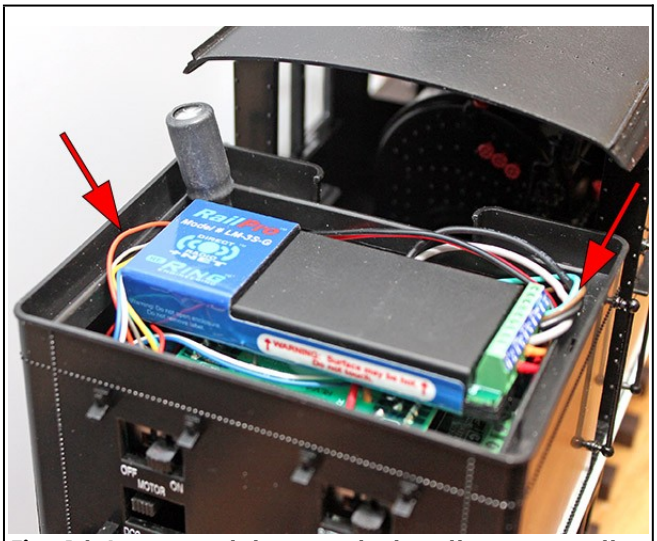

Fig. 14: Loco module mounted on the spacer; the red arrows are discussed in Step 12

Step 12: Replace the fuel bunker cap

The final step is to put the coal load or oil bunker cap. But wait – it doesn't fit! When I set the top onto the bunker, it sat high – the sides didn't drop into the slot around the bunker cavity.

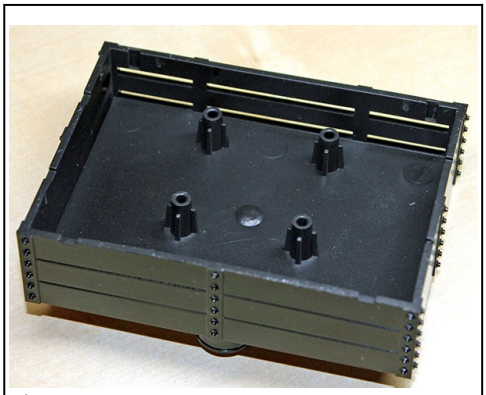

Fig. 15: Fuel bunker cap studs

The problem is apparent in **Fig. 15**. Four plastic studs project from the underside of the top, and hit the loco module before the top seats in its slot.

My solution was simple. I used angled rail cutters to snip off the studs at their base. See **Fig. 16**.

There is plenty of clearance above the loco module with the studs removed.

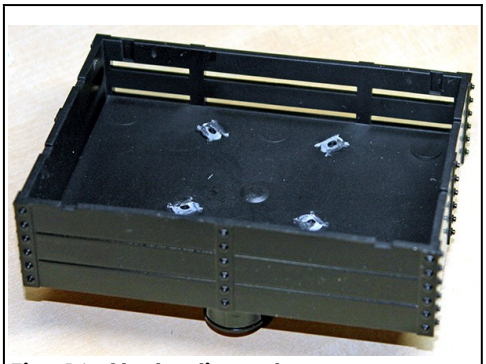

Fig. 16: Studs clipped

One more adjustment is needed – push the loco module wires clear of the slot that supports the bunker cover. As you can see in **Fig. 14**, even though I folded the wires under the loco module as instructed in **Step 11**, they still projected over the slot (red arrows).

Use a flat-blade screwdriver to push the wires toward the center of the bunker, away from the slot, as seen in **Fig. 17**.

Finally, tuck the capacitor on the red and black wires in the space forward of the loco module.

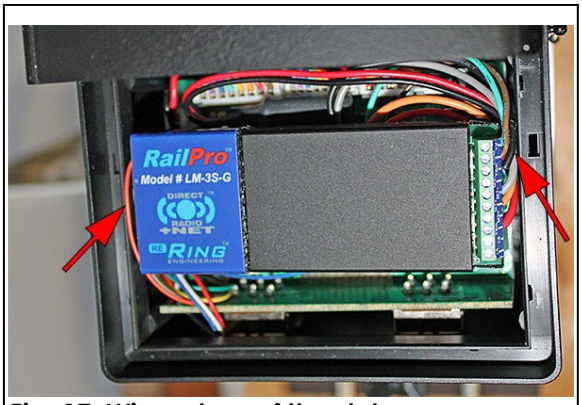

Fig. 17: Wires clear of the slot

Done!

That's it – your Climax can now be controlled with a RailPro hand controller via a radio link.

Congratulations on a job well done! Enjoy your large scale model railroad.

Appendix A: Comments about the RailPro PWR-56 power supply

I learned a few things about the PWR-56 power supply while installing and testing two LM-3S-G loco modules.

A notice on the PWR-56 Web page (http://www.ringengineering.com/PWR-56.htm) states:

> ***IMPORTANT NOTE for G Scale Users***
>
> *The PWR-56 was primarily designed for HO scale locomotives but can be used to power G scale locos that use our LM-3S-G Module. The PWR-56 has enough power for 1-2 G scale locomotives with LM-3S-G modules installed. The PWR-56 has about 20% less voltage than a typical G scale power supply so your trains top speed will likely be about 20% slower.*

The PWR-56 user manual says it produces 14.5 volts at up to 4 amps current. Surely 4 amps is enough current for more than two G scale engines running at realistic speeds with moderate-length trains. Is maximum running current really the limiting factor? I don't think so.

What is the limiting factor?

If the 4-amp maximum running current doesn't prevent running three G scale engines at once, what *does*? ***Answer: A power-up current surge that trips the PWR-56.***

My tests revealed that the PWR-56 trips-red (overload, red light) immediately at power-up if detects a current surge – even a brief one – that exceeds its maximum current rating.

- Large capacitors on a locomotive's internal electronics boards can cause a surge.
- So too, apparently, can the LM-3S-G loco module. In my tests, a PWR-56 that powers-up normally with both my engines on the track trips-red at power-up with a third LM-3G-S connected to the rails.

In my opinion, the combined power surge of three LM-3S-G loco modules – not the maximum running current – is the reason for the "1-2 G scale locomotives" website notice.

A solution

I discovered that introducing ***a one-second delay between powering-up the PWR-56 and connecting its output to the track eliminates the trip-red*** with three LM-3S-G loco modules connected.

Appendix C describes a circuit I built to do this automatically. With this circuit wired between the PWR-56 and the track, the PWR-56 powers-up normally with a third LM-3S-G loco module connected to the track.

I also tested the time-delay with the internal capacitors still in my two engines, and the PWR-56 powered-up normally with both engines on the track. I did not test it with the capacitors *and* a third LM-3S-G loco module, but I expect the PWR-56 would power-up normally.

Bottom line

If you remove your engines' large capacitors, the PWR-56 will power-up correctly with ***two*** G scale engines on the track with LM-3S-G loco modules installed. But if you want to run three or more engines, you should install a track power delay circuit.

Appendix B shows how to remove the capacitor, and **Appendix C** describes the delay circuit.

APPENDIX B: REPLACING THE LARGE CAPACITOR INSIDE THE ENGINE

Overview

The Bachmann Climax contains at least two electronic printed circuit boards (PCBs) that interconnect track power pickups, motors, lights, and other features. Ring Engineering recommends removing the internal electronics, and connecting everything to the locomotive module.

I studied the Bachmann wiring diagrams and identified the PCBs in the locomotive. It became clear that "removing the internal electronics" is not a simple process, but involves major surgery in the engine. So I decided to keep the internal electronics, wire the loco module to trigger them, and let the electronics actuate the feature lights.

I have two G scale engines – this Climax and a 3-truck Shay. With both on the track, the large capacitors on their internal PCBs produced a large current surge on power-up, causing the PWR-56 to trip-red. Removing a large capacitor in each solved the problem.

Follow the steps below to remove the large capacitor in the Climax, and read this corresponding Appendix B in the Shay document for details about that engine.

Please read "**Bottom line**" **above** before you decide to remove the capacitor.

Step B-1: Remove the fuel bunker shell

T\In **Step 11** we installed the loco module on a jumper board that plugs into the main PCB inside the fuel bunker. We need to gain access to the underside of this PCB because that's where the large capacitor is located.

First, use a #1 Phillips screwdriver to remove the four screws that secure the PCB to a plastic stand inside the bunker. These screws are circled in **Fig. 18**. The PCB must be loose to allow the four switches on its rear edge to clear the holes in the bunker shell.

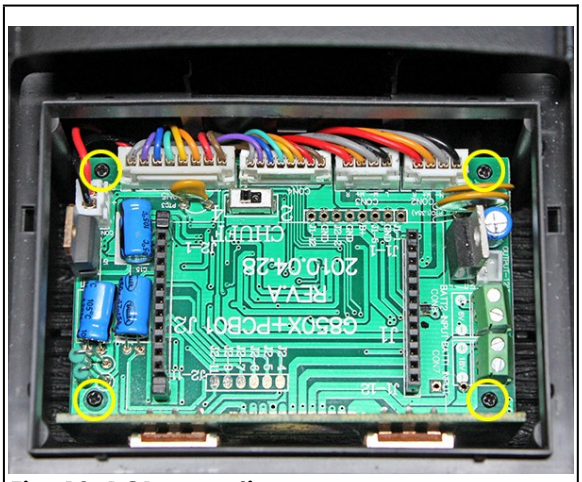

Fig. 18: PCB mounting screws

Next, turn the Climax on one side, and use a #1 Phillips screwdriver to remove the two screws that holds the bunker shell to the engine chassis; see **Fig. 19**. Turn the engine on its other side, and remove the two screws on that side.

Lift the rear of the bunker and slide it rearward slightly to disengage the two hooks on the bottom of the front edge from the engine deck.

work the PCB switches loose from the shell's rear wall, and lift the shell off.

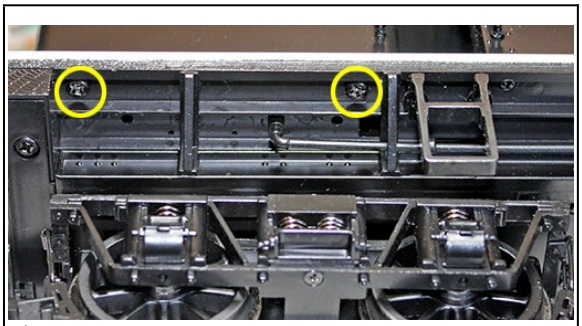

Fig. 19: Bunker shell screws

Step B-2: Remove the capacitor

Turn the PCB upside-down and locate a large capacitor near one corner, directly behind two of the four switches on a small PCB soldered to the main PCB . On my Climax, the capacitor was a blue cylinder with a black stripe along one side. It was marked '470µF 50V."

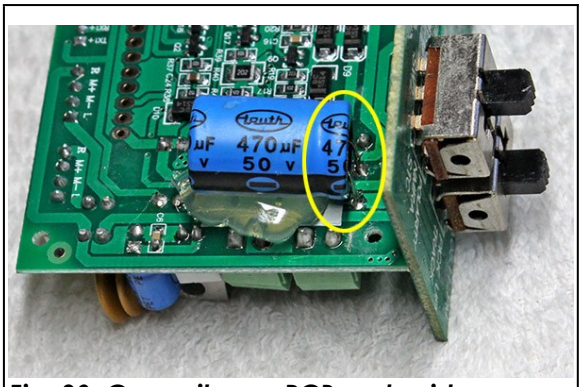

Fig. 20: Capacitor on PCB underside

My capacitor was hot-glued onto the PCB, but the glue had broken loose. You should be able to pry up gently with a screwdriver to break the glue joint.

There are two ways to remove the capacitor: unsolder it or cut its leads. The two wire leads are circled in yellow in **Fig. 20**.I chose to unsolder it. First I used a soldering iron to melt the solder on one pad, and pulled the wire loose with needle-nose pliers. Then I unsoldered the other lead the same way. **Fig. 21** shows the removed capacitor and the empty pads on the PCB.

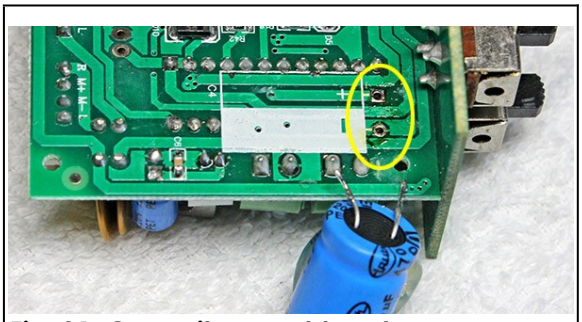
Fig. 21: Capacitor unsoldered

It might be easier for you to cut the capacitor leads instead of unsoldering them. If so, cut them close to the PCB so they can't touch each other or any other PCB points, and cause a short-circuit.

Set the capacitor aside – don't leave it leaning against the PCB as seen in **Fig. 21**! It's a good idea to not discard the removed capacitor, in the unlikely event you'll need to replace it sometime.

Step B-3: Reassemble the bunker

Reverse the steps in B-1 to replace the bunker shell.

- Latch the hooks on the front edge into their holes in the deck.
- Adjust the PCB so all four switches project into their holes on the shell rear wall.
- Lower the shell onto the deck, being careful that no wires are trapped under it.
- Replace the four screws that secure the PCB to its plastic stand.
- Turn the engine on one side and replace the two screws that secure the shell to the desk. Repeat for the opposite side.

Step B-4: Final test

Place the Climax on the track and power-up the RailPro system. Verify that the PWR-56 power supply does not trip-red. Verify that the engine runs, and that all features you connect operate as expected.

If you have two engines, remove the capacitor from both, and confirm that the PWR-56 powers-up without tripping-red with both engines on the track.

APPENDIX C: A TRACK POWER DELAY CIRCUIT

The PWR-56 checks for an overload immediately after powering-up. If locomotives on the track cause a large current surge, the PWR-56 trips-red. The same thing happens if there are three LM-3S-G loco modules connected to the PWR-56.

The PWR-56 doesn't trip-red if its output current is limited briefly immediately after power-up. I built a simple time-delay circuit that connects a 4.7-ohm resistor in series with one track wire to limit the current, then bypasses that resistor to supply full track power. See the diagram below.

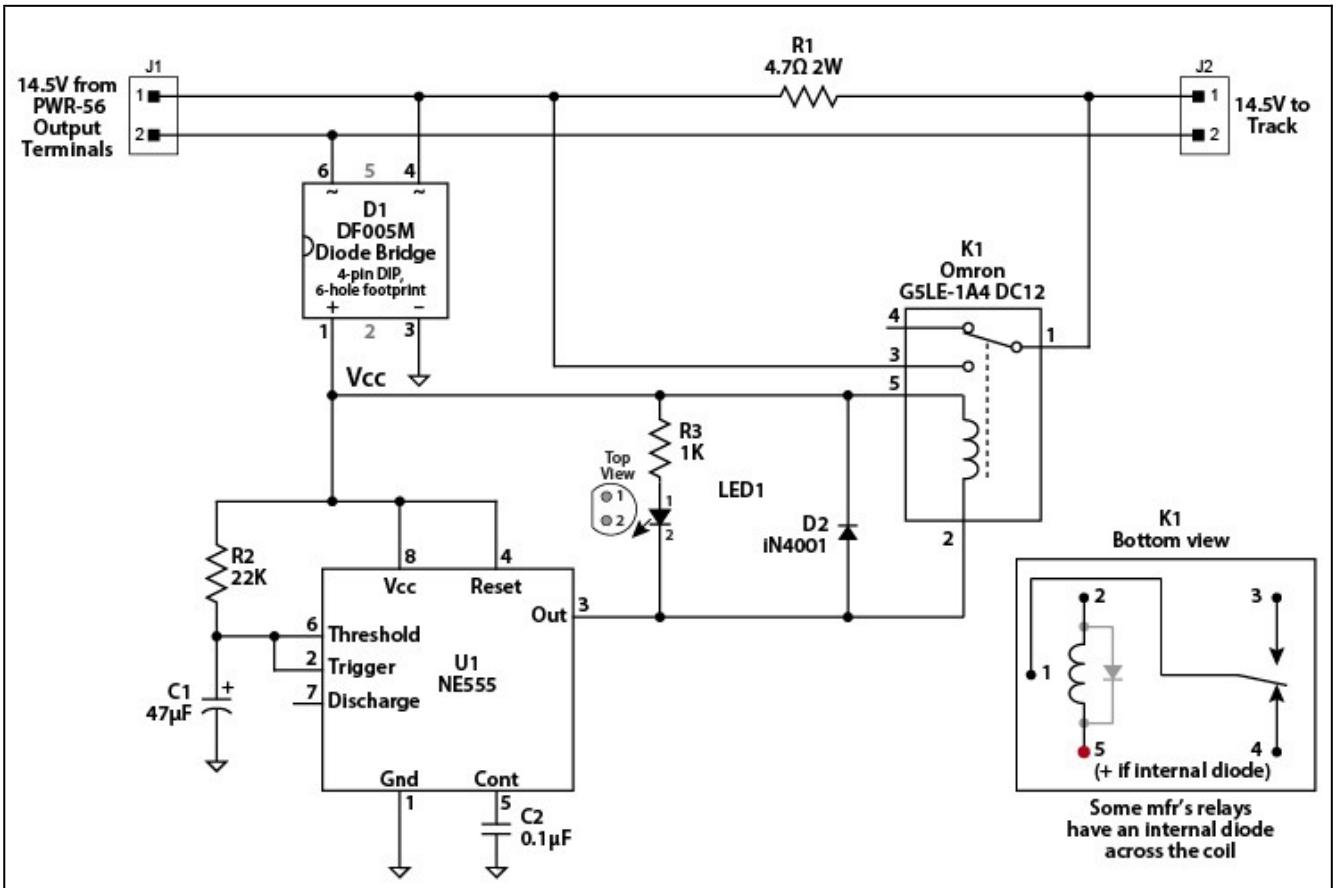

Fig. 22: Track power delay schematic diagram

Circuit description

Beginning at the top of the diagram, the PWR-56 output terminals connect to J1, and the track wires connect to J2. Resistor R1, 4.7 ohms, limits the track current to about 3 amps **(Ohm's Law: 14.5 volts / 4.7 ohms = 3.085 amps)** – well below the PWR-56's 4-amp maximum. The time delay allows everything connected to the track to charge-up and stabilize at the lower current, so the PWR-56 doesn't trip-red.

The remainder of the diagram includes:

- D1 is a diode bridge that accepts PWR-56 output voltage of either polarity, and supplies the correct polarity to this circuit.

- K1 is a relay with 10-amp contacts that shunts R1 after one second, and carries track current during normal operation.
- U1 is an NE555 timer chip wired to hold its output (pin 3) high for the length of time determined by R2 and C1, approximately one second. At the end of that delay, U1 pulls pin 3 low, which energizes K1 to shunt R1 and allow full current to pass to the track.
- D2 is a diode that protects U1's output pin 3 by suppressing the opposite-polarity voltage spike produced by the coil in K1 when it is de-energized. Some relays have an internal diode, but D2 is included to protect U1 with relays from *any* manufacturer.
- LED1 and R3 provide a positive green indication when K1 is energized and shunting R1 to provide full power to the track.

Circuit board

Fig. 23 shows the track power delay breadboard I hand-wired. I will provide circuit boards and parts kits if there is sufficient demand from the large scale community. Send an email to mike@mdodd.com if you are interested.

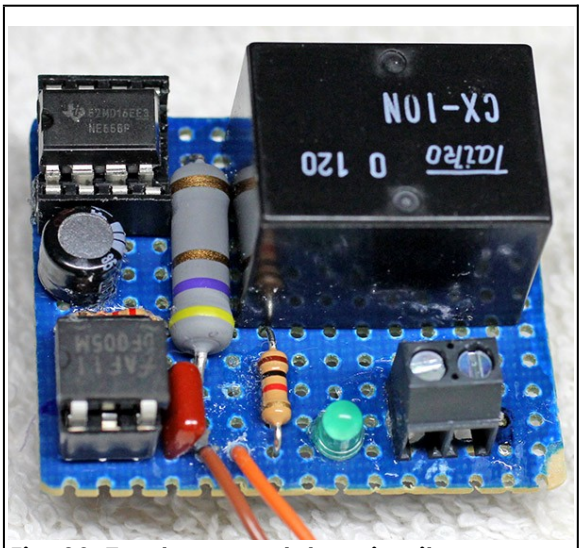

Fig. 23: Track power delay circuit breadboard

Appendix D: About soldering

Soldering tools

You'll need to solder wires to the Climax's jumper board. This is easy with right tools.

- Use a small "pencil" soldering iron rated for about 30 watts. This one from All Electronics https://www.allelectronics.com/item/ir-330/30-watt-hobby-soldering-iron/1.html is suitable for soldering wires to the Climax jumper board, but for general electronics work you'll want a better, temperature-controlled, iron.
- Use solder that has a core of rosin flux that cleans the metal as the solder melts. This solder is suitable: https://www.allelectronics.com/item/ts-110/60/40-solder/1.html
- You don't need separate flux if you use rosin-core solder. If you *do* decide to use separate flux, use ***only*** rosin flux. ***Never*** use plumber's acid flux, because it will corrode wires and the copper on the circuit board.

Unsoldering aides

When unsoldering wires, it's a good idea to clear the hole of excess solder. Two products can help with this:

- "Desoldering wick" is a flux-impregnated copper braid that wicks molten solder, leaving a clean hole. You can buy desoldering wick at All Electronics (https://www.allelectronics.com/item/swk-3/de-soldering-wick/1.html).
- A "solder sucker" is another option. You depress a spring-loaded plunger, melt the solder with your iron, then press a button to release the plunger and suck the solder away. All Electronics sells a solder sucker (https://www.allelectronics.com/item/swk-3/de-soldering-wick/1.html).