



About our DCC columnist



Bruce Petrarca is a well-known expert on all things DCC.

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DCC Impulses: Anatomy of a DCC system

What makes up a DCC “set”

 **Reader Feedback**
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Understanding the terminology

When folks get started in DCC or are thinking about starting in DCC, I frequently hear them say, “Gee, there are so many terms and they don’t make sense.” Well, let’s do what we can to blow away some of the mist and remove the mystery.

This is not just a column for the newbies; I hope to enlighten folks who have been around the block a few times, too.

This is a “kid’s” issue of MRH. Look at the SMP sidebar for a way to keep your expensive locos safe from the grandkids and other guests.

What makes up a system?

I frequently use the analogy that you don’t have to know the theory of color TV transmission to watch your favorite show.

While this is true of DCC, there are a lot of the terms relating to the internals of a DCC system that become important along the way.

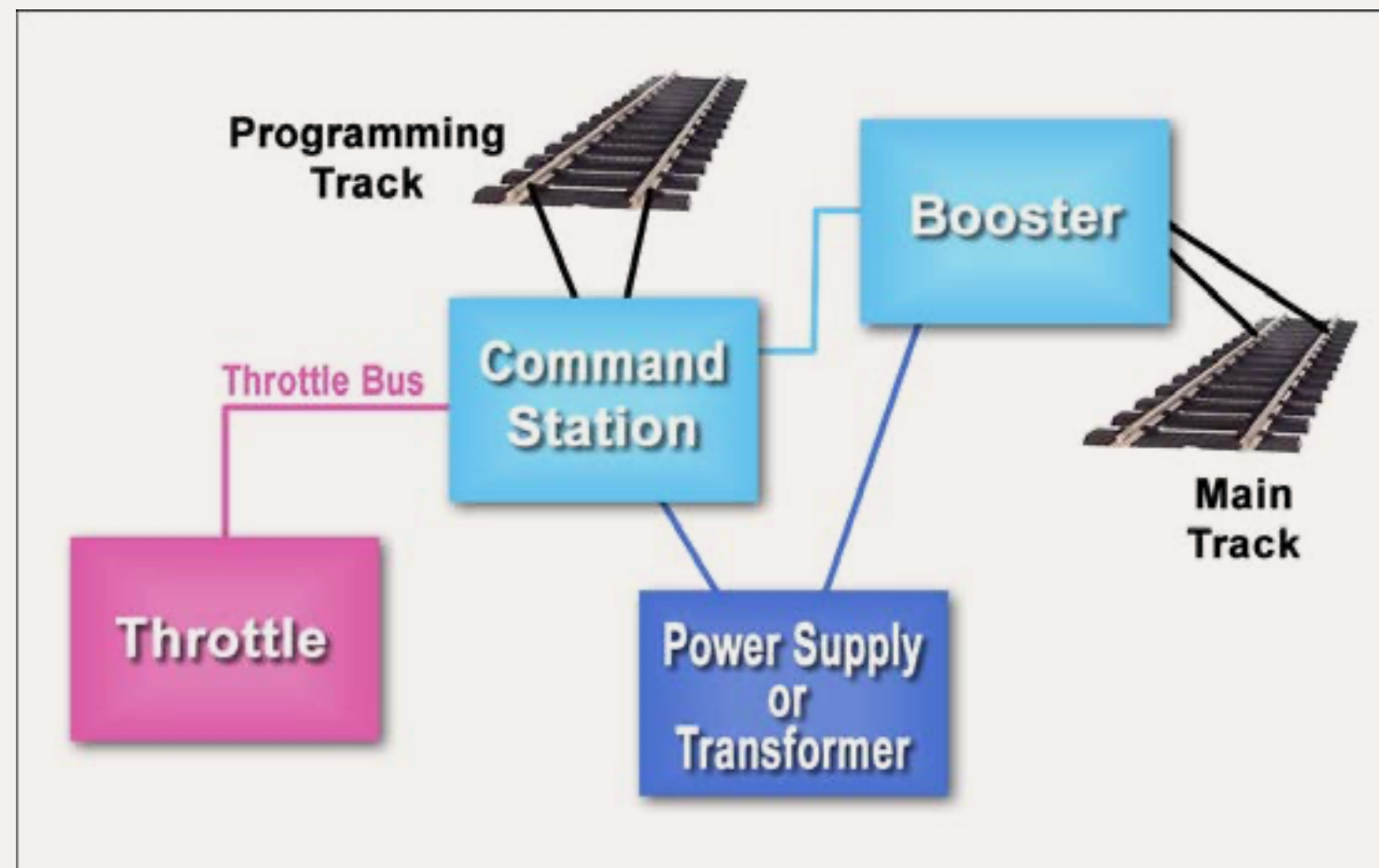


Figure 1: DCC system components

A DCC system takes your input (in the form of speed and direction requests, as well as activating functions) and turns that information into high-powered data. That data is put on the rails as “track voltage”, to command and run your trains.

Early DCC systems had the piece-parts in separate boxes, which led to folks talking about the piece-parts.

So, since folks discuss them, let’s define them.

Figure 1 shows the building blocks that make up a DCC system.

Throttle

The throttle (AKA cab) takes its cue from the operator – which loco you want to run and how fast – and talks to the command station in a language specific to the brand of DCC set that you have.

There is no standardization of the communication between the throttle and the rest of the system. This allows the designers to customize their throttle bus for their specialty. While this allows unique features for each system, it also makes it virtually



Figure 2: The Lenz LH-90 is an example of a DCC throttle.

impossible for one manufacturer's throttle to work on another's system.

Unlike computer keyboards, DCC throttles are not interchangeable between systems.

Command Station

The next item in the signal chain is the command station.

The command station takes the data from the throttle and converts it into low-level data pulses that meet the NMRA standards for DCC data timing. They don't (yet) meet the NMRA standards for voltage and current on the track. That transition is the booster's job.

Frequently things such as turnout routes and consists are stored in the



Figure 3: NCE CS-02 is an example of a DCC command station.

command station. Some command stations contain a battery to retain data while the system is powered down. This battery requires regular replacement to avoid losing data.

The command station is also responsible for controlling the programming track.

A stand-alone command station is frequently the heart of higher-powered (10 amp) DCC systems. The NCE CS-02 in figure 3 is one of the most common. When connected to the PB110A booster shown in figure 4, it makes up the powerful NCE 10-amp set for O-scale and larger layouts.



Figure 4: NCE PB110A is an example of a DCC booster.

“You don't have to know the theory of color TV transmission to watch your favorite show ... this is true of DCC.”

Booster

Perhaps the most misunderstood function in a DCC set is the booster.

Some of the confusion comes from the name and its similarity to the (illegal) CB amplifiers popular in the 1970s. Understand, a “booster” doesn't push your DCC signal any farther.

The term comes from the fact that the booster takes the low-level data pulses from the command station and “boosts” their power to meet the NMRA standards for current and voltage as track power.

Booster: data in → track power out.

If you have a functioning layout, there are a couple of things that adding a booster won't do for you:

- A new booster won't make your trains go faster.



Figure 5: Digitrax DCS-100 system box: booster and command station bundled together.

- A new booster won't make up for inadequate track bus wiring.

Splitting your layout into districts and adding boosters to the new districts on your functioning layout will allow you to draw more current over the layout. This means:

- More locos running at the same time
- Power for lights in buildings or in cars
- Redundancy that can be exploited to keep running in the case of the failure of another booster.
- Cooler operation of the existing booster(s), since it (they) won't be asked to deliver as much current.

I find that many layouts have more boosters than they really need. One

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extra is redundancy. Many extras are usually a waste of money.

Think of boosters as similar to amplifiers in audio systems, while we discuss this idea. Boosters take their input from one of two sources:

- Track data – like car stereo amplifiers that hook into the speaker outputs of your existing radio.
- DCC bus data – like a low level (line output) audio source for an external amplifier.



Figure 6: Bachmann E-Z Command starter set.

We will talk more about boosters and their relationship within your DCC system and layout later in this column.

System Box

In many designs, the booster and command station are bundled into the same box. This bundling is sometimes called a “system box”.

The Digitrax DCS-100 shown in figure 5 is representative of this design. This single box combines the command station and booster functions shown in the aqua blue color in figure 1.

Starter Sets

In some basic sets, the throttle is bundled in a box with the command station and the booster, to make a complete system in a single container.

Examples of this packaging include Bachmann's E-Z Command (figure 6), Digitrax' Zephyr, and NCE's PowerCab.

These systems frequently include a power supply. You have everything

you need to get started in one package. Hence the name, starter set.

Power supply or transformer

Okay, here is an area where terminology can get confusing. I'll be consistent, but not everybody is.

A few DCC systems come with a power supply or transformer designed specifically for them. Starter sets frequently are packaged this way. Most systems do not include a power supply for a variety of reasons, leaving the modeler with the need to pick one.

There are two different ways to get the necessary power:

- A transformer changes line (or mains) voltage (115 VAC in North America and 230 VAC in most of the rest of the world) to the AC voltage needed (frequently 15 VAC) for the DCC system. See figure 7.
- A power supply converts the line voltage to a DC value needed by the DCC system (frequently around 20 VDC). A representative power supply is shown in figure 8.

If your system manufacturer recommends a power supply or transformer, buy it, as long as it works with your power line (main) voltage. Who knows better what works than the folks who designed the system?

If you have selected a “go-to” DCC dealer, you might want to ask them for their recommendation.



Figure 7: NCE P515 is representative of transformer units.

If you want to set out on your own, then consult your owner's manual. There should be a section listing the power requirements. Note that AC and DC voltage ranges are frequently different. Be aware of the maximum current needed.

Make absolutely certain that you get a supply that provides voltage within the specified range at both zero current and the rated maximum current. It must also provide as much current as your system needs, or more.

If you are having a hard time understanding my terminology here, it may be best not choose your own power supply or transformer. Let the system designer or a trusted DCC dealer lead you.

The rule here is voltage must match the needs, current must at least match and may exceed the needs. Systems may be damaged by excessive voltage.

As an example, think of your desk lamp. Your home wiring has a fixed

voltage and the capability of delivering probably 15 to 20 amps of current. The desk lamp needs an amp or less. It only takes what it needs, even though the wiring is capable of delivering much more. However, if you connect a lamp to a voltage above its rating, its life will be very short.

The trend is toward regulated DC power supplies and away from transformers for DCC system operation. The advantages of power supplies are:

- They are perceived as being "greener" than transformers.
- They can accept the input power available anywhere in the world.
- They weigh less per watt than transformers, making them less expensive to ship.
- They provide the same output voltage over a wide range of input voltages, making for more stable DCC operation in brownout type conditions.



Figure 8: Crest 55465 is representative of power supplies.

- They can be smaller than transformers with the same power rating.

Even suppliers can goof

The MF615 transformer from DCC Specialties is similar to the NCE P515 shown in figure 7. It has been a staple of the industry for years, powering many 5-amp and 8-amp DCC layouts.

Figure 9: Notebook computer supply similar to the proposed MF615GU.



The MF615 has been phased-out for a new product, the MF615GU – a switching power supply that looks very much like the notebook computer supply shown in figure 9.

However, the MF615GU introduction has been marred by confusion about voltage.

The initial data sheets showed 15 VDC output at 6 amps, for a power rating of 90 watts. That is too low a voltage to provide the popular 14 to 16 volts on the track. Early shipments were verified to be putting out 15 VDC or even a bit less.

As this column is being written in late March 2012, the importer's web site says that the data sheets are being revised. A recall has been issued for the 20 or so units shipped so far and they are being replaced with transformers. New switching power

supplies are promised sometime this summer. They are planned to be 120 watts (20 VDC at six amps). DCC Specialties is doing the right thing, paying return postage and making things right. I extend kudos to them.

Personally, I believe that somewhere the AC voltage and DC voltage needs got confused. I tell the story here to show that even the professionals can get things mixed up at times.

As an aside, the original MF615 transformer put out 9 amps before it dropped below 15 VAC (135 watts). This would work fine with the Digitrax 8-amp sets set on HO- or N-scale settings.

Unfortunately, the replacement, with 20 VDC and 6 amps, will not have the reserve power necessary to work with the Digitrax DCS-200 or DB-200 units.

Bringing it all together

Okay, now you have some idea of what goes into the various functions inside your DCC system, whether it is in a single box or many.

In December (mrhmag.com/magazine/mrh-2011-12-dec/dcc-impulses), I talked about how to wire your layout.

That column didn't deal with the parts of the DCC system itself, but explained track bus and throttle bus wiring with

fascia panels, circuit breakers, etc.

Do I need another booster?

This is one of the most frequent questions I get. Earlier I discussed what boosters will and will not do for you.

If you still have a question on this topic, answer these questions:

- Am I planning a large expansion of operations? This is not the length of your track, but more locos or operators.

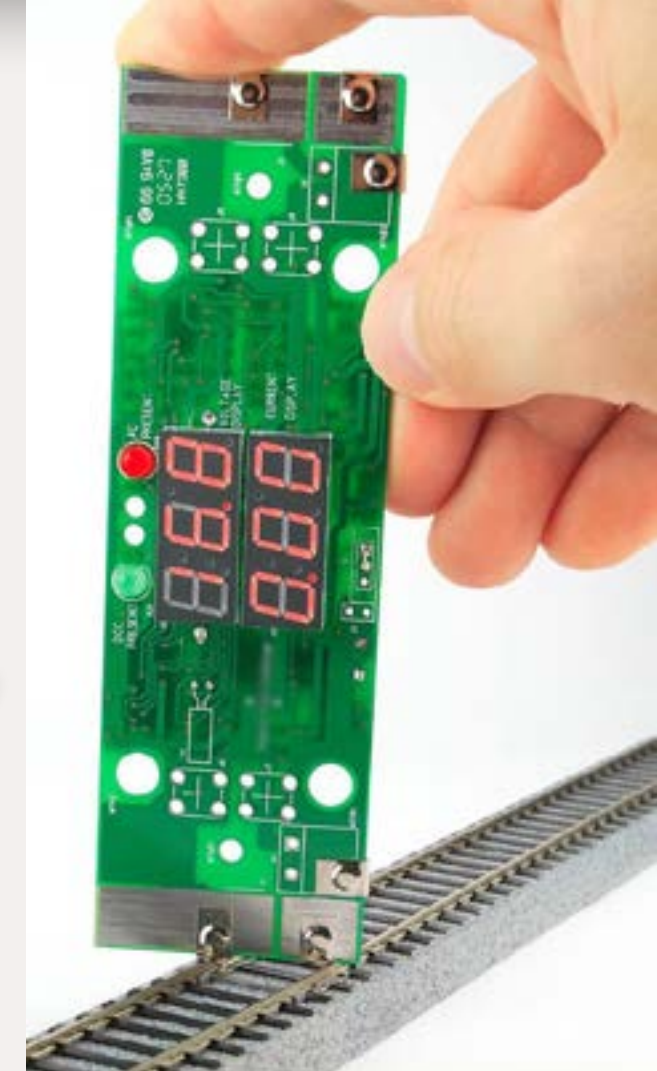


Figure 10: RRampmeter measuring track voltage – photo courtesy of American Hobby Distributors.

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■ Is my system shutting down or overheating?

If either answer is yes, then you may need an additional booster or two.

However, if you are getting involved in a layout large enough to have these questions, then you need to know more about what is happening on your layout.

Nothing tells better than a meter. Unfortunately the nature of the DCC signal makes normal meters read inaccurately. The only way to accurately measure DCC track voltage is with an oscilloscope or a measuring device designed for DCC.

The only DCC-specific measuring device that I know of comes from American Hobby Distributors. Known as the RRampmeter, it measures DCC voltage and current accurately. It will also measure AC or DC voltage and current. There are several different options available, as shown on their web site (amhobby.com/products/tech/ahd/rram-notes.html).

I suggest you get one and measure the amount of current being drawn from your booster(s). If you are consistently pushing 75% or more of your booster's rated current, then you probably do need more power on the layout.

As I discussed in December (mrhmag.com/magazine/mrh-2011-12-dec/dcc_impulses), you will need booster districts – separating your layout into manageable sections, and powering

each section from a booster and/or circuit breaker.

Another way

With his inexpensive boosters, Duncan McRee of Tam Valley Depot has introduced a new idea in DCC network design.

Duncan offers a five-amp booster and power supply for almost the price of a good circuit breaker – about \$60. His boosters run on the “car stereo amplifier” methodology discussed earlier – they take their input data from the DCC track bus, not from some proprietary manufacture-specific bus.

So you can start off with a simple system and expand by adding these small boosters instead of circuit breakers and using your old track bus to bring data to the inputs of the new boosters.

Duncan told me that his layout has a NCE PowerCab running his boosters.

This concept can significantly change the thought processes behind layout design and wiring.

Consider a friend of mine who has a Digitrax HO layout in a 10 x 20 room. He is looking at adding a small section in the hallway adjacent to his existing layout, with barge service from the main layout.

One option to expand this layout is to wire the new layout as a single district with 14 AWG wire. He can use one of Duncan's boosters to connect from the



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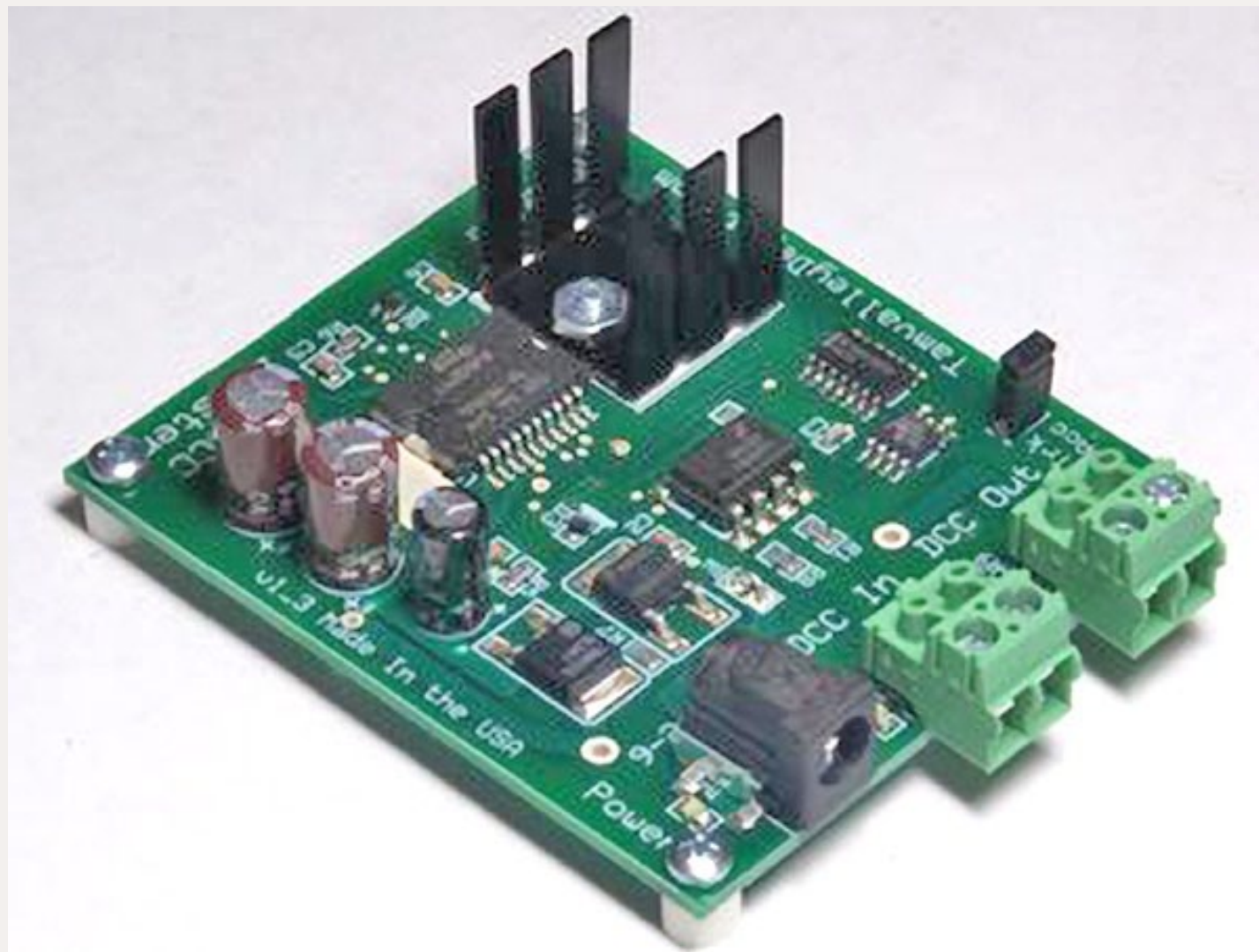


Figure 11: Tam Valley Depot five-amp booster – photo courtesy Tam Valley Depot.

new layout to the main DCC track bus in the existing layout. The new section becomes isolated and fully powered.

My glossary

I've been working on a glossary of DCC terms on my web site. The terms discussed here will be covered, as well as many others.

I'll be building upon it as I find time. Send your friends there, or look yourself, and see if understanding DCC terms helps your overall experience.

The glossary is at: mrdccu.com/curriculum/glossary.htm.

Until next month . . .

Have fun with your railroad and blow a whistle or blink a light for me.

If you like this column, be sure to click the button below and rate it *awesome*. Your votes made DCC Impulses the top rated article or column in the March issue.

Thanks.



SMP* from Mr. DCC

One of the common complaints about the Lenz LH-90 throttle is that it is so difficult to input a new loco to it. Most throttles accept a new loco address by turning a few knobs or punching a few buttons.

The LH-90 requires a combination of dial turns and button presses that I find too difficult to remember. I have a tough time with them, even with the instruction book in hand.

Many folks use the difficulty of setting an address in the LH-90 throttle to their advantage. They put all of their inexpensive (read: non-brass) locos in the LH-90's eight-unit roster, allowing a simple selection by pressing the button.

Here come the grandkids or other visitors. They get an LH-90 from the host. They can have a field day running trains, just not the prize units that the owner reserves to run on his LH-100, with its simple "punch in the address" set-up. ■



Figure 12: LH-90 throttle from Lenz

* SMP comes from the Amtrak world and is short for Standard Maintenance Procedure.