

# DCC 102

## **DCC Power Districts and Short Circuits**

By Dennis Turner, Superintendent

**Denver's RailRoads**

<http://denversrailroads.com/>

# Introduction

- **We will cover in this clinic:**
  - Power Districts
  - Short Circuits
  - Circuit Breakers
  - Boosters
  - Turnouts
  - Frog Juicers
  - Reversing Circuits
  - RRamp-AmpMeter

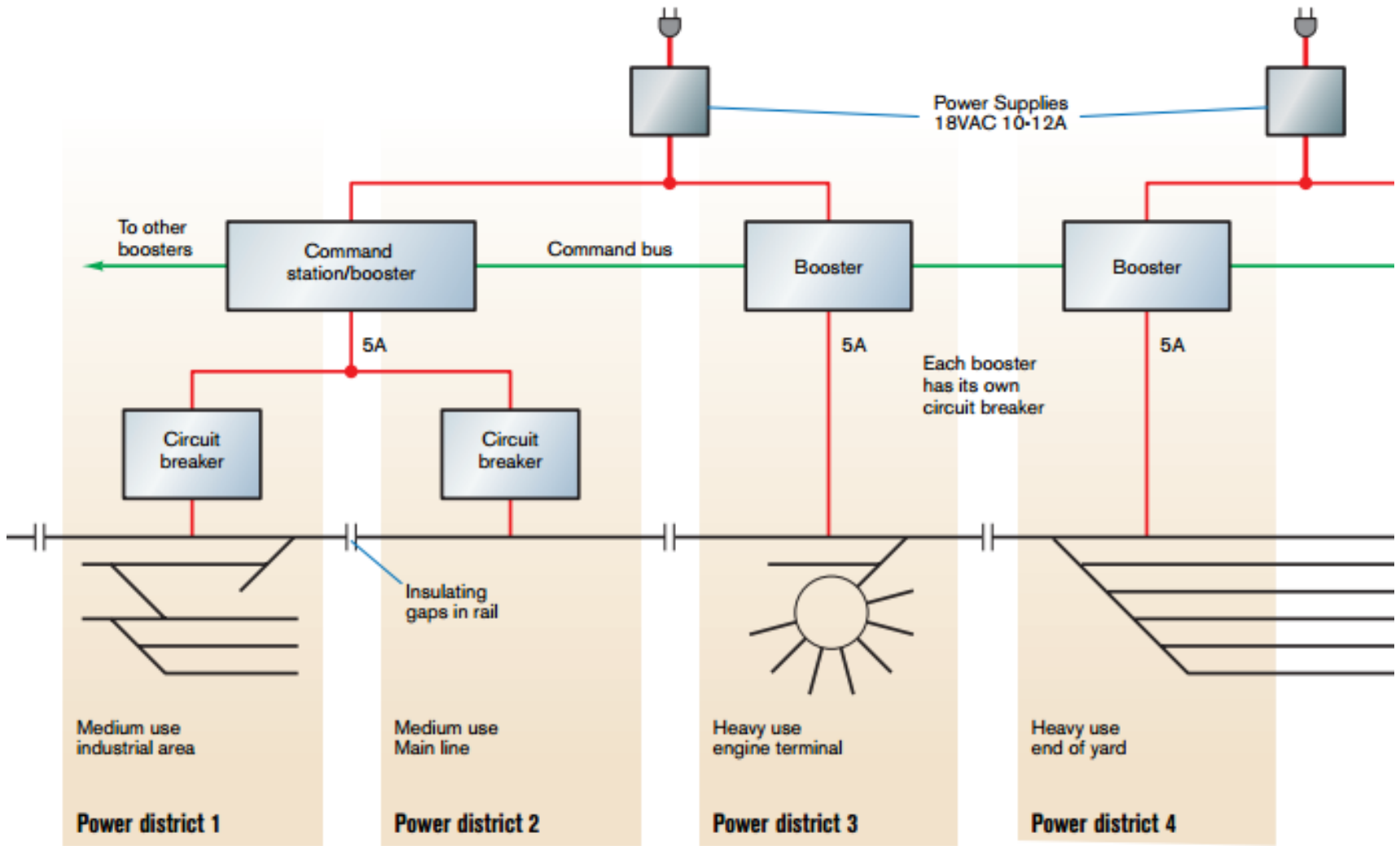
# DCC equipment brands

- A note here to explain that DCC Accessory devices:
  - ie. Circuit Breakers, Decoders, Frog Juicers, Reversing Units, Boosters, etc.
  - But **Not** Throttles or Decoders
- that you add to your DCC System can be of any brand and do not have to be the same brand as your DCC Command Station.
- NCE accessory products get a lot of coverage because they manufacture good and useful devices.

# Power Districts

- **Why divide your layout?** After all isn't one of the big selling points of DCC that you don't need to divide your layout into individual electrical blocks for independent train control?
- Well yes, but . . . In addition to minimizing operating disruptions, power districts are also the key to good DCC power management.
- If you're running a lot of trains, you'll need to make sure your DCC system can supply all your power needs efficiently and safely.
- Adding power districts to your layout will help you do that. By separating your layout into power districts, you divide the total track power available into smaller, more manageable units.

# A Large DCC Layout



# Short Circuits

- **In addition short circuits happen . . . A LOT!**
- With DCC a short has the potential to disrupt all operators. That's because when one train causes a short, it trips the master circuit breaker, interrupting power to all trains on the layout.
- Once you clear the short, the circuit breaker resets itself and your trains are back in operation. But these breaks in activity aren't realistic or fun.
- Fortunately, you can minimize this type of disruption by dividing your layout into smaller power districts – electrically isolated sections that have their own protective Boosters or Circuit Breakers.

<http://tonystrains.com/download/MRR-PowerDist.pdf>

# Causes of Short Circuits

- **Whatever you last did or whatever you recently did but have not tested.**
- Broken wires or a metal object touching the track or across control panel wires.
- A Non-DCC friendly turnout or driving into a live frog turnout set against you.
- A reversing loop or any other arrangement that allows a train to end up going back the way it came.
- Bad track wiring - eg, un-insulated feeder wires coming into contact or feeder wire connected to the wrong BUS wire.
- A derailment shorting opposite polarity rails.
- A locomotive crossing between unmatched power districts.
- **Dirty track.**

# Circuit Breakers

- “The goal of the DCC circuit breaker is to protect the Booster by isolating the short locally within the breakers power district so the booster can remain powering the other power districts to keep the other parts of the layout running.
- For the DCC circuit breaker to act, a short circuit has to meet specific criteria:
  - a) The short circuit current must be above the trip point of the DCC circuit breaker.
  - b) The short circuit current must last for a period of time.”



# Why use a Circuit Breaker

- **A Circuit Breaker protects the Booster.**
- A Circuit Breaker is wired between the DCC system's booster and the track BUS.
- **It does NOT protect the Decoder in the Loco.**
- The reason you would add protection of some sort – the Circuit Breaker is not the only choice – is that you don't want your entire railroad to shut down just because you have a short circuit that only effects one part of your layout.

# Circuit Breaker Options (US\$ Prices)

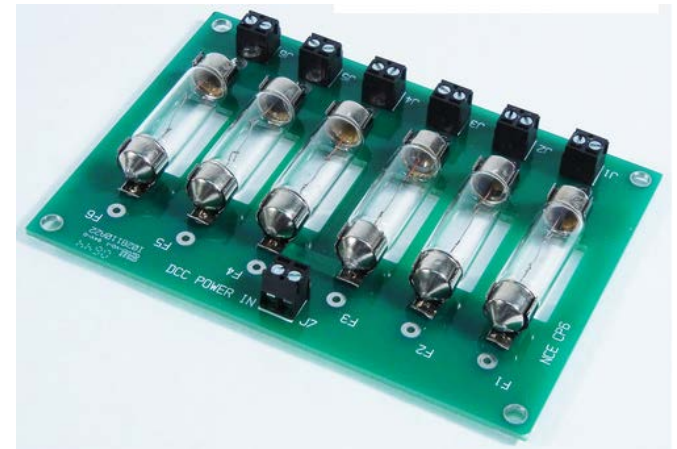
- **From the cheapest to the best:**
  - An 1156 automotive 12 volt 32 candle power (27 watt) brake lamp bulb. About A\$2.00.
  - NCE CP6, 6 Zone DCC circuit protector. \$34.95 for 6.
  - DCC Specialties OnGuard! OG-CB Circuit Breaker. \$24.95.
  - NCE EB1 Circuit Breaker. \$29.95.
  - DCC Specialties PSX1 Circuit Breaker. \$37.95.

# 1156 Automotive Bulb

- To quote Alan Jones, writing on the [cs.trains.com](http://cs.trains.com) web site:
  - “I use a 1156 car light bulb to limit the current for my NCE Powercab to under 1.5 amps. It works well for me.
  - The theory is that a cold filament in a light globe has a low resistance, so long as the current thru the globe stays at that low level there is very little voltage drop in the globe, but once the current reaches the point that warms the filament sufficiently, the resistance increases and prevents the current from getting so high it causes damage elsewhere in the circuit.
  - If you have a large layout it is best to use several globes, each one feeding a separate part of the layout.
  - Two big advantages are you get visual indication of a short and it resets automatically once the short is removed.”

# NCE CP6, 6 Zone DCC circuit protector

- The CP6 is a current limiting device that provides circuit protection for up to 6 sections of your railroad and operates with any DCC system.
- It can power 6 - 1 amp power districts with current limiting. Bulbs are in series with load. It allows 1 amp to pass thru while the rest of the load (up to 12 amps) burns off as heat/light. Multiple sections of CP6 can be used in parallel to create larger limits.



# A note on the NCE Power Cab

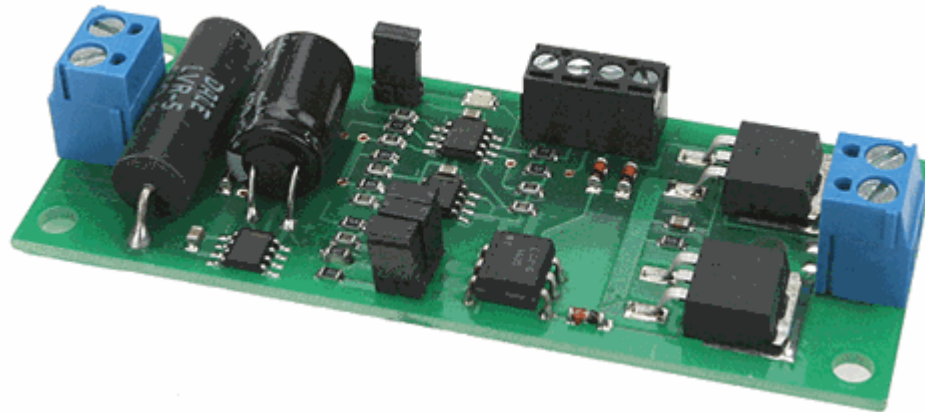
- The CP6 is recommended for the NCE Power Cab because it provides basic current limiting protection of 1 amp per section for 6 areas.
- **The CP6 will not make the Power Cab reboot.**
- The Power Cab is rated around 1.7–2 amps. I am currently using a Power Cab on a temporary basis and have it hooked to an NCE EB1 Circuit Breaker. The lowest setting of an EB1 is 2.5 amps and consequently although the EB1 identifies the short circuit the Power Cab does keep rebooting itself, which is not good for the device!
- And NCE Power Cabs supplied with Australian power supplies have been known to melt!

# OnGuard! OG-CB Circuit Breaker

- According to Bruce Petrarca of MRH Magazine:
  - “The OG-CB. . . is a good reliable device, again coming from DCC Specialties. It is older technology and does not play well with sound decoders. I'd much rather have an EB1. With a street price of \$25 for the OG-AR, I cannot see any reason to pay more for older technology.”
- **That about sums up this device.**

# NCE EB1 Circuit Breaker

- I have 9 of these devices on my layout protecting 9 of my 12 power districts. Of the other 3 power districts, 2 are protected by reversing units and 1 by a DCC Specialties PSX1 Circuit Breaker.
- **I use the EB1 instead of the PSX1 because it is cheaper.**



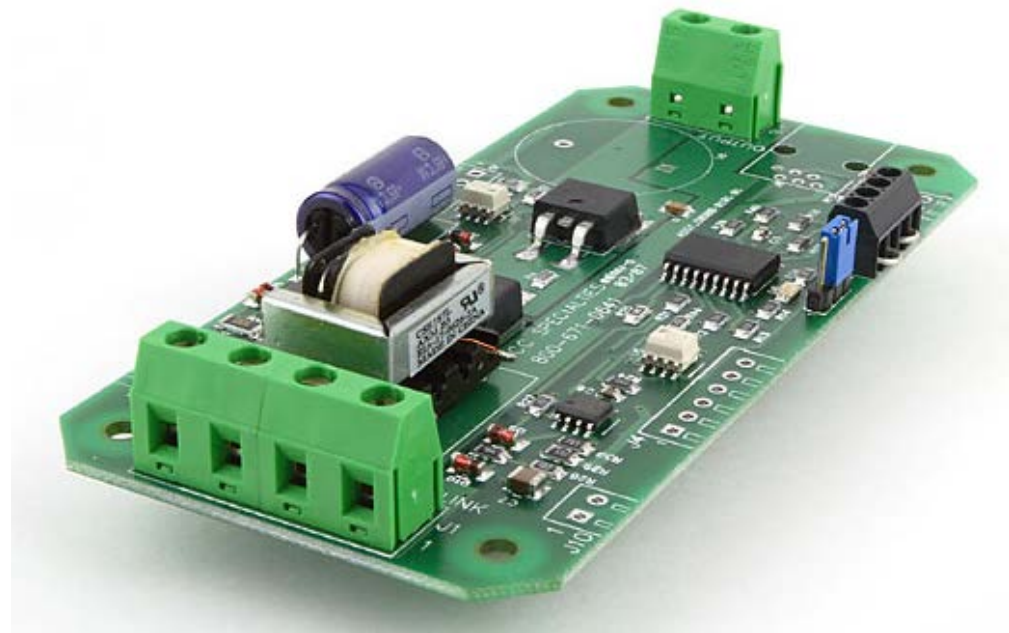
# NCE EB1 Circuit Breaker Stats

- “The EB1 Circuit breaker provides short circuit protection for one power district and can be used with most DCC systems. Threshold, Duration, type of reset can all be configured.
- The EB1:
  - Provides short circuit protection for one power district.
  - Is trip current adjustable for 2.5 to 8 Amps.
  - Is easy to hookup using screw terminals, no soldering.
  - It has a status indication LED and additional output for remote LED.
  - Optional manual reset.
  - Adjustable short circuit response time.
  - Adjustable power-up response time to accommodate sound decoder equipped locomotives.”



# DCC Specialties PSX1 Circuit Breaker

- The PSX1 Circuit Breaker includes Network Feedback, Shorted and Occupancy Status to Digitrax LocoNet, Lenz ExpressNet and NCE Cab Bus.
- The PSX-1's trip current is set at 3.81 amps. You can adjust it from 1.27 amps to 17.8 amps easily via programming or jumper connections on the board.



# To quote Bruce Petrarca of MRH Magazine:

- “I personally use and most highly recommend the PSx series. They were designed after sound decoders and stay alive capacitors became the norm.
- Thus, they can handle restarting close to 20 locos with sound decoders in a single district . . .
- It was designed for DCC Specialties (a company started by Tony Parisi of Tony's Trains) and is contract manufactured for them by NCE.
- They can accommodate any system from the NCE PowerCab (one of the lowest powered units on the market, but has a very quick shut down) to the BRUTE FORCE short circuit current (60 amps) from the NCE PowerHouse Pro. Every other system I know about falls between these extremes.
- They even have a "weak booster" mode to ease the load onto Digitrax boosters to keep them from shutting down with several sound locos in the same district.”

# DCC Boosters

- **Boosters are responsible for the following tasks:**
  - Converting the incoming AC or DC power into a local internal DC power source suitable to drive the track.
  - Providing short circuit protection, so any short circuits will trigger the circuit breaker to cut power to the track before something is damaged.
  - Provide an automatic resetting "Circuit Breaker" function.
  - Convert the command station's digital level signals into a DCC track waveforms with suitable voltage and current to run locomotives.
  - Optionally provide a regulated voltage for the track.

<http://www.dccwiki.com/>

# Adding Boosters

- To add additional boosters, you will need to electrically divide your track into power districts, and connect a new booster to that section of track.
- The booster may need a separate power supply, and must be connected to your DCC system's booster bus.
- By connecting the booster to the booster bus, all boosters on the layout will send out the same commands to all sections of the track. This allows trains to receive commands, even if they are crossing between power districts controlled by different boosters.
- **Be sure to double gap the tracks to fully isolate the boosters.** That is, both rails need to be cut at the same spot. Otherwise you can create a short if one booster on the section goes out of sync with the others.

<http://www.dccwiki.com/>

# How many Boosters do you need

- **At least one!**
- If you have bought a DCC Starter System that does not include a 5 amp booster (eg. NCE Power Cab) and you grow your system you will need to buy a Booster sooner or later.
- Such as a **NCE SB5 5 Amp Smart Booster** for a NCE Power Cab.
- But you will only require additional Boosters if your system gets **really really big** (unlikely for an N Scale System) or you decide to use Boosters instead of Circuit Breakers or you use an Accessory Booster.

# Tam Valley Depot Booster

- **This DCC Booster was designed to solve two issues that putting a lot of DCC accessory decoders on your layout brings up:**
  - 1) They are a drain on your precious loco amps and
  - 2) When a loco causes a short all the accessories lose power.
- To solve this problem Tam Valley have made a DCC booster that can provide about 5 Amps of power to run the DCC accessories independent of the track power from your command station.
- During a short on the layout, when the DCC signal dies, the booster continues to deliver full power. This is a so-called "dumb" booster in that it does not need a cab bus - it connects directly to the track output of your existing command station.

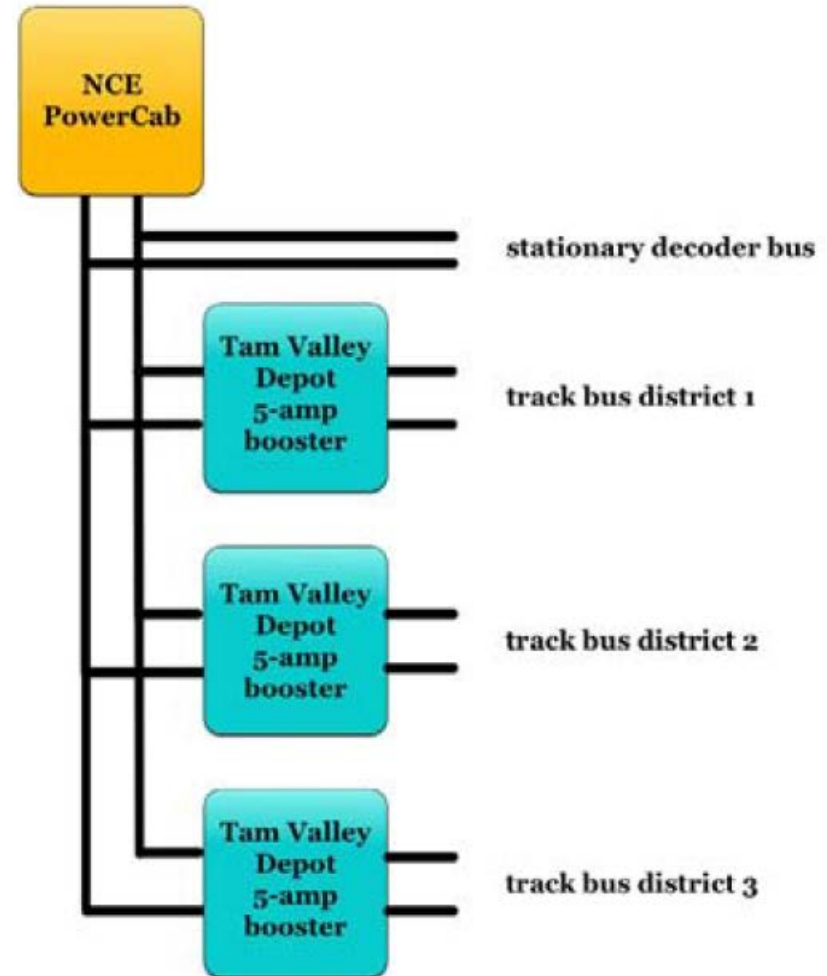


# Powered circuit breaker

- You can also use the booster as a "powered circuit breaker".
- It fills all the functions of a circuit breaker but provides its own power. Each of your power districts puts no load on the command station as it is fully buffered.
- Auto-shutdown – the unit shuts down after 5 minutes of no DCC signal (accessory mode) or immediately (power district mode). When the DCC signal returns it wakes up immediately. Just plug the booster in and forget about it.
- The booster has protection against shorts and overheating.

# Boosters instead of Circuit Breakers

- Used with the 16V 4.5A 72W 110/240v switching power supply (available from Tam Valley) you get about 14.5 Volts on the track to power a layout with just a single NCE PowerCab.
- The diagram of the right is of Bruce Petrarca of MRH Magazine's own layout.





# Booster as an Accessory Booster

- I use the Tam Valley supplied 12V 5A 60W switching power supply with the Tam Valley Booster on my layout for all of my accessories.
- It powers 50 or more frog juicers and works like a dream.
- The Power supply is a Laptop type and comes with a US 110V plug.
- But by swapping the power cord (available from OfficeWorks) it can be used with 240V~50/60Hz power.

# Tam Valley Booster Cost

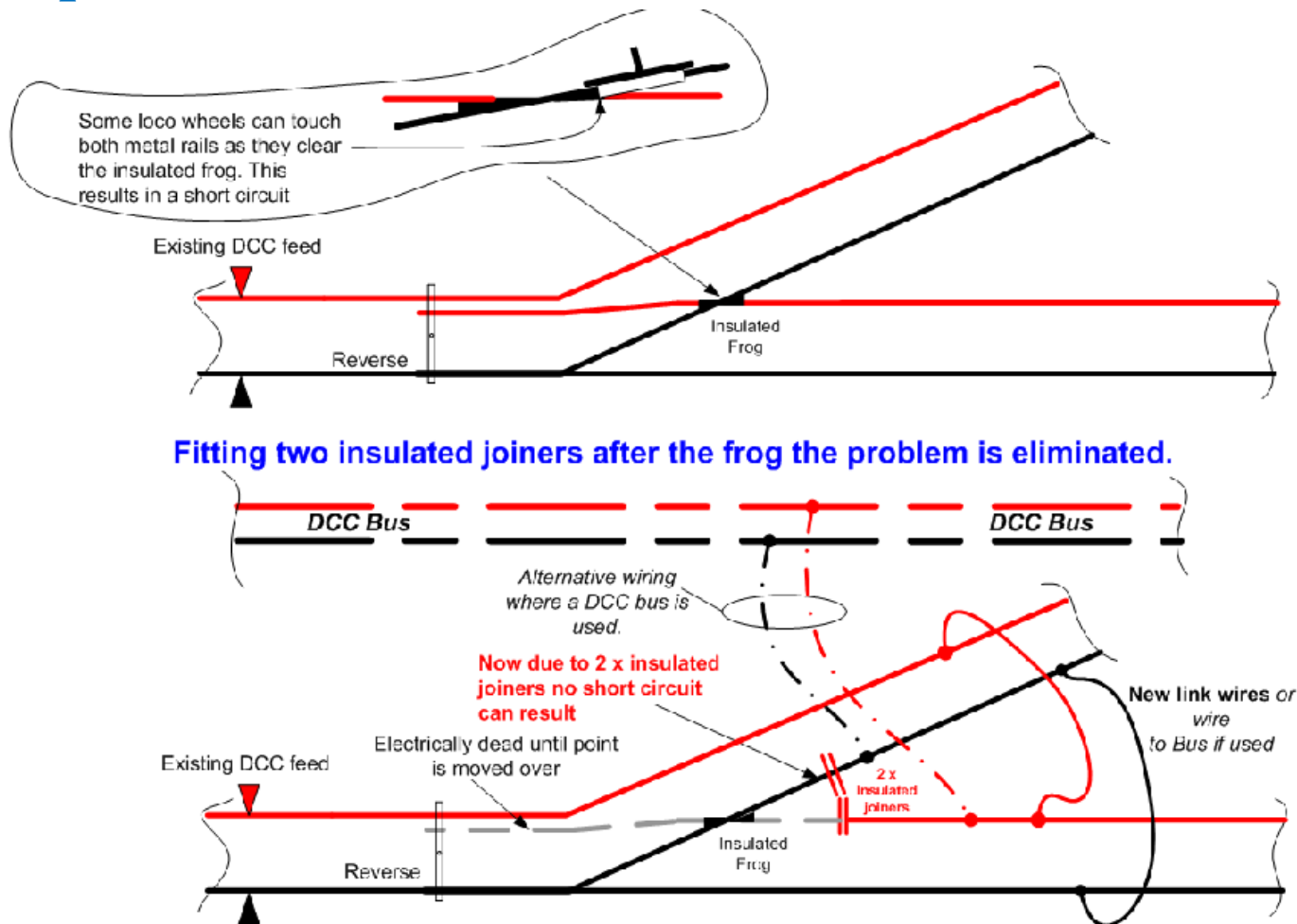
- The Tam Valley Booster is quite expensive to use as a circuit breaker but not as an extra Booster.
- The base cost is US\$55 for 1 and US\$50 each for 3. Plus the power supply, which is US\$17.
- The power supply is available on its own and is a very good price for a 16v 4.5 Amp device.
- They are available directly from Tam Valley, payment by PayPal, at <http://www.tamvalleydepot.com/products/dccbooster.html>
- MRRC Shop does import some Tam Valley devices but not the Booster.

# Turnouts

- Turnouts and DCC can be a really big challenge as short circuits are caused by the metal wheels touching both rails.
- The problem is even greater if they are live frog turnouts like Peco Electrofrog.
- The HO guys even go to the trouble of adding extra wires to their turnouts . . .
  - See Allan Gartner's site at <http://www.wiringfordcc.com/switches.htm> and at Brian Lambert's site at [http://www.brian-lambert.co.uk/DCC.html#On\\_1](http://www.brian-lambert.co.uk/DCC.html#On_1)
- However this is not an option for our smaller N Scale turnouts, **nor is it necessary.**

# Solution No.1 for Insulfrog Turnouts

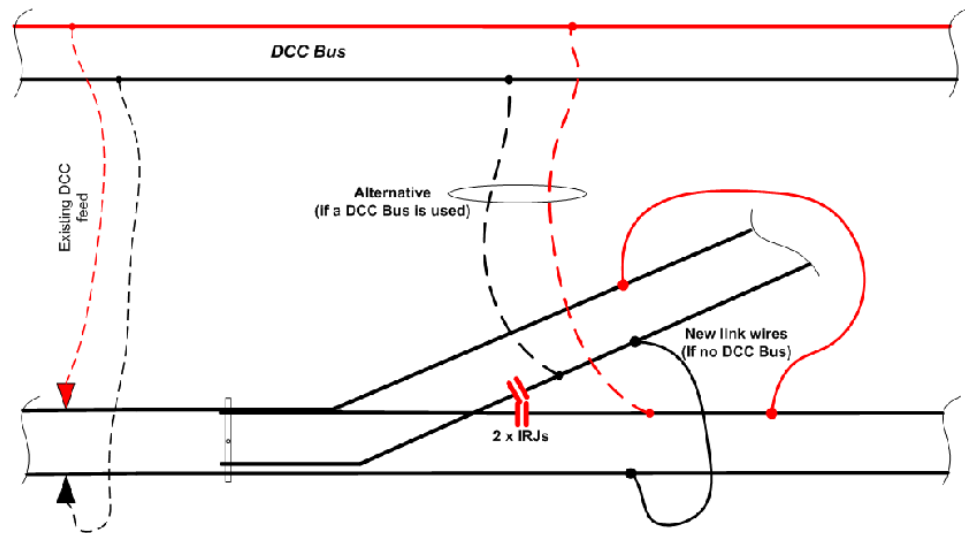
- As per Brian Lambert:



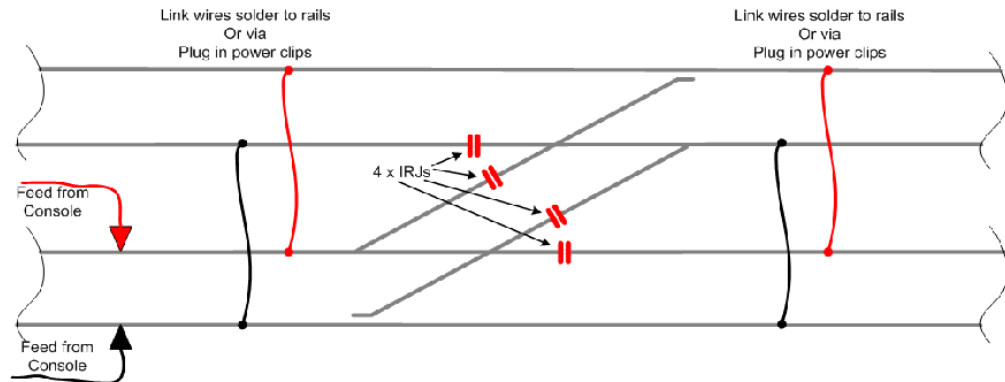
# Solution No.2 for Electrofrog Turnouts

- As per Brian Lambert:
- Note that the most important action is to insulate both frog rails.

Basic Electrofrog DCC Connections

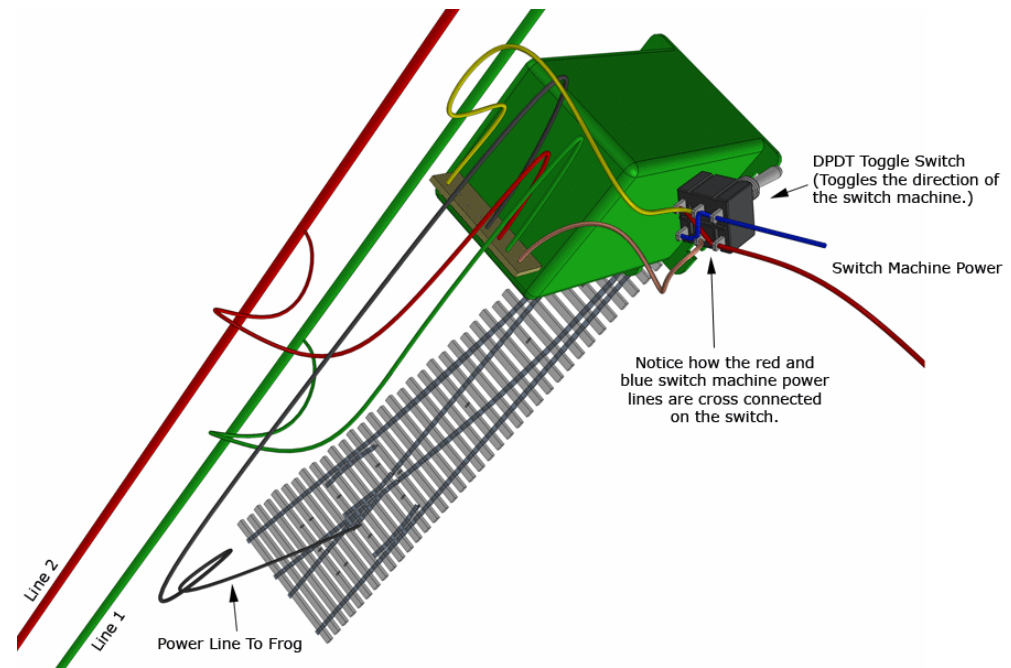


Basic example of a Electro frog (Live frog) cross-over wired for DCC



# Solution No.3 – Accessory Contacts

- Using an accessory switch added to a Peco point motor, or the built in DPDT contacts on the SEEP and Tortoise point motors you can power the frog rail in the direction of travel.



# Solution No.4 – Frog Juicers

- Frogs need to be powered to prevent interruptions in power to your locomotives and short circuits as they pass over a turnout.
- The issue with powering a frog is that you have to switch the power to the same polarity as the points when the turnout is thrown.
- **The frog juicer automatically switches the power on a frog.**
- A wire from the frog juicer is used to power the frog - if the frog is of the wrong polarity the frog juicer detects the current surge and nearly instantaneously switches the power before the locomotive decoder or the command station can notice.

# Tam Valley Mono Frog Juicer

- Tam Valley make 3 different Frog Juicers:
  - **DCC Mono Frog Juicer – US\$15 or \$12 for 3**
  - For all DCC systems including NCE PowerCab. This board is an automatic polarity reverser for a single frog. Setup is simple, connect two wires to the DCC bus and one wire to a frog. The frog should be fully isolated.
  - When a train crosses the turnout and the frog is the wrong polarity, the frog juicer will reverse the polarity so quickly that the train and the rest of the DCC system will never notice.



# Tam Valley Other Frog Juicers

- Tam Valley make 3 different Frog Juicers:
  - **DCC Hex Frog Juicer US\$80**
    - This board can be configured for use as an automatic polarity reverser for six frogs, or a reverser for one to three reversing loops, turntables, wyes, or crossings.
  - **DCC Dual Frog Juicer and Auto-Reverser US\$32**
    - This board can be configured to use as an automatic polarity reverser for two frogs, a reversing loop, a turntable, a wye, or a crossing.
    - An example of its use is to power the frogs on the Peco SL-E383F Electrofrog Scissors Crossover. Two Dual Frog Juicers are required for this crossover as there are 4 frogs involved.
  - Available from <http://www.tamvalleydepot.com/products/dccfrogjuicers.html>

# DCC Specialties Reversing Circuits

- **DCC Specialties OnGuard! OG-AR Auto Reverser**
  - This is a low cost auto reverser and circuit breaker rated at 4 Amps.
- **DCC Specialties PSX-AR Power Shield Auto Reverser**
  - This is both an auto reverser and a circuit breaker, which electronically senses if the overload is a real short or due to in-rush capacitance of sound decoders.
  - It can automate Reverse Loop Turnouts – either stall (Tortoise) or snap coil (Peco or SEEP) motors.
  - It has a wide Range of Current Trip Settings, adjusted by jumpers or CVs from 1.27 to 19.2 Amps.

# Tam Valley Hex Frog Juicer

- By means of jumpers this board can be configured for use as a reverser for one to three reversing loops, turntables, wyes, or crossings.
- Tam Valley frog juicers are available from Tam Valley at:  
<http://www.tamvalleydepot.com/products/dccfrogjuicers.html>
- DCC Specialties products are available from Tony's Train Xchange at: [https://tonystrains.com/product-category/products/auto\\_reverser/](https://tonystrains.com/product-category/products/auto_reverser/)
- MRRC Shop also imports these circuits into Australia and retails them at significantly higher prices.

# Tony's Train Xchange

- **A word about Tony's Train Xchange** . . . They are genuine DCC Specialist and a one stop source for products from:
  - DCC Specialties
  - Train Control Systems (TCS)
  - NCE
  - Digitrax
  - And many others (but not Tam Valley)
- And their pricing is often very sharp.
- Check them out.

# RRampMeter by DCC Specialties

- The only inexpensive device that accurately measures DCC Volts/Amps.
- Also measures AC and DC Volts/Amps.
- Measures true RMS Volts/Amps, +/- 2%.
- Suitable for all scales.
- PCB length 5.63"; Enclosure length 4", width 2", height 1.25"



# Uses for the RRampMeter

- The RRampMeter was designed for Model Railroaders by DCC Specialties and does what no other meter can do!
- It tells you the total Amps that your Locos and lighted equipment are drawing from the Booster.
- Easy walk-around measurements of layout voltage drops.
- Accurate booster output setup to optimum voltages for decoders and sound units.

<https://tonystrains.com/product/dcc-rrampmeterhp-circuit-module-with-battery-backup-ver-iv/>

# Using the RRampMeter

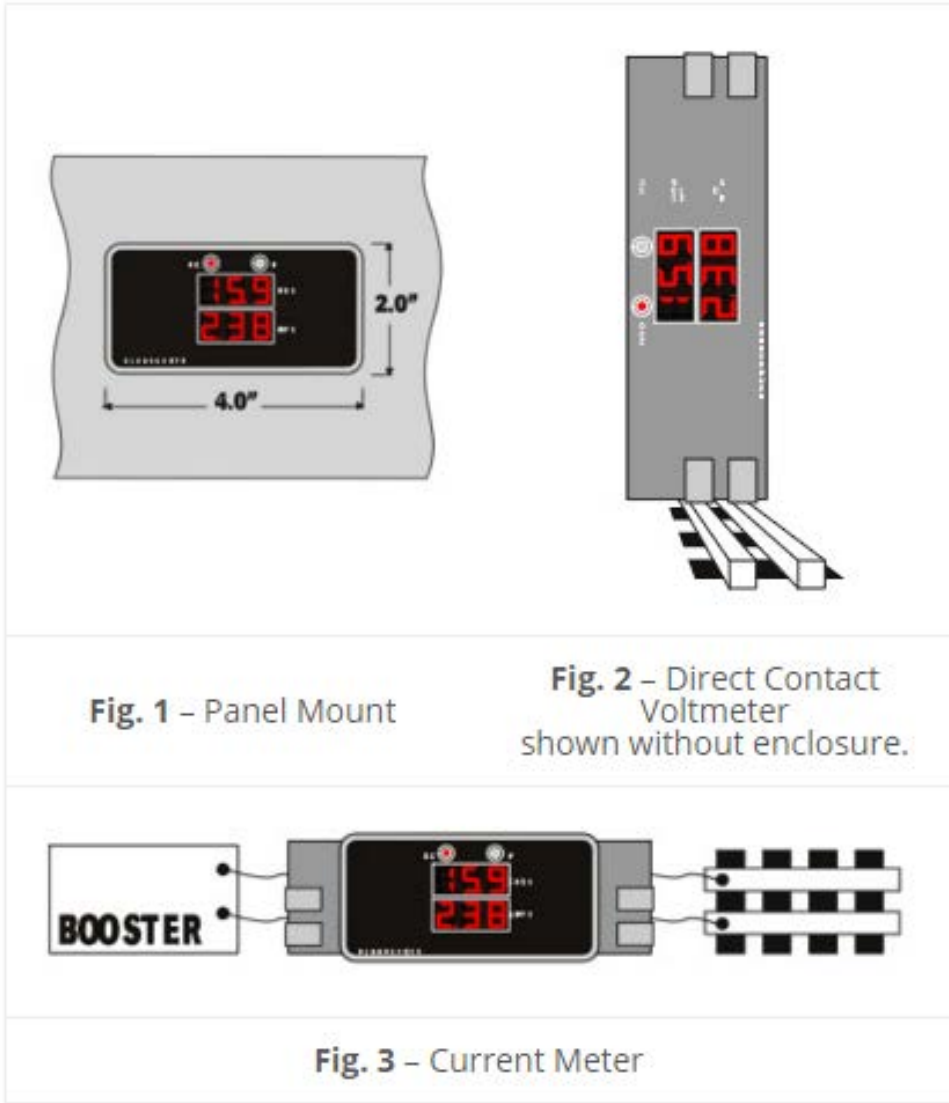


Fig. 1 - Panel Mount

Fig. 2 - Direct Contact Voltmeter shown without enclosure.

Fig. 3 - Current Meter

# Summary

- **We have covered in this clinic:**
  - Power Districts
  - Short Circuits
  - Circuit Breakers
  - Boosters
  - Turnouts
  - Frog Juicers
  - Reversing Circuits
  - RRamp-AmpMeter