



Model Railroad Hobbyist |

# DCC IMPULSES

column

BRUCE PETRARCA

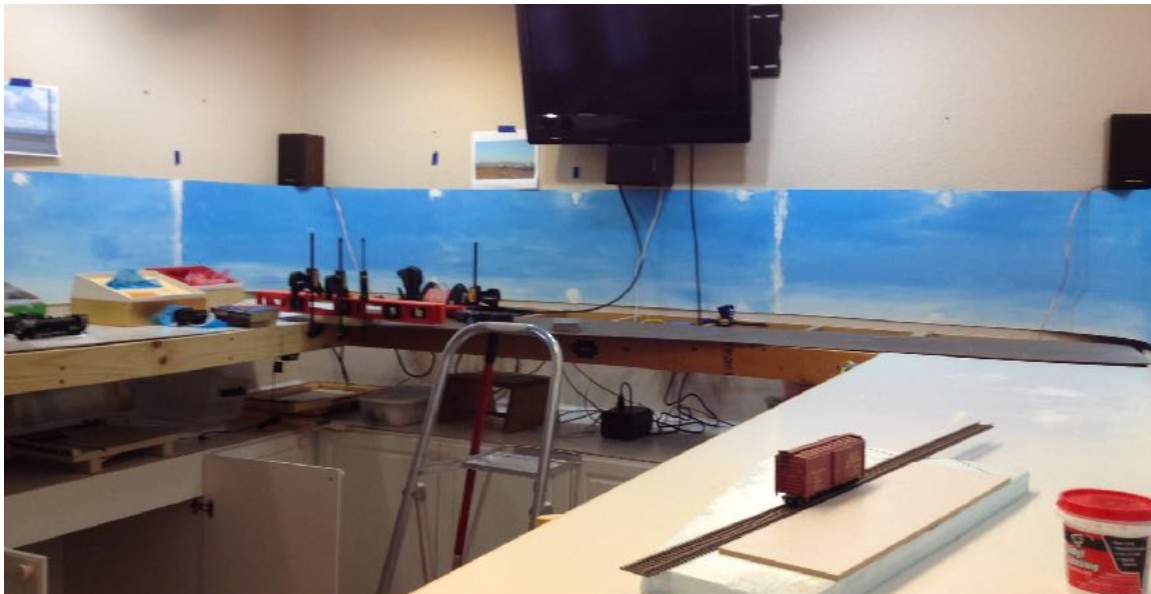


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## Getting started in DCC

I got a question in a recent eMail about how to get started in DCC. This led me to go back and review the early columns that I wrote for MRH. They may have been a bit too detailed for beginners.

### 1. My HO Santa Maria Valley Layout - bench work in and working on the backdrop, as it was in 2015



This column is to bridge that gap. It is aimed at folks who are not familiar with DCC, or just starting out with DCC. Hopefully, there will be a tidbit here and there for the more experienced folks. Something for everybody is the goal. So, after reading this column, it might be a good time to work through all my columns, starting with the first: **Back to Basics** from October 2011.

► DCC TIPS, TRICKS, AND TECHNIQUES

This column will be the basis for clinics I'll be doing at upcoming NMRA conventions: the national convention in Portland, OR, in late-August, 2015, and the Pacific Southwest Region convention in Scottsdale, AZ, in mid-September, 2015. I plan on a presentation based on topics raised here and time for an open discussion with attendees. Plan to take one in.

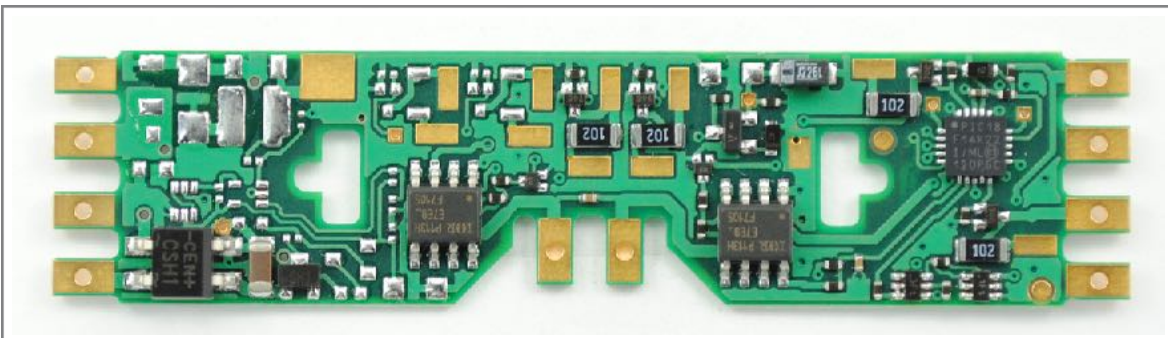
I'll talk a bit about my HO Santa Maria Valley layout in this column, too. It is a small switching layout [1], that has been designed from the get-go for DCC.

## Terminology

One of the things that folks need to get a grasp on when they are starting out on a new adventure, like DCC, is what specific words mean. A lot of that is covered in my May 2012 column, *Anatomy of a DCC System*. There is also a glossary on my web site (<https://mr-dcc.com/index.php/dcc-info/glossary>).

While I'm on the topic, I'll hit one term that is incorrectly used: chip. Chip is slang for an integrated circuit (IC). They are used in most of the electronics that is DCC [2]. Folks incorrectly use "chip" to refer to the decoder that gets put inside a loco. "Chipping a loco" actually means breaking a piece off of it, not installing a decoder into it. Statements like this label the speaker as unaware of DCC or electronic parlance.

**2. DCC decoder (SoundTraxx Tsunami TSU-AT1000) which contains several chips. This model decoder is designed to replace the light board in Atlas and other similar locos.**



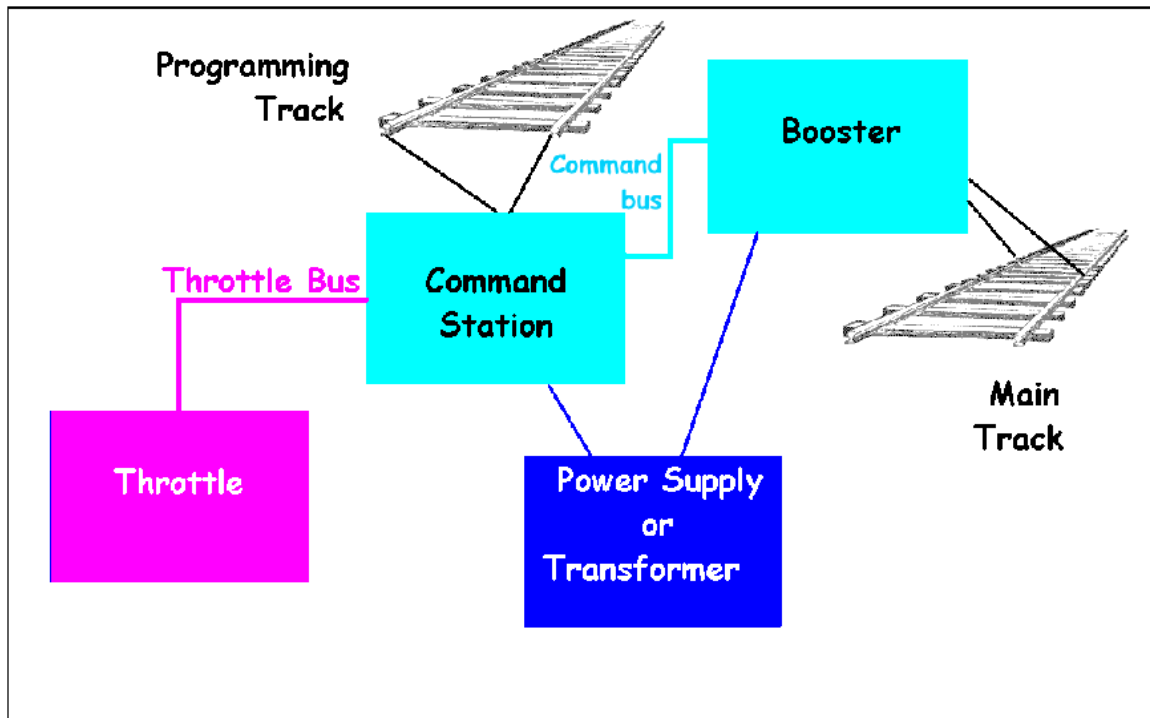
A spelling issue: "bus" is a term used in the computer world to refer to things that carry data, like the bus wiring from the DCC booster to the track [6]. "Buss" is a kiss.

The item that you use to control a locomotive is variably called a "throttle" or a "cab". I'll use the term "throttle" in this column.

## Converting or building new?

The easiest time to plan for DCC is when one is contemplating a new layout. The wiring can be optimized for the DCC experience and there are no remnants from DC wiring, like undersized block selector switches or tiny bus wires.

**3. Functional block diagram of a DCC system. Many systems combine the functions of two, or more, of these blocks in one box.**



If you have a DC layout that you wish to convert, there may or may not be a lot of work ahead of you. If you have fairly robust wiring, you may be able to use it for DCC. In a recent on-line discussion, a modeler wanted to convert a DC dual-loop layout to DCC. His layout was well enough wired that all he needed to do was install a DCC system and two circuit breakers, one feeding each loop using his existing wiring. See the section on the “quarter test”, below.

Even the most meticulously wired DC layouts may not be directly convertible to DCC. I was a member of a club that had spent lots of time and money on a DC rewire before they decided to convert to DCC. Their DCC layout never worked as well as they hoped until they ripped out all the DC wiring and started over. They had many issues: tracks wired into two (or more) different districts, inadequate drops and general confusion under the layout. After several months of rework, the new “DCC designed” wiring is working fabulously and the members are less frustrated.

## Mixing DC and DCC

Running both DC and DCC on the same layout at the same time is a very expensive accident waiting to happen. If the two ever get joined (wheels bridging blocks or a tool touching both tracks), there is a high probability that it will be fatal to some or all of the DCC decoders on the layout, as well as the DCC booster, any circuit breakers installed and, perhaps even the DC power pack.

If you must run both, use a connector or a double pole double throw switch to firmly and completely switch the entire layout at once.

That said, experience shows that once folks have fun with DCC they tend not to revert to DC. One local club switched their HO-scale standard gauge layout to DCC, while leaving the separate narrow gauge section DC. They more than doubled the participation in their operations sessions once the DCC was installed. After a year of not one train running on the HOn3, they converted it to DCC and saw a rebirth of interest there, partially fueled by the Blackstone HOn3 products.

## Planning for DCC

To build a layout, it's not a good idea to just go out and buy some track and just start gluing or nailing it down. Planning is always helpful. The same holds true with DCC.

From the DCC design standpoint consider:

- Layout scale which affects track voltage.
- The final size of the layout which affects wire size and the number of boosters needed.
- The number of operators on the layout which affect the number of throttles needed and the location, size and quantity of power districts.
- What will be drawing power at once which will affect the number of amps of DCC power the system must supply.
- Your plans for advanced features, such as radio control or a computer interface, which will affect the choice of DCC system.
- It is always good to be able to reverse a train or, at least a loco, so a loop or wye or turntable can be helpful. The track plan and DCC plan must be coordinated for best results in a reversing section.

## Wiring differences between DC and DCC

DC wiring, even on the most elaborate layouts, is designed around the ability of power packs to withstand shorting. Power packs don't need to handle large amounts of power (amps), as they are usually only powering one or two locos at a time. This frequently results in DC layouts using small gauge wires and miniature switches, which are inadequate for DCC.

The DCC booster cannot stand to operate into a short for more than a fraction of a second. Thus, they all have self-protecting circuits designed to detect a short and shut off the power until the short is removed. The trick is for the system to understand the difference between a high-current draw loco and a short circuit. Thus, DCC-bus wiring needs to be much more robust than most modelers are expecting. For more information about ***DCC Layout Wiring***, check out my December 2011 column.

The feeders that wire between the bus and the track, if kept short (2 feet maximum) are frequently the size that folks expect to use to wire an entire DC layout. Use table [4] to size the bus and feeder wires for your layout.

#### 4. AWG vs length of DCC run

AWG gauge	Maximum Length feet
12	50
14	31.45
16	19.77
18	12.44
20	7.82
22	4.92
24	3.09

#### The “quarter test”

This is a way of making sure that your DCC wiring is adequate for the booster to detect a short. The name comes from a great way to test a layout with track Sn3-gauge and narrower. Simply, it consists of putting a quarter (US currency - high conductivity coins from other countries can be used as well) across the rails and observing if the booster shuts down.

**5. Applying the quarter test to HO track. The light goes out showing that the booster or circuit breaker sensed the short and shut down when the quarter bridges the rails.**



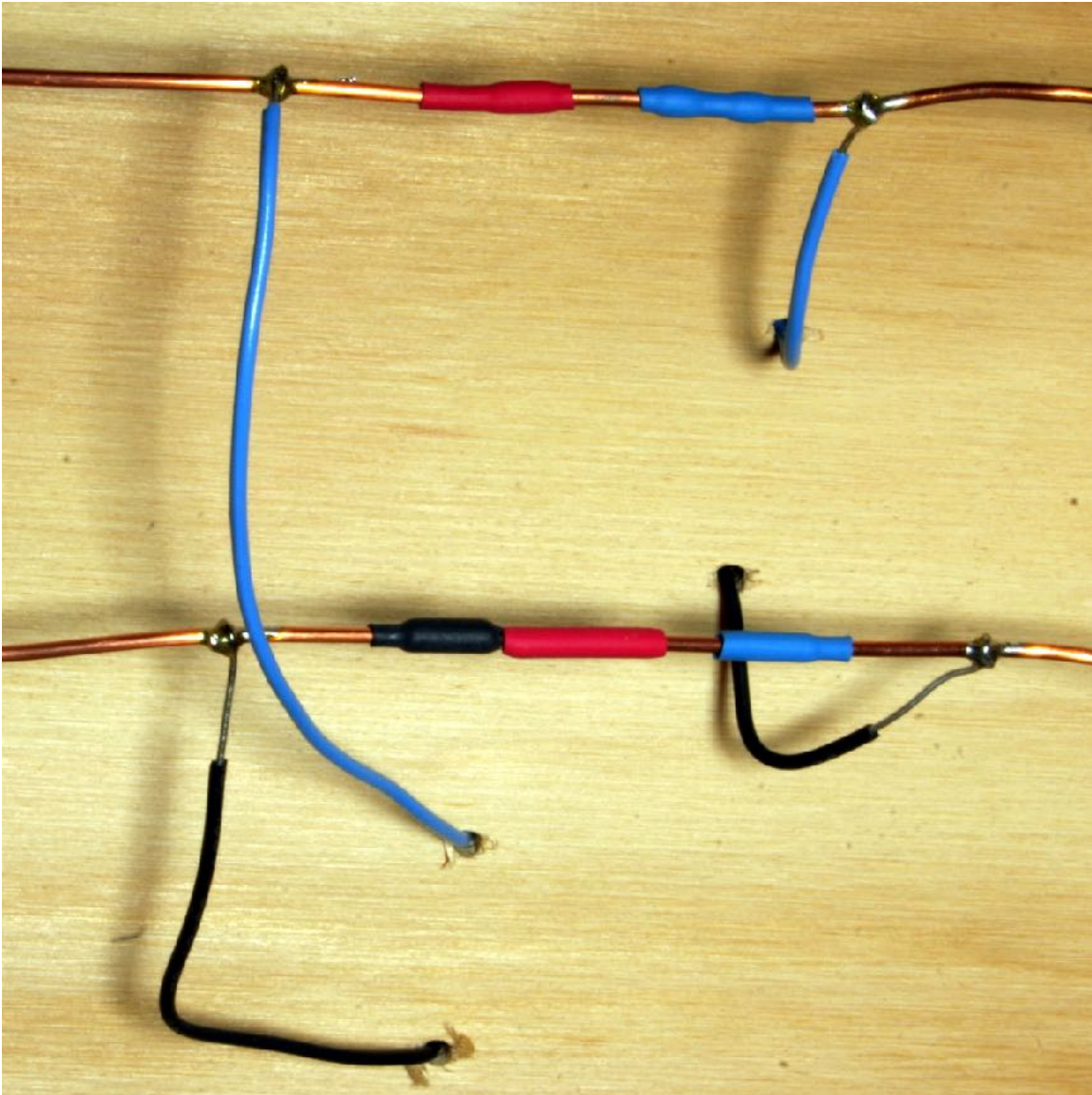
The “observing” becomes the critical issue. With a booster (such as most Digitrax) or circuit breaker that beeps on a short, observing is trivial - listen for the beep. For ones that don’t beep (Digitrax’ Zephyr or Lenz or MRC or NCE), I like to put a bulb across the track and see if it goes out when the quarter is applied. An automotive test bulb is a good choice [5].

Larger scale track can be tested, too. A larger coin, or similar object, is required. I use a bit of track as a short on my garden layout.

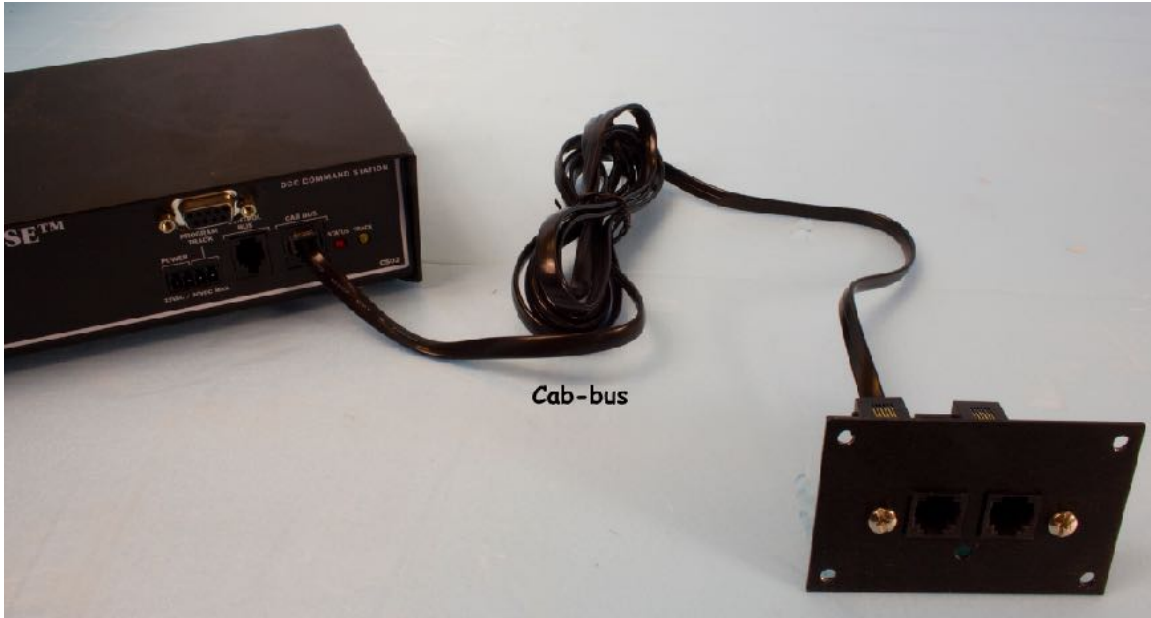
## Buses needed

There are three sets of communication buses that may be needed on a DCC layout. See figures [6], [7] and [8].

**6. The DCC-bus (or track-bus or booster-bus or district-bus). This is relatively large gauge wire (frequently 12 AWG or 2 mm) that runs around under the layout. Shown here is a 14 AWG district-bus connected to some 20 AWG feeders. The buses are color coded. This is the blue district off the red booster - the black denotes the common side of the track signal.**



**7. The cab-bus (NCE term) connects throttles to the command station. Digitrax uses its proprietary LocoNet to combine both cab-bus and control-bus functions. This photo shows the Universal Throttle Panel (UTP) connected to the Cab Bus connector on the NCE CS02 command station. The second connector on the rear of the UTP may be used to connect additional panels in a daisy-chain fashion.**



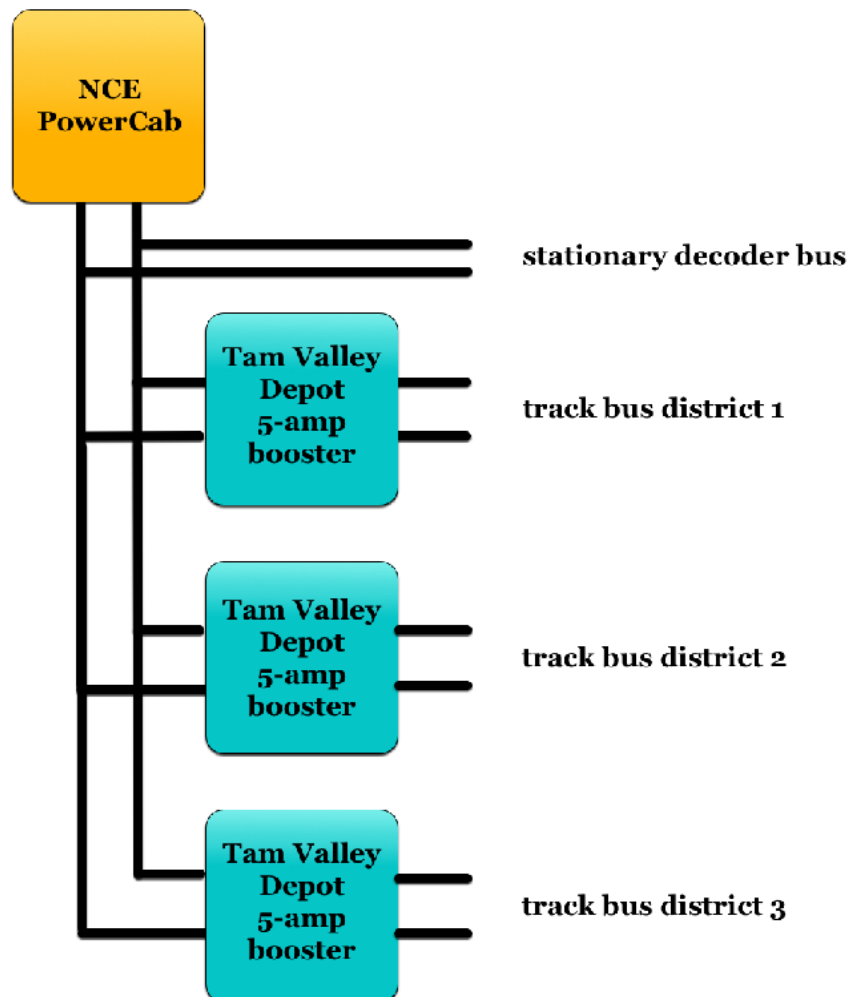
I choose to picture these two data buses, (7) and [8], with the NCE PowerHouse 10-amp system, as the various components are in separate boxes, so they may make more sense to newbies.

**8. The control-bus connects the command station to the booster(s) on the layout. Here is the control-bus between the command station box (right) and the booster box (left) in an NCE 10 amp system, designed for garden layouts.**



Many boosters need specific low levels of input data, called a control-bus [8]. Some are designed to be hooked directly to a track bus, thus they don't need a control-bus running around the layout. An example of the latter is the Tam Valley Depot booster. Figure [9] shows how I'm using this booster on my HO layout.

**9. Bus structure on my HO SMVRR layout. NCE PowerCab drives the input to three Tam Valley Depot 5-amp boosters, one for each district. Stationary decoders will be connected directly to the PowerCab. If the draw on the stationary decoder bus becomes too large, another TVD booster can be added there. Each TVD booster provides power for its district while also providing circuit protection.**



## Selecting a system

It was about 15 years ago when I started Litchfield Station as a DCC specialty shop. Since then, I have frequently been asked, “What is the best DCC system?”

My response has always been, “**DCC systems are like life partners. They all have good points and they all have limitations. You need to find what fits your needs without too many things that you don’t like.**” Items to consider are:

**Upgradability** - Can the system you select grow with your hobby interests? More power, more throttles, radio connection and computer control are areas to analyze. Also, will what you start with be usable in your version of the final layout or will you have to discard or sell some parts?

**Do you have local support?** - Are there other users or clubs near you that use the system you are considering and are they available to help you? What about a local (DCC savvy) dealer?

**Hand-held vs. bench-top** - While most basic DCC systems use hand-held throttles, some use a bench-top box with the speed and function controls on them. The Digitrax Zephyr Xtra [10] is an example of this sort of system. Frequently desk-top systems have limited usage as your pike grows. On the other hand, I had a customer use four Zephyrs to run his Sn3 layout, giving him four throttles and four boosters.

### 10. Digitrax Zephyr Xtra desk-top basic DCC system



**Ergonomics** - How well does the throttle fit your hand and how easy is it for you to use and to see? Try all varieties of throttle for the system you are considering. For example, if you are thinking of starting with the Digitrax Zephyr, try the UT4 and DT402 throttles, as they are the present upgrade route for the Zephyr system.

Get some "seat time" with throttles that you are considering. How easy is it to perform basic actions using throttles for the system you have under consideration, such as:

- Select engine or consist
- Start, accelerate, brake and stop the train
- End your session with the loco, "Dispatch" in Digitrax parlance
- Build and alter and clear consists
- Reverse direction of your consist - many folks think NCE excels here
- Program CVs in the loco (to set its personality)
- Access a function higher than 6 or 12 or 20

**Features** - Does the system you are considering read out the track current being drawn? Does it need a programming track booster to read back what has been programmed in sound decoders? Does it read back any decoders?

Don't buy a system too soon. DCC products are basically a computer system. Like computers they get better and less expensive with time. For example, in 2000, a good non-sound four-function decoder was about \$60. Today, in a smaller package, you can get a decoder with better motor control and more lighting and control features for about \$20. I frequently hear about folks who bought systems when they started planning their layout and have to do a major update or completely replace their system when they finish their layout. Wait until you need something to buy it. Technology marches on.

### **Find a DCC dealer**

I believe in supporting the dealer that supports you. The support they supply may range from eMails to phone calls to in-person discussions. Many brick-and-mortar hobby shops have few or no DCC savvy folks, even though they may sell DCC equipment.

Find one that works with you and helps you and buy from them. Avoid the temptation to buy from someone else because they are a few pennies less expensive. If you are lucky enough to have a local shop that can help, patronize them. You may pay some sales tax but you probably won't pay shipping costs and you'll have local support.

## How much power - volts and amps?

Different scales frequently mean different track voltages. Many systems make it easy to change track voltage settings in a range between 12 and 18 volts. Some ardent Z-scale folks want to go as low as 10 volts, while many garden railroaders push over 20 volts. Don't worry about tenths of a volt. Just get within one and you'll be fine.

Decide on a track voltage for your layout and make sure the system(s) you consider can support it. Digitrax' 5- and 8-amp systems have a track voltage setting of N (12), HO (15) and O/G (18) volts. These settings represent a good starting place for selecting your own track voltage. Many HO-scale layouts use the Digitrax N-scale setting, locos run a bit slower, which is usually good and bulbs tend to last longer. The N-scale setting is close enough to the fixed voltage from the NCE PowerCab of 13 volts to be compatible.

Unsure about track voltage? Ask your friends. Remember, if you set the performance of your loco at 15 volts and then run them at 12 volts, they will run slower and may not be as responsive as you planned for. If you are planning on moving locos from home to the club and back, it is a good idea to adopt the club track voltage settings for your home layout.

Lots of things go into figuring the current your layout will need. Avoid the temptation to buy the biggest, baddest booster you can find for your HO- or N-scale layout. Leave those brutes for the larger scales. See my March 2014 column, ***A Dozen DCC Myths***, for a discussion of this idea and a revealing video about possible damage to your loco wiring.

One of the surest signs that you need more power (amps) is that your system keeps shutting down.

### 11. RRampMeter by DCC Specialties



The best way to measure track voltage and current is with a piece of test equipment that is specifically designed for DCC. The RRampMeter [11] is sold by most DCC dealers and can show you track voltage and current directly. In a pinch, a multimeter set on the AC scale can show you relative voltages but cannot be relied upon for accurate and precise readings.

Five-amp systems [12] are the backbone of DCC for many reasons.

- A five-amp system can operate a reasonable number of trains moving at one time, perhaps even a dozen modern locos in HO- or N-scale.
- Limiting the length of track-bus runs helps keeps the wire size to a reasonable level. A five-amp system balances well with DCC-bus lengths of 12 AWG wire.
- The instantaneous short circuit current from a five-amp system is consistent with the wiring found inside HO- or N-scale locos.

**12. NCE PowerPro five-amp DCC system - the control-bus goes between one of the sockets on the left (booster) and the socket on the right (command station). The other left socket can be used to connect the control-bus to other boosters.**



If you need more than five amps for your entire pike, all you need to do is add another booster, or more. Planning on the power districts of your layout to accommodate this may help later.

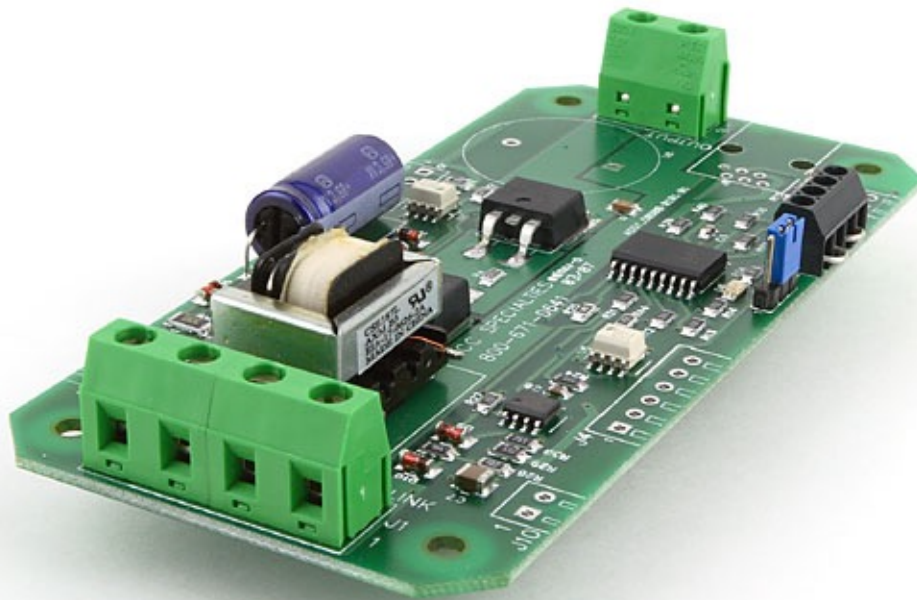
### **Power districts**

Just as DC systems have power blocks, DCC systems have power districts. In the DC case, they are necessary to stop locos and reverse direction. With DCC, districts are not needed for that reason. They, however, break the layout into manageable sections. Troubleshooting is easier when only part of the layout is down, instead of all of it. When one

operator shorts out, he only takes down part of the layout, not everybody.

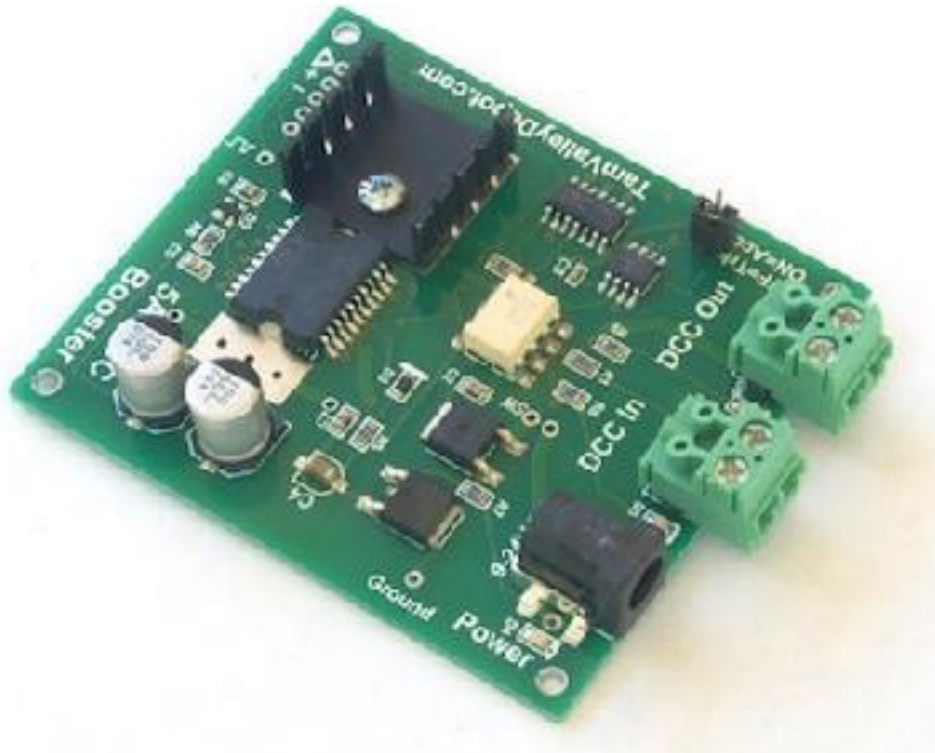
The most common way to separate districts is to use an electronic circuit breaker module, such as the PSx from DCC Specialties [13] to separate each district from the booster-bus. For more information on these various DCC buses, I refer you again to my December 2011 column, ***Layout Wiring***.

### 13. PSx circuit breaker from DCC Specialties



On my Santa Maria Valley layout, I'm planning on three districts, even though I don't expect more than two, or possibly, three locos to be active at any time. Rather than using circuit breakers, each district will be driven off the (very small and inexpensive) five-amp booster boards from Tam Valley Depot. Figure [9] shows how this will all connect. These boosters are only slightly more expensive than the PSx [13] circuit breakers. Using them eliminates a more expensive system box (command station and booster combined) and power supply. These three boosters are more economical for me.

14. Tam Valley Depot 5-amp boosters, as I'm using on my layout, see [1] and [9]



If you want to use stationary decoders - see my June 2015 column **DCC Stationary Decoders**. I recommend connecting them directly to a booster [9].

### The reversing situation

Whether it is a loop or a wye, a DCC reversing section needs to be designed from both a track-plan and DCC system viewpoint. I'll refer to them as loops.

Many loops are obvious, such as a tear-drop. Others are subtle, like a mainline crossover on a dog-bone style layout.

The key point is that the reversing section must be longer than the longest train you will run through it. Thus, it is good if you design the track plan and the DCC plan together.

For more detailed information, see my **DCC Reversing Loops** column from January 2015.

There was lots of fun stuff to cover this month and lots of references to outside data. Folks always seem to have additional ideas to share. Just

click on the Reader Feedback icon at the beginning or the end of the column. While you are there, I encourage you to rate the column. “Awesome” is always appreciated. Thanks.

Until next month, I wish you green boards in all your endeavors. There will be no Mr. DCC’s Workbench segment this month. Once again, this entire column would qualify.