DCC Impulses column

by Bruce Petrarca

The lowdown on bulbs and circuit breakers.

What causes a short on the layout? Close clearances in turnouts. Derailed rolling stock. Tools on the track. Wiring failures in the loco or on the layout.

Protection, that is the name of the game. The DCC booster includes a short circuit detector that shuts off the power in the event of a short on the track or the DCC bus. This protects the booster, but is not necessarily designed to protect ~~the~~ rolling stock.

This month we'll talk about protecting your locos and cars and sanity. It is so distracting to be working on a set of moves and have your loco stop dead because someone somewhere else on the layout shorted. There are several ways to accomplish this task. I'm gonna show you the pros and cons of each.

Light bulbs

Light bulbs in series with the potential shorting point are the most rudimentary version of short circuit protection. They are not circuit breakers, but circuit protectors.

Implementations run the gamut from a simple 1156 (2.1-amp) automotive bulb connected between the DCC bus and the frog of a turnout, to the 6-position unit sold by NCE, called the CP6.

Let's look at how a light bulb [1] protects a track section. When nothing is in the protected section, no current flows and the bulb has a very low resistance (almost a direct connection). If a loco enters the section, the power is shared between the loco and the light bulb. Until the current being drawn through the bulb approaches the rated current for the bulb, the majority of the power is routed to the loco. More

current draw (a second loco entering the protected section) will result in the bulb getting more of the power, perhaps glowing dimly. Correspondingly, the track voltage will drop a bit. A full short will result in the bulb glowing brightly and the track voltage will go to zero.

1. 1156 automotive bulb, rated at 2.1-amps.

When DCC was in its infancy, there were few electronic circuit breakers. They were expensive and sometimes difficult to deal with.

Over the years, folks who have asked my opinion of bulbs have learned that I don't favor them. Here's why. They can isolate one section of the layout from another. For example, they can prevent a short in one yard from impacting operations in another yard. However, the full bulb current is flowing in the path from the bus through the bulb and the short. If one uses a robust bulb, for example one that as a 2.1-amp rating, then the short (perhaps a wheel crosswise on a turnout) is carrying the full current. Yes, the power is being limited by the bulb, but high current can pit and even spot-weld parts. Also, the DCC system is supplying that power, about 30 watts (15 volts X 2.1 amps) to the short, which may melt plastic truck frames.

Even with their limitations, bulbs still are being installed on layouts. Let's look at their pros and cons.

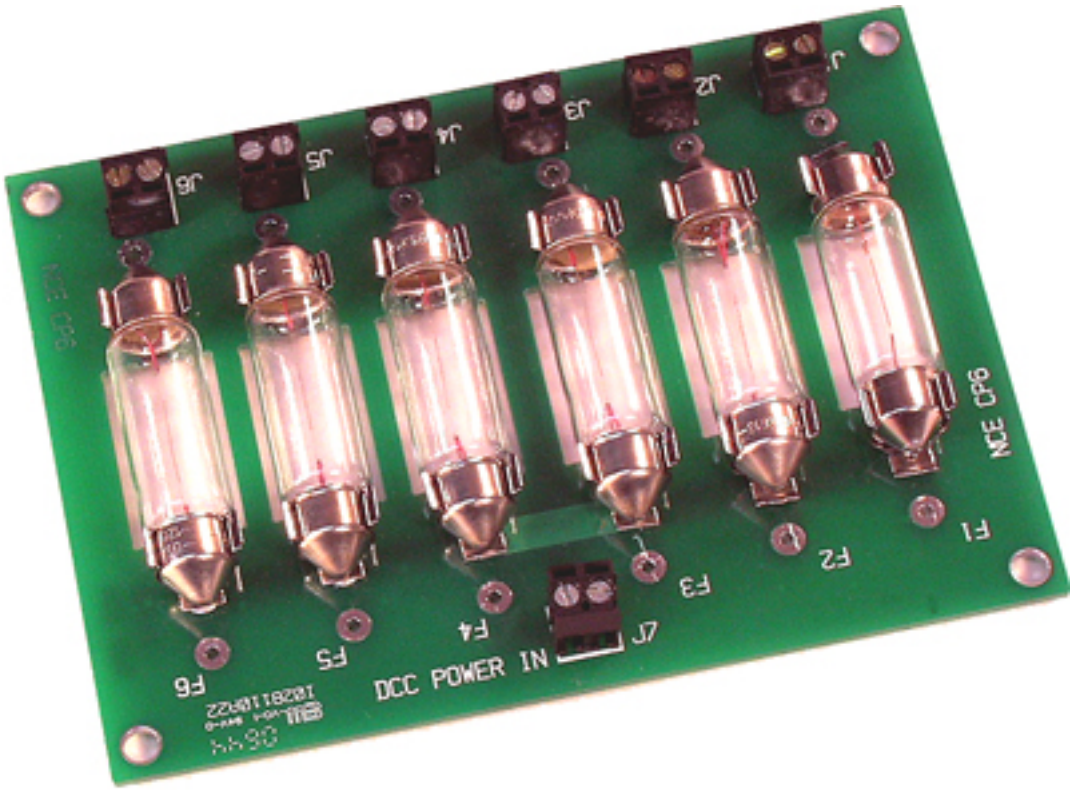
Advantages of bulbs

- Bulbs are inexpensive
- Bulbs operate instantly, allowing even fast systems like the NCE PowerCab to be separated into sections.

Disadvantages of bulbs

- Bulbs generate light (distracting) and heat (possibly a hazard) when they are protecting a short.
- Bulb protection draws the bulb's rated current from the DCC system during a short.
- The spike of current (seen as a spark) when a short occurs can pit wheels or whatever is causing the short.
- When you have a bulb in series with a track section, the track voltage will vary a bit, depending upon power being consumed in the section. Two locos or a power hungry loco may change speed upon entering the protected section.

2. CP6 - 6-bulb circuit protector from NCE. NCE Corp. photo



When the NCE PowerCab (all-in-one DCC system) was being developed, there was no electronic circuit breaker that would react fast enough to keep the protection circuitry in the PowerCab from tripping. In response to the desire by users to separate districts, NCE developed the CP6 [2]. This circuit board holds six bulbs, allowing a PowerCab user to split his pike into six sections. The user has a choice of (standard) 1-amp bulbs or (optional) 1.75-amp bulbs. The PowerCab can only supply about 1.75 amps. Consider the standard 1-amp bulbs. If a short occurs in one district, the remaining five continue to operate, but only have about ¾ amp

remaining available. If a second district has a short, the combined two bulbs will try to draw 2 amps from the PowerCab (plus any current being drawn in the remaining four districts) and the PowerCab may still shut down.

If you want to use bulbs on your layout, consider these selection criteria:

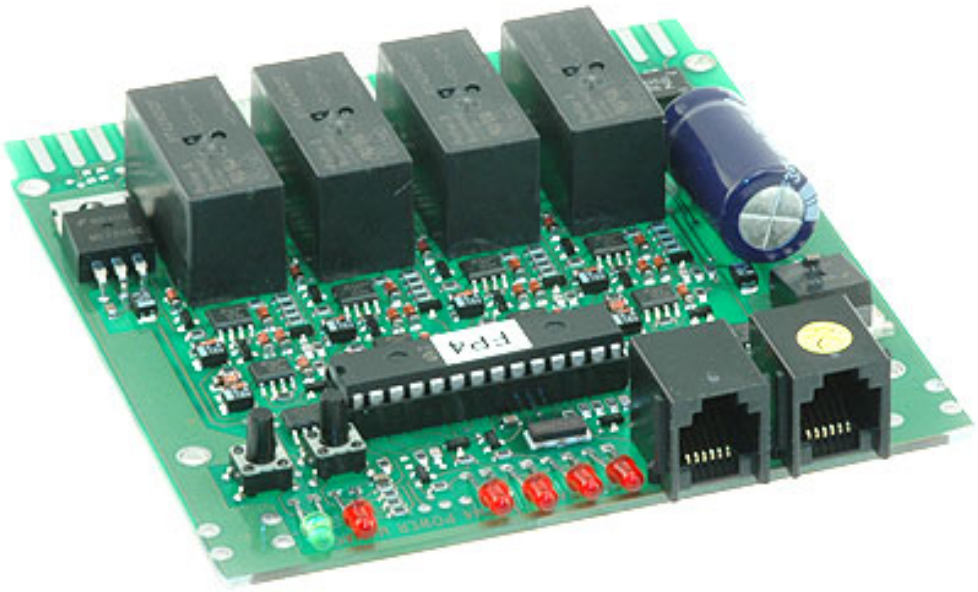
- The bulb must be rated for the track voltage of the DCC system. Automotive systems are called 12 volt, but they actually push 15 volts with modern alternators. So automotive bulbs are good for all but the highest voltage DCC systems (such as 20+ volt garden layouts).

- The bulb current rating must be a fraction of the maximum current the DCC system will supply. I recommend the bulbs be rated at less than half the DCC system's capabilities. That way, two districts shorted at the same time may not take down the system.

Given all of the above, I would stick with 1.75-amp automotive bulbs on 5-amp rated DCC systems running track voltages up to 16 volts.

Relays

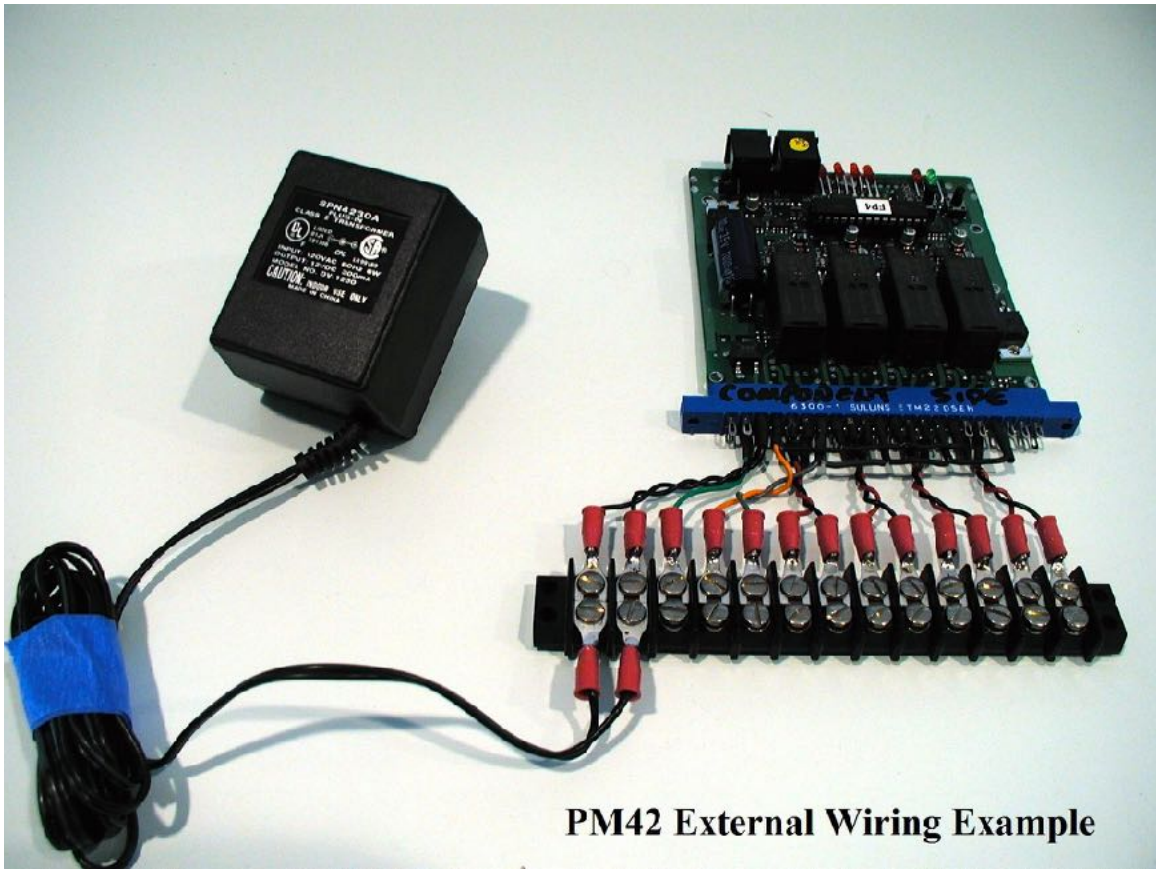
3. PM42 4-section power manager from Digitrax. Digitrax, Inc. photo



Some of the earliest circuit breakers were current sensors that drove relays to interrupt the current flow to the track. The sensing circuitry was pretty rudimentary on some versions, resulting in some rather spectacular sparks and the resulting wheel pitting.

The Digitrax PM42 four-section circuit breaker or auto-reverser [3] was one of the first electronic units to achieve wide usage.

4. PM42 wired to terminal board and external power supply.
Bruce Petrarca photo



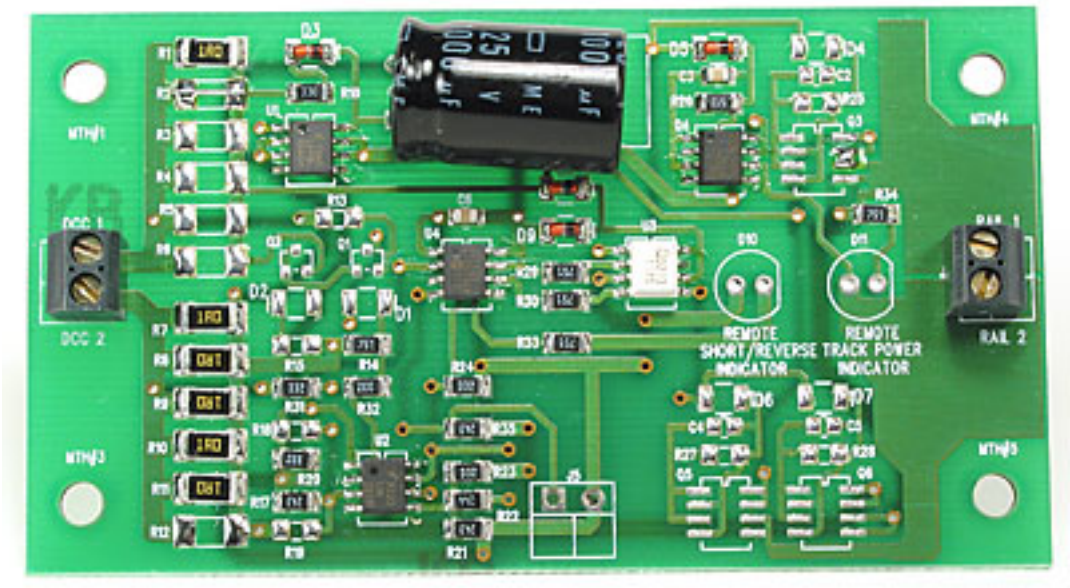
As low-on-resistance transistors have become more available and less expensive, the relay-style circuit breakers have tended to fade away. Given today's technology, I would eschew relay breakers on a new layout and suggest upgrading to fully electronic units on older layouts.

Electronic

Modern detection circuitry and switching transistors make for durable, reliable and relatively inexpensive circuit breaker modules from several manufacturers.

If you have electronic circuit breakers on your layout and are not having any issues, I see no reason to change.

5. OG-CB basic electronic circuit breaker from DCC Specialties. American Hobby Distributors photo



For those of you who are having issues, or are designing a new layout, or are converting an existing layout to DCC, or have relay style circuit breakers, or are using bulbs as your primary circuit protection, I recommend electronic breakers.

I like to divide electronic circuit breakers into three categories: basic, general purpose and advanced.

Basic versions are represented by units like the OG-CB (MSRP $30) [5] from DCC Specialties and the similarly priced AR1 from Digitrax. Units in this group tend to have less sophisticated detection circuitry, resulting in larger sparks (causing more wheel pitting) than the more advanced units.

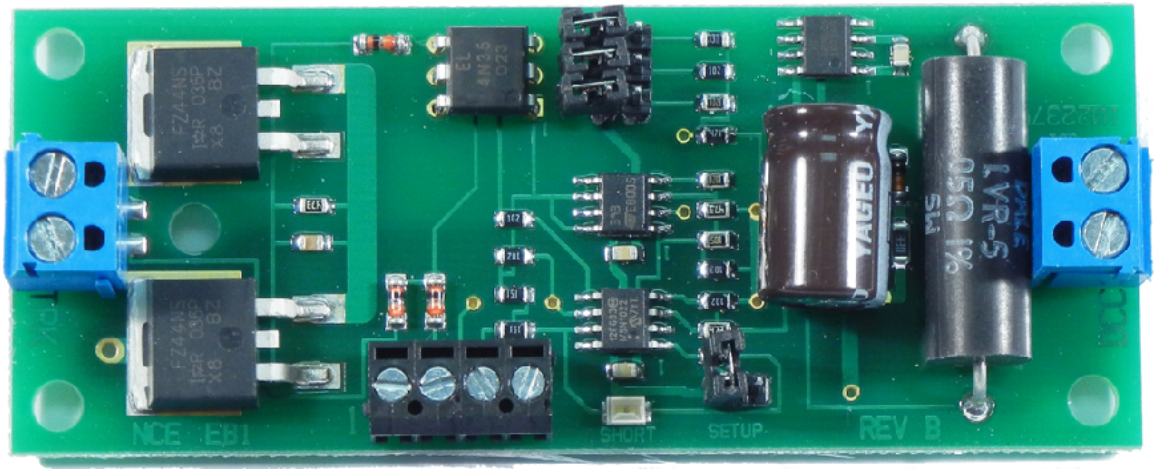
Some units in this group have knob-adjustable current settings. My experience with these has shown that many users have a hard time adjusting them to their liking. With the possibility of the knob getting bumped as well, I tend to shy away from those with knobs.

Most of the basic units were designed before sound decoders became so prevalent, so they tend to not make allowances for the inrush current to the energy storage schemes prevalent with sound decoders. Symptoms of this are that you have a short in a section with a bunch of sound locos and the system won't start without having locos removed from the layout.

A fine example of a general purpose circuit breaker is the EB1 [6] from NCE. Do not confuse this with the predecessor EB3. The EB1 has been redesigned with sound

decoders in mind and offers good performance at a price similar to the basic units mentioned above.

6. EB1 general purpose circuit breaker from NCE. NCE Corp. photo

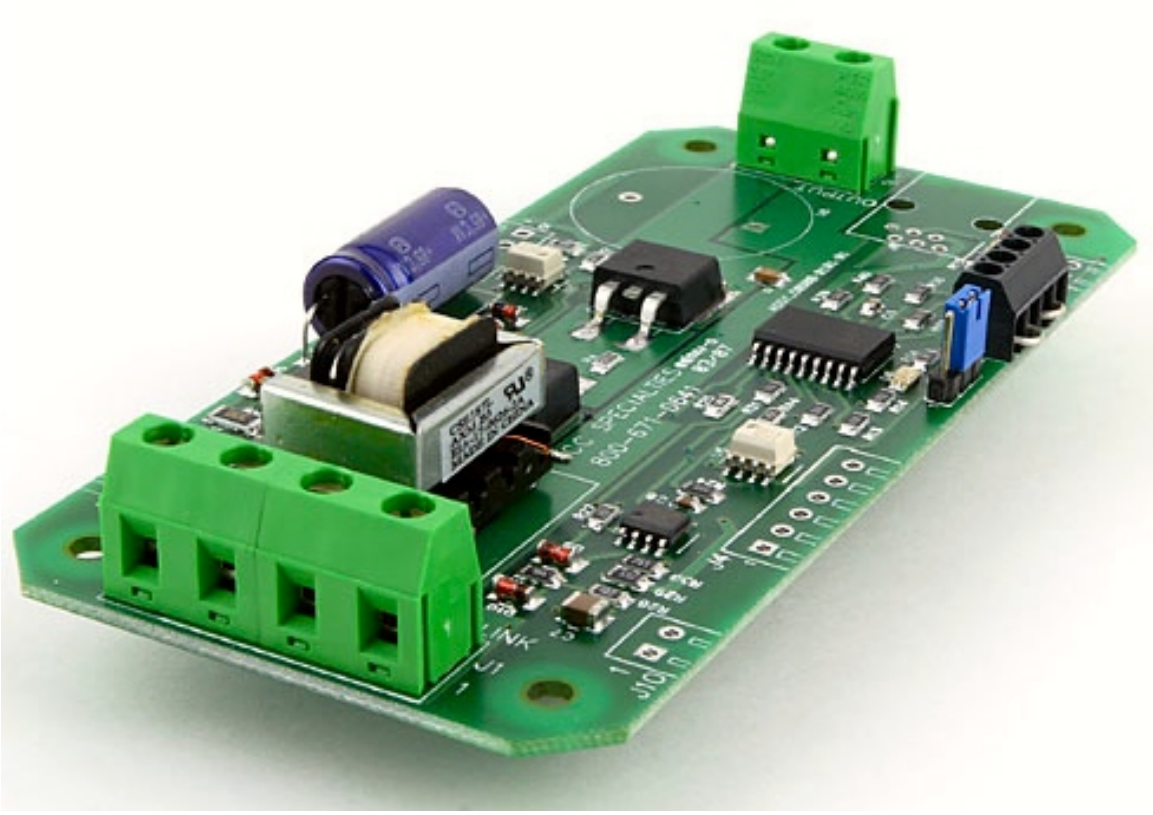


The PSx series of circuit breaker fits my advanced category. Priced about $10 above the general purpose units, it offers a lot of bang for the buck:

- It can handle sound.
- It can handle up to 20 amps with an external heat sink.
- It offers manual reset or automatic reset.
- It is faster than any booster currently on the market. That, coupled with a 1.27-amp setting and manual reset, makes it the only circuit breaker currently on the market that works with the NCE PowerCab.
- It has a “weak booster” setting to ease the load onto boosters so that a bunch of discharged capacitors in sound locos don’t shut it down.
- It has a very controlled trip, so there isn’t a large spark (pitted wheels) when the short occurs.
- It has connections for external LEDs to show status.
- It has parallel input terminals for easy daisy-chaining of the DCC supply bus.
- There is a location to add a buzzer on board if you want a sonic alert.
- All the current settings are done by jumpers or setting CVs, so there are no knobs to bump. I recommend using the jumpers unless you need finer trip current settings that can only be achieved with CV settings. As they come, they

are set for 3¾ amp trip current. This is a good compromise for use with a 5-amp system. Remember, unlike the circuit protection bulbs, when the circuit breaker trips, it removes all the load. That way, the full power of the system is available for the remaining (functional) districts.

7. PSx advanced circuit breaker from DCC Specialties. American Hobby Distributors photo



Auto-Reversers

The heart of a circuit breaker is exactly what is needed for an auto-reverse module, the ability to detect a short.

The PSxAR is an example of sophisticated design technology. It combines an auto-reverser and a PSx series circuit breaker into one board. When a short is detected, first the module will flip the polarity. If the short persists, then the module will shut off the power.

The subject of auto reversing is a topic unto itself. Guess that will be something for a column in the near future.

One rail or two?

Relay-designed circuit breakers tended to disconnect the power from both rails. Electronic breakers tend to only open one rail. In normal usage, the difference is very minimal. There is one circumstance where there can be an issue with only one rail opening.

Consider a modular meet where two adjoining (sets of) modules are wired differently, one interrupting the outside rail and the other interrupting the inside rail. It is possible to have a short on the boundary between these two (sets of) modules that will not shut down the districts, but will take down the booster(s) supplying them.

There are two ways to remedy this.

- Set a standard that a specific rail is interrupted and enforce it.
- Use a circuit breaker that interrupts both rails.

If I were setting standards for a modular club, I'd include a requirement that each section (group of modules that must be used together) drive a local DCC bus off the main DCC bus that passes through the module (set). This local bus would be isolated from the DCC bus with a circuit breaker that interrupts the outside rail. Thus every scene becomes its own domain and a short within it won't bring down the entire setup.

I asked Larry Maier, the designer of the PSx series about this. His reply: "The PSX breaker only opens one rail because we know that model railroaders have a limited budget and we are trying to make them as cost effective and affordable as possible. To answer your question: Yes, the PSX-AR opens both leads. Should you have a situation that requires BOTH track leads opened, the PSX-AR will do it."

There you have a bit about circuit protection, both bulbs and breakers. In a future column, I'll delve into auto-reverser modules, based the start we made here.

I invite you to share your experiences on the blog that is linked to this column. Just click on the Reader Feedback icon at the beginning or the end. If you liked this column, you can register your "awesome" vote there, too. Until next month, I wish you green boards.

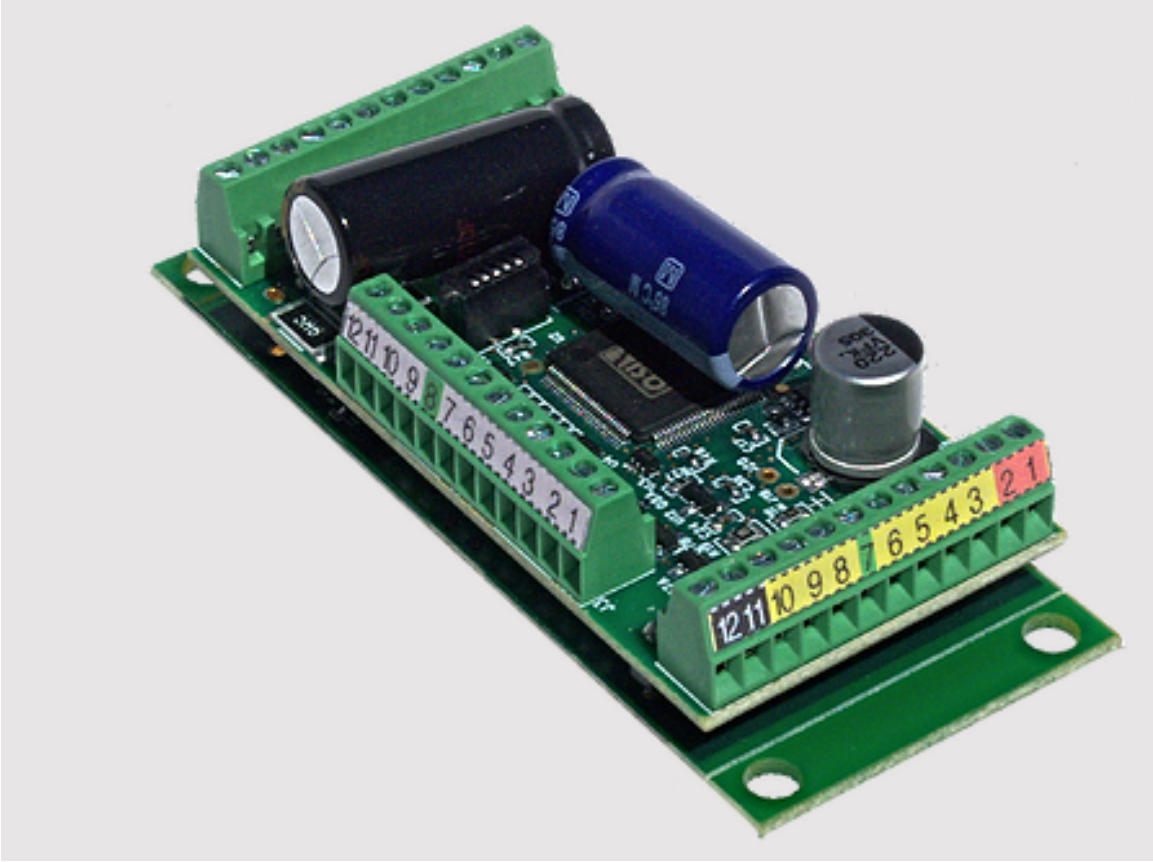
This month, I have an installation to share with you. Check out "Mr. DCC's Workbench," coming up next.

Mr. DCC's Workbench
An O-scale diesel sound installation

Our club is building a set of modules for a layout set in the late '50s to early '60s, centering on the Pennsylvania Railroad. Toward this end, they purchased a 2-motored Weaver RS3 without DCC or sound. Here are some of the obstacles that I encountered installing the decoder. For more information, go to my web site https://mr-dcc.com/index.php/dcc-info/installations/o-gauge.

The first step was to select a decoder for the loco. A stall current test showed that each motor drew close to 2 amps. That means that, if the motors are in parallel, the decoder needed to handle almost 4 amps. Even in series (which was my plan to limit top speed), they would need more than a simple HO-scale decoder. Josh at QSI suggested that one of the Titan Magnum decoders [8] would fill the bill and he was, justifiably, proud of the sounds that they put into the decoder.

8. QSI Titan Magnum decoder rated for 6 amp stall, 10 amp run. QSI photo

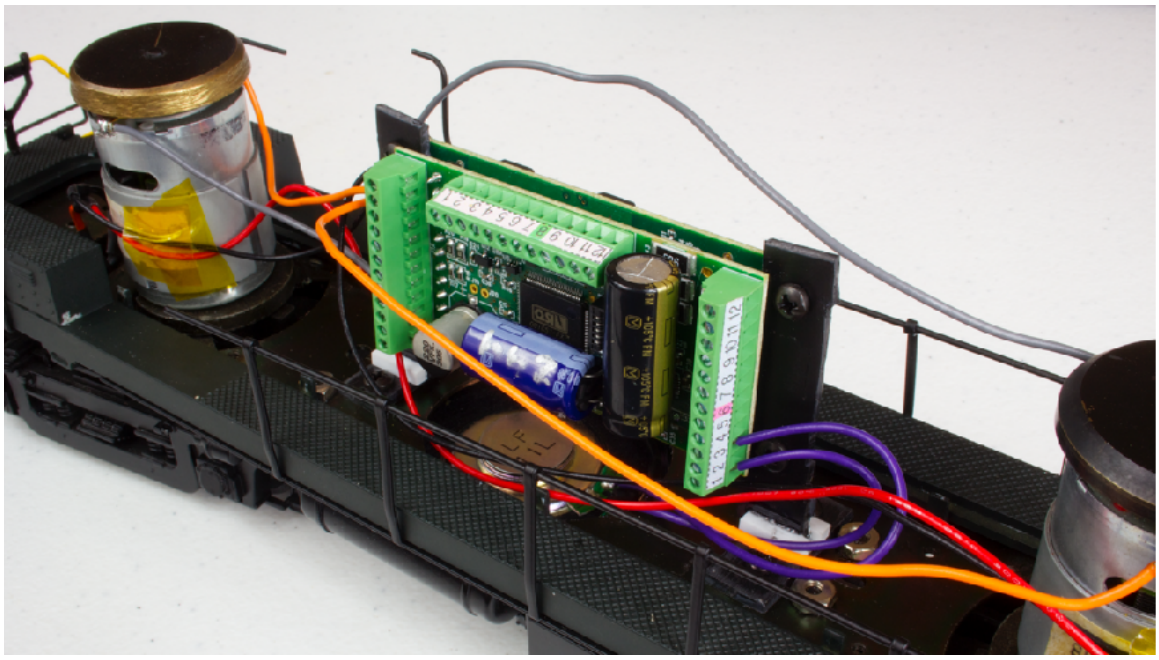


Next came the speaker selection. There was a 50 mm diameter boss molded into the fuel tank. I had a 50 mm speaker with a tall magnet structure in my stock, but it was rated for ¼ watt. With the decoder able to supply 2 watts of power, I wanted a more

robust speaker. Chatting with Jack at Litchfield Station, I found exactly what I needed, a thin-profile 50 mm speaker with a 1½ watt rating.

The next stumbling block was fitting the decoder into the loco. The Magnum is designed with garden scale in mind and the RS3 is a very narrow and low hood loco. Well, I was all set to install the decoder on the floor pan of the loco when I realized that the hood opening is narrower than the decoder. OK, I had to design a vertical mount and even then, the decoder reaches almost all the way from the floor to the roof.

9. Decoder installed in the loco floor. Bruce Petrarca photo



Once all of these issues were addressed, the installation was straightforward. I did adjust rail wires to the NMRA color code of red and black, away from orange and black. I'm still experimenting with series vs. parallel for the motor connection. But the decoder is capable of handling either connection.