DCC Impulses column

By Bruce Petrarca

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These must be true, because folks say them

In the years that I've worked with DCC, I've heard many "truths" about DCC that just aren't correct. Or, they may be correct for one situation, but not for another. So, in true "Ghostbuster" tradition, I decided to take some of these head-on. I asked a few friends to contribute their favorites.

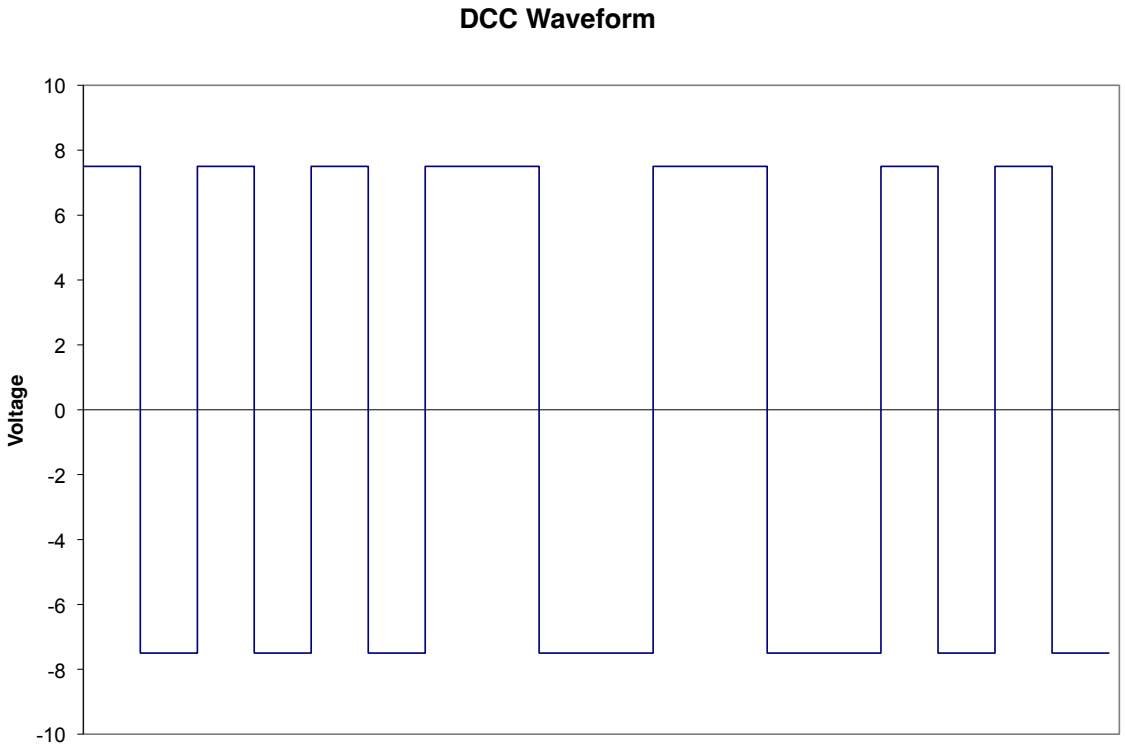
You know it is easy to believe something that you see on TV or on the Internet as being gospel, not realizing that it is pretty easy for inaccuracies to get out there.

1. The DCC track signal is AC (or DC) voltage

The correct answer is: "D, none of the above".

DCC puts a voltage across the rails that is a collection of computer data pulses. Assume a 15 volt track voltage; at any given time, the voltage on one rail will be 15 volts higher than the other. They take turns being the higher voltage and they switch at the same time. The time span between when they switch varies based on the data being sent between the DCC system and the decoders. This is square-wave data, as shown in figure 1.

If you measure from a common point like the case ground on some DCC systems to each rail, you will see half of figure 1, for example, the signal going from zero to + 7.5 volts.



1: DCC Data – What's seen on the rails with 15-volt track setting

> ***So, to answer the question "Is DCC AC or DC?" I say: "Neither, it is DCC!"***

This confusion contributes to other myths about DCC. See number two, below.

2. My multi-meter accurately reads my DCC track voltage

Your multi-meter will **not** give you accurate readings, due to the fact that the DCC signal is neither sine-wave AC nor steady DC, which are the two types of voltage that multi-meters are designed to measure.

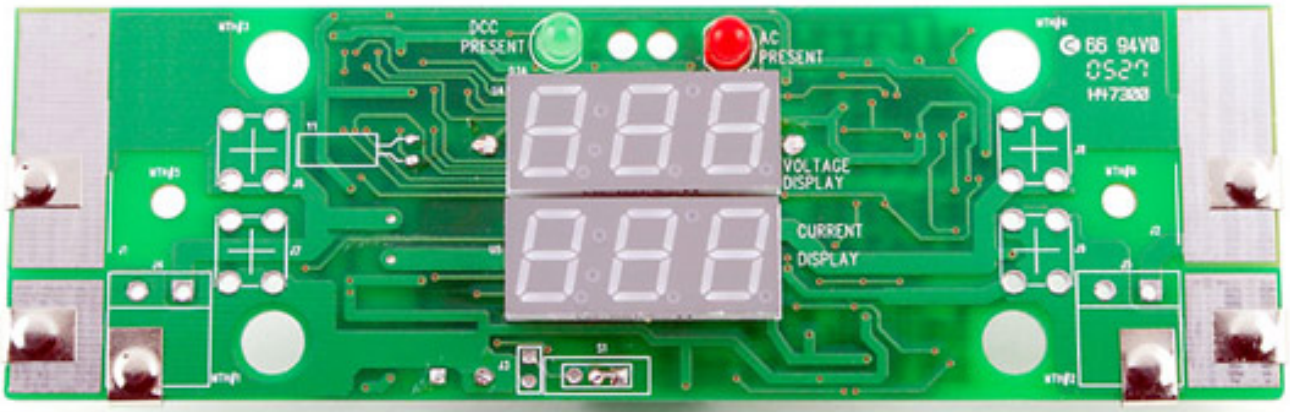
2: Inexpensive digital multi-meter

You can get a **relative** measurement with your multi-meter set on AC, but don't take the numbers you get to the bank.

> ***When measuring DCC track voltage with a multi-meter, the actual number you get is inaccurate, but you can rely on the differences in values obtained different places on the layout.***

But what those AC numbers actually are means nothing. If you set the DCC track voltage with an oscilloscope to 15 volts, your multi-meter may read anywhere from 9 to 22 volts.

For accurate DCC measurements, I highly recommend the RR-AmpMeter shown in figure 3.



3: The RR-AmpMeter is designed to measure DCC signal voltage and current. Photo courtesy American Hobby Distributors

You can build circuitry to measure DCC. My friend Marcus Ammann, from Australia, has a circuit on his web site to build your own DCC ammeter (**TINY URL?** http://www.members.optusnet.com.au/nswmn2/DCC_Meters.htm#Ammeter).

His method drops the DCC voltage by about 1.5 volts, so it is not a good thing to leave connected all the time. However, it is an inexpensive way to build your own DCC current measuring system.

3. The larger your layout, the more boosters you need

I think this is left over from the CB days, when folks saw that an (illegal) amplifier would send their signal further. So, a DCC booster must be needed to send the DCC signal further down the track.

Okay, assuming that your layout is wired as I described in my December 2011 column (**NEED A TINY URL**), the power required to run the layout is not determined by how long the mainline is, or by how many yards or spurs you have.

Whether your layout takes up 2000 square feet or it is a 6-foot shelf layout, your power needs will be determined by power consumed on the layout, not the physical size. Points to consider are locos (powered, either stationary or running), lighted cars, and accessories like lights and stationary decoders powered from the track bus.

The need for boosters on a layout is determined by the power used, not the physical size of the layout.

Each locomotive will always draw some power, ranging from a little when it is sitting quietly on track with its lights turned off, to a lot when it is making loud sounds and pulling hard with all the lights on. Okay, let's assume that you have a loco that draws ½ amp maximum – a reasonable value for modern HO models. It will draw the same ½ amp whether it is on a yard-long test track or 100 yards away on a huge layout.

Yes, large layouts have more room for more locomotives to be running or sitting and idling.

An HO scale passenger car with incandescent bulbs can draw more power than a modern loco. It is possible for a long string of passenger cars and a multi-unit locomotive set to overwhelm a DCC system rated at 5 amps.

If you are using your DCC power to run turnouts, either directly or through stationary decoders, they add to the load, too. Don't forget those lighted buildings that you tacked on to the track bus.

I recommend building your layout with power districts in mind – based on what area of the layout is likely to be under the control of a single operator. This way, you can split sections off, using circuit breakers as needed.

4: I can run a low current draw G loco over my entire garden layout with my PowerCab (1.5 amp) system due to good wiring practices.

If you need more power, your booster will tell you by shutting down during peak operations. Add another booster and move some of the circuit breakers over to it.

4. The highest current booster is best

Initially, this makes sense. You add up your power needs, factor in something for future expansion and buy the booster that fills that need, say 10 amps. Then you use circuit breakers to break it up into reasonable districts.

> ***Two or three smaller boosters and power supplies will be more useful than one large booster. In the event of a booster failure, you will be able to jumper from one district to another and keep running, perhaps with a reduced roster. One large booster and the necessary power supply may NOT be less expensive, either.***

Points to consider are:

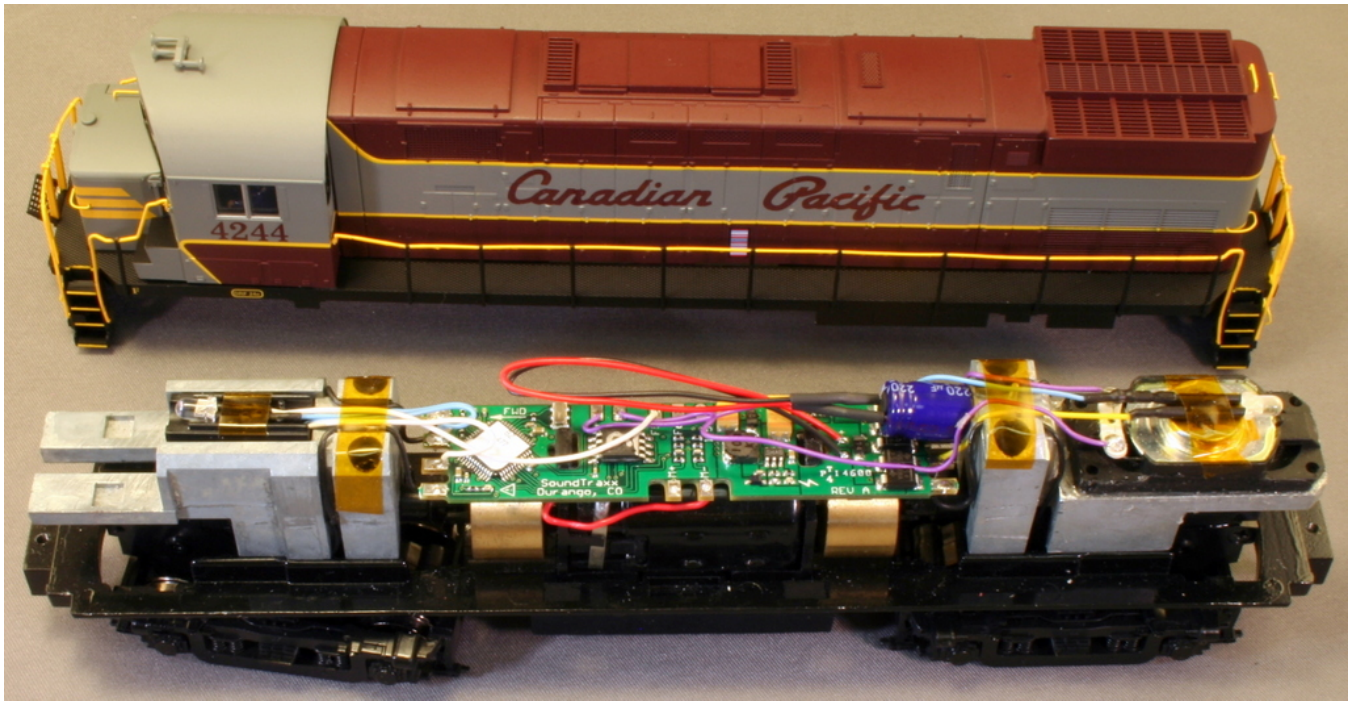
- This makes the operation of your layout dependent on a single item – the large booster. If you were to use two smaller boosters and one failed, a jumper cable would have the single booster delivering power to the entire layout for running, perhaps in a diminished capacity.
- Many of the high amperage boosters are designed for larger scales and have unbelievable power delivery capabilities. They can overwhelm smaller scale rolling stock with their instantaneous current delivery possibilities. The NCE 10-amp booster, for example, can deliver 60 amps into a short faster than a circuit breaker can trip.

Our club layout (http://pcmrc.org) uses three boosters feeding 17 circuit breakers to distribute power across the layout. When we had a failure just before an operation session, we jumped a connection between two booster districts and keep on trucking.

5. Sound decoders take a lot more power

I think this got started when sound decoders started using larger energy storage capacitors to keep them running over minor power dropouts. They **do** consume a lot of power when they are "cold started." The initial inrush current is quite large and can overwhelm some boosters and circuit breakers.

> ***After start-up, a sound decoder does not use appreciably more power than a non-sound decoder.***



5: Tsunami sound decoder in Atlas C-424 HO-scale loco

Consider this. A very common rating for the audio power out of a decoder is one watt. One watt of power from a 10-volt supply (a low value for the DC generated off a DCC waveform) will consume 0.1 amp when making a lot of noise. A running HO loco will consume probably ½ amp under the same conditions. Thus, the sound decoder only increases the power needed for the loco by about 20% when running hard.

6. BEMF never works for consisted locos

Absolute statements are always wrong.

"Can have issues", yes. "Is more sensitive to loco and decoder differences", yes.

Let's use my club's experience again. We have six consists of two or three locos that we use on a regular basis. All but one consist has BEMF enabled and runs smoothly. The one that does **not** have BEMF enabled has three identical era Stewart F unit models but the engines have different-vintage decoders with different BEMF designs. Disabling BEMF for the group was finally my choice to achieve the desired performance without changing decoders. If I were to put TCS A4 decoders in all locos, they would run fine with BEMF enabled. The same holds true if I were to put a SoundTraxx Tsunami in one loco and "Tsilent Tsunami" (motor and lights only) decoders in the others.

Let's look at the majority of the club consists that run flawlessly with BEMF enabled. Within each consist:

- They have the same manufacturer, vintage, and model locos. For example: Life-Like Proto 2000 GP20 models from a light blue box.
- They have the same model and vintage decoders. For example Digitrax DN-143 decoders.
- They have high quality 5-pole can motors.
- They have the same settings for momentum (acceleration and deceleration).
- They were speed matched with BEMF enabled (see my December 2013 column – **TINY URL NEEDED HERE**):
    - They start to creep on a low speed step (lower than 5 out of 128)
    - They would run several yards at top speed in both directions and not close up a space of a few inches.
    - They are speed limited to about 40 SMPH, plenty fast enough for operations on our layout.

- Even though we have a Digitrax system, they are consisted by advanced decoder-based consisting (see last month's column for more information – **TINY URL NEEDED HERE**).

6: Consisted locos on the PCMRC layout – consistent loco and decoder design and attention to detail allow them to run together with BEMF activated

Did it take some time fiddling with them (using DecoderPro) to achieve this result? Definitely. Was it worth it? Yes, I believe so. They pull smoothly around the layout (most are used on through freights, running from staging to the main yard, exchanging cars and returning to staging).

7. The command station shuts down when the booster sees a short

My friend, Ross Kudlick, contributed this myth.

Apparently some folks, dealers included, will tell newbies that the DCS100 command station will shut down function when the booster shuts down. Somehow this is conveyed as a negative and folks are told they need to spend close to $200 for an additional booster.

I don’t understand why folks in a single booster system care. If the booster section shuts down, it doesn’t matter whether the command station is running or not.

7: Digitrax DCS100 – command station and booster in one box.

> ***Intrinsically, the command station does not know whether the booster is functioning normally, or is shut down due to an overload.***

On larger layouts, if one booster stops providing power, the rest of the boosters, and the command station, will continue to run normally. This can drive a train from a powered region into one that has shut down, temporarily bridging power from the active region to the dead one, as the wheels of the loco(s) bridge the gaps between the districts.

Lenz provides a way to overcome this. Connecting the E terminal between their boosters and their command station will force a shutdown of the command station if any booster stops supplying power due to either a short or overheating.

8. Programming-On-the-Main is dangerous

This myth comes from down under, where Marcus Ammann suggested it. But it is a world-wide myth.

First, let's talk about two similar, but different things:

- Programming-On-the-Main (POM, aka Ops-Mode programming – shown as Po on Digitrax DT400 series throttles) – where you tell your command station to program a specific CV in a decoder with a specific address.
- Blast-mode programming – where (frequently by selecting address zero) you tell the command station to program the same value into every decoder on the layout regardless of its address.

Both of these are methods of programming a loco that is not located on an isolated programming track, so they are frequently confused.

8: PowerCab POM screen asking for locomotive address

POM uses the same mechanism (sending a packet of data to a specific address on the DCC track bus) that is used, for example, to tell a loco to turn on its headlight or ring its bell or move down the track. POM is no more dangerous than running a loco on your layout. There is no reason to remove all the locos from the layout or any such drastic measure when using POM.

> ***Assure that you are, indeed, programming-on-the-main. Your system should ask for an address to receive the data. If you aren't asked for an address, beware. Don't use address 0, as you'll probably be in blast mode.***

Blast mode is the "nuclear" option. It will reprogram any decoder that sees its commands. It is designed to globally set things like acceleration rates or to recover decoders that seem to have totally lost their way.

Understand that, without the rare installation of bi-directional layout communication, like Digitrax' Transponding or Lenz' RailCom, you cannot read back CVs from your decoders using POM or blast-mode programming.

There are two cases where hardware creates similar situations and can reprogram every loco on the layout.

- The Digitrax DB150 has a very limited command station function. It has no programming track connection. As such, it cannot read back CVs. It also uses the layout as its programming track – sort of like a hardware version of blast mode programming.
- The NCE PowerCab has a single 2-pin track connector. It functions as the DCC track bus for the most part. When the PowerCab is put into service-mode programming, that single output becomes the programming track. If you use an external booster, like the NCE SB5 or a Tam Valley Depot booster, this possibility is eliminated. The PowerCab loses its programming abilities while plugged into a SB5 and the Tam Valley Depot booster won't pass the service mode programming onto the track.

There is an accessory from NCE that can be used in either of these situations. The Auto-Switch has three connectors: one to go to the track output of either the DB150 or the PowerCab; and one each for the DCC bus and the programming track. When either unit goes into service mode programming, a relay inside the Auto-Switch picks and disconnects the DCC bus from the track output, preventing programming what is on the layout.

9. CV 29 is different among different decoders

Here is another ditty from Ross.

There are only four CVs that are mandatory in the NMRA Recommended Practice 9.2.2 document: **Primary (short) Address** (CV 1), **Manufacturer's Version** (CV 7, selected by the manufacturer), **Manufacturer's ID** (CV 8, assigned by the NMRA) and **Configuration Data #1** (CV 29). RP 9.2.2 also specifies exactly what every bit in the CV29 must control and how.

> ***Any decoder from any manufacturer that pretends to meet NMRA standards must have CV29 defined per RP 9.2.2.***

9: DecoderPro - CV 29 collects data (orange background) from several tabs in DecoderPro – but it is the same data for all decoders

If you want to check this out, you can read NMRA RP 9.2.2 on the NMRA web site (http://www.nmra.org/standards/DCC/standards_rps/RP-9.2.2%202007%20July.pdf - **TINY URL?**).

10. Knowing the stall current to select a decoder

Mark Gurries, an electronics engineer who maintains an extensive website on DCC topics, raised this one.

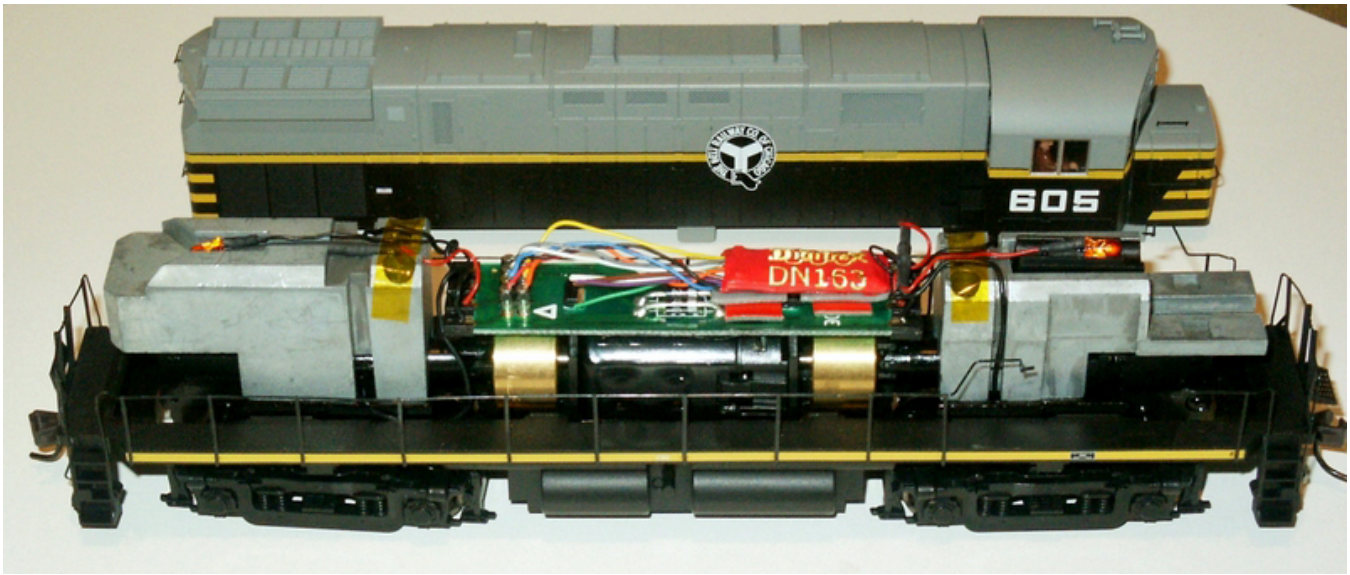
Folks who have followed my column know that I have long discussed the use of stall current to safely size decoders. No, I'm not backing down on my stand there, but let's look at Mark's viewpoint, explained on his web site (https://sites.google.com/site/markgurries/home/decoders/decoder-motor-ratings - **NEED TINY URL**)

Current generation HO and N scale locomotives are far more efficient than those built as recently as a decade ago. Modern locos rarely stall above one amp. Many stall well below one amp. Most operate at a small fraction (1/4 or so) of an amp.

Modern decoders in all sizes can handle at least one amp on a continuous basis and most have thermal protection to shut themselves down before the internal temperatures get too high.

Thus, if you go to your local hobby shop and purchase a recent design HO or smaller loco and a similarly new DCC decoder, you can use them together without a lot of testing or danger.

However, there are situations where stall and running current are still important, such as larger scale locomotives and older-vintage locomotives. If you are working on a situation like this, you can read about stall current on my web site (http://mrdccu.com/curriculum/stall.htm).



10: Current vintage loco and decoder – N-scale (DN163) decoder is just fine running an HO-scale locomotive. This is the same design Atlas C-424 as was shown in figure 5.

11. You can only use a N-scale decoder in a N-scale loco

Similar to the discussion in section 10, technology has impacted this myth.

Early on, manufacturers struggled to make decoders small enough for the smaller scale locos. To do so, compromises were made, including low power transistors and power supplies. This created a group of small decoders that were less capable than their big brothers. Today's N (and even Z) decoders typically have operating current ratings of an amp or more.

I select decoders based on what I need to fit in the available space, not what "size" the manufacturer hangs on the package.

Small decoders are usually a bit more expensive than their larger brothers. They also tend to have fewer lighting functions. But they are easily capable of running most HO and smaller locos.

One significant exception is the SoundTraxx Micro Tsunami (TSU-750). It packs a lot into a small package, so is limited to ¾ amp total current (motor and lights). It has an internal fuse that requires factory replacement if it blows. Also, it is sensitive to heat build-up and is much happier with an external way to dissipate some heat, as I've discussed several times.

12. It's OK to run DC and DCC at the same time

Another topic suggested by Mark Gurries.

I'm sure the source of this myth is folks who are trying to ease the transition to DCC. Over the years, I've seen many ideas of how to mix the two technologies on a single layout at the same time.

The only safe way to run DC and DCC on the same layout is not at the same time. Completely disconnect one before you connect the other.

If you want to go this way, wire your layout with DCC in mind (large gauge bus wires and frequent feeders). If you design in some block switches, make sure they are heavy-duty automotive type (rated 10 amps or more), not micro-miniature toggles. Don't use any DCC-only accessories, like reverse loop controllers. Then, use a connector between your DCC system and the layout. I currently use a two-pin connector from Molex that is rugged, reliable and inexpensive; previously, I used Cinch-Jones connectors. That way, you can unplug your DCC system and plug in a DC power pack and run the layout on DC, if you so choose.

The danger of simultaneous running is the possibility of interconnection between the two technologies, even when they are on separate tracks. If a loco jumps the track and bridges to a parallel track that is being used with different technology, the resulting interconnection can seriously damage the DCC system, any decoders on either part of the layout, and even the power pack supplying DC to the layout.

Schemes that use block selection switches to accomplish the transition had best be protected, as we did for a bit on the Flagstaff (AZ) club. There was a box with a two-direction (center off) switch that provided AC power to the DCC system or the DC power

packs. Thus there was no way that both systems could be active at the same time unless someone bypassed the switch and plugged one system directly into the wall.

Enough for now

So there you are, a dozen dragons slain. Hopefully, I explained the “why” behind the “what” well enough that you don’t have to take my contentions purely on face value. If you found this column helpful, please click on the Reader Feedback link here and rate it **awesome**. Please join in the conversation that invariably develops there about the topics presented in the column. Share your experiences. Thanks.

This month’s column is long enough, so we’ll not stop by Mr. DCC’s Workbench just now. Check back next month. Until then, I wish you green boards.