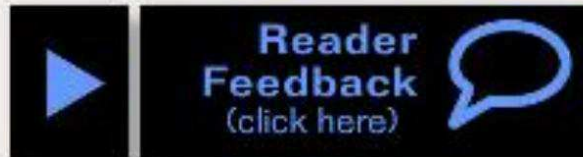




Where is my train?

Basics of block detection



DCC Impulses Column by Bruce Petrarca

What you need to locate your train on the layout.

One of the main benefits of DCC is that you have constant power on the track. This allows things like cars having constant brightness lights - perhaps we'll delve into techniques for this in a later column. The topic on the table just now is how to know if there is a train on specific section of track?

The constant power allows a simple device, known as a block detector, to see if any power is being consumed in a specific section of track. DCC decoders draw some power, even if the loco is not moving and no lights are on. So, locos are easy to detect, as are lighted cars. Unlighted cars, like freight cars, are more difficult, but possible.

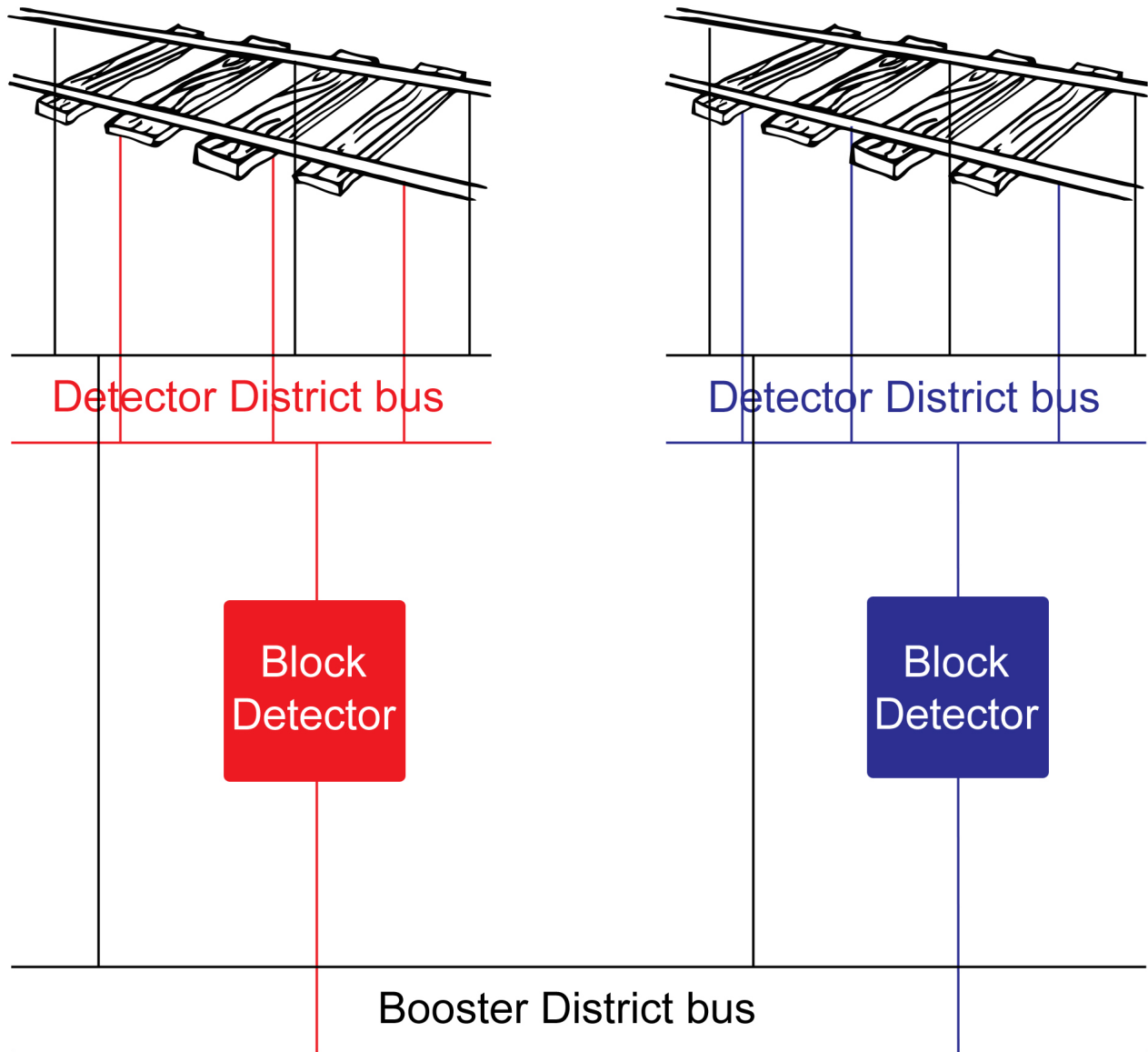
First, why do folks care about knowing that a track is occupied? There are many reasons, running the gamut from following the progress of a train through hidden staging to signaling the layout to full computer control of a layout.

Okay, you isolate the section (cut gaps or use insulated rail joiners) that you want to detect from the rest of the layout, add a block detector and you are done. Yes? Not quite. Let's try to take some of the mystery out of the process.

Districts

One of the first things that folks encounter when moving from DC to DCC is revising their terminology. No longer do folks talk about blocks. In the DCC world, there are

power districts: a section of track that is isolated from the rest of the layout and driven through some sort of power manager or electronic circuit breaker.



1: Wiring detector district buses to the booster district bus

Reasons for this isolation include:

- Troubleshooting (isolating where the short is on the layout)
- Power distribution (supplying enough power to the entire layout to support all the locos moving at one time on larger layouts)

- Job isolation (if Sam runs a turnout on his job and takes down part of the layout, Dave can still run)

Within a power district, there may be sections of track that you want to detect individually. For example, on our PebbleCreek club layout (<http://www.pcmrc.org>), we have 9 tracks in double-ended-hidden staging, all in one power district, see figure 8. Each of these nine tracks, as well as the incoming and outgoing leads are detected, so we can tell what is happening without having to look under the layout. Each of these 11 sections of track might be a block on a DC layout. To avoid confusion, I'll call them detection districts, not blocks.

Figure 1 shows a two detector district buses (red and blue) wired to a booster bus. One side of the rail is represented by black wiring and is connected between all buses. The red detector district bus has power coming to it from the other booster bus wire (indicated by a purple color (mixture of red and blue) through a block detector. Similarly, the purple detector district has power coming through its own block detector. All of the track feeders in a detector district come down to the bus for that district.

Understand that a booster district may include one or more detector districts. However, a detection district cannot be part of two power districts without some fancy electronics that are beyond the scope of this column.

Plan ahead

If you think you might ever be interested in signaling or computer control, you can make later conversion so much easier if you plan for it before you build (or rewire) your layout. What I recommend is:

Decide what sections of track you might want to make into detection district in the future, then:

- Cut the track gaps to isolate these sections
- Wire each section to its own (14 AWG) detection district – both rails
- Connect each detection district bus to the booster district bus

That way, you are ready to add block detection whenever the mood strikes you.

Also, if your goal is to signal your layout, you may want to decide upon a signal system before you choose your detectors. While any detector can, theoretically, work with any signal system, many are plug-and-play, if you have the right parts. The signal systems will be a topic for a future column.

Gap one rail or two?

Since detectors sense current flow in one rail only, there is no reason to gap both rails, as long as you are consistent in which rail you gap throughout the layout. However, gapping both rails is essential in reversing districts, as you must switch the power being applied to both rails.

That said, I recommend that you gap both rails, especially if you are building a new layout. Why? As I mentioned, you need to be consistent throughout the layout and it is easy to gap the wrong rail in a very inconvenient place. If they are both gapped in the construction phase, it is simply a wiring change to adjust which rail is isolated.

My preferred method of gapping is to use the thinnest (0.02 inch) cutoff wheel in my rotary tool and slice the rail in a straight section of track. Let me say that again, “in a STRAIGHT section of track . . .” Gluing a piece of 0.02 inch thick piece of (black) styrene in it makes the joint disappear. I use the fine grit emery boards (from the beauty supply store) to smooth out the top and sides of the rail head, especially the inside. Plastic sticking out from the web will be mostly covered by balast and not very obvious. The result is much better looking than the ugly insulating joiners to my eye.



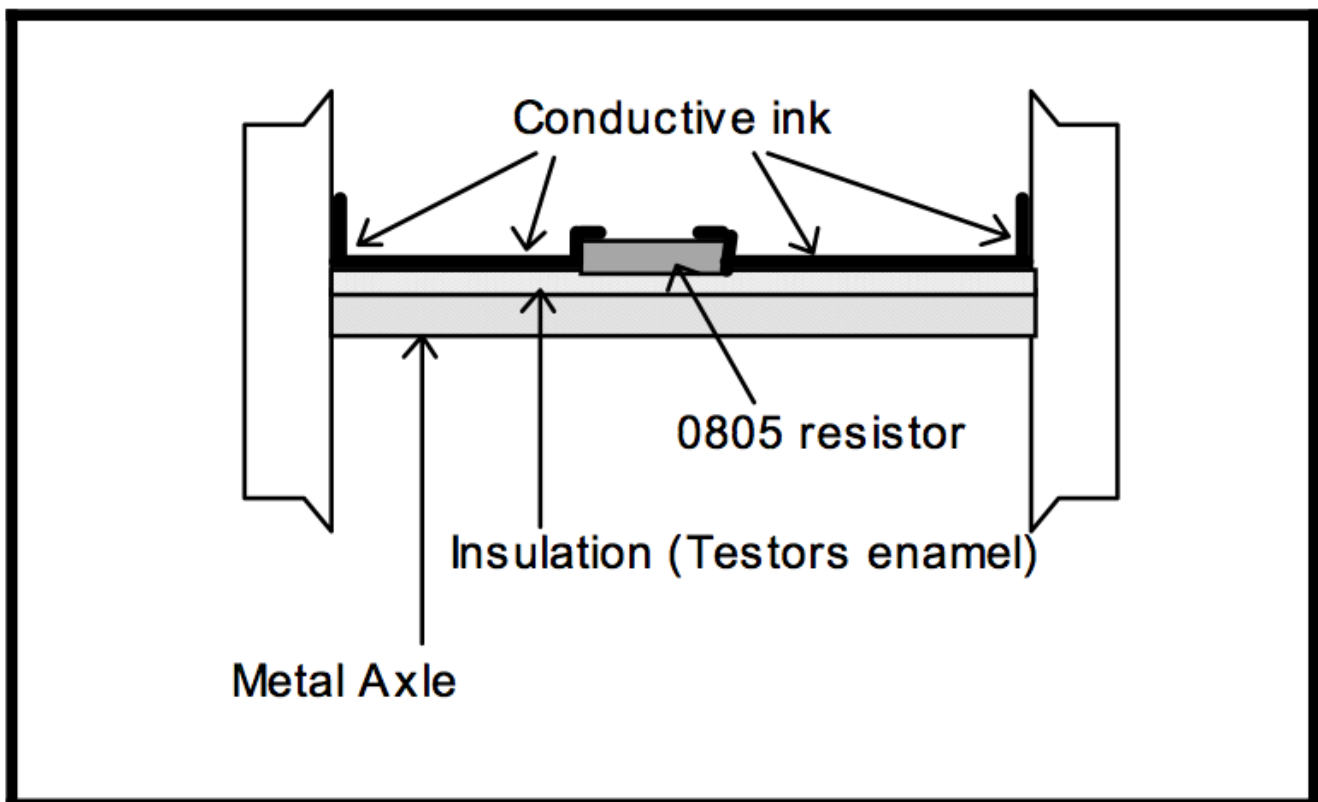
2: Resistor wheesets from Jay Bee – photo by the author

Detection

How do the block detectors know that a train is in the detection district? They sense current flow into the district. Okay, the locomotive with a DCC decoder will always draw current, but how do you draw current from the rest of the train? Resistor wheel sets.

“Huh?”, I hear you say. A high value resistor (typically 5 to 40 kohms; 5 kohms = 5,000 ohms) is connected between the two tires on a single axle. This allows any wheel on the train to draw some current, keeping the detector satisfied after the loco leaves the detection district.

These wheel sets are commercially available through companies like Jay Bee.



3: Drawing to build your own resistor wheel sets – from the BD-20 manual. Courtesy of NCE Corporation

Some hearty souls seek to make their own version with surface mount resistors and conductive paint. There are instructions on how to do this in NCE’s manual for their BD-20 block detector. You can download the manual from their web site (<http://www.ncedcc.com/images/stories/manuals/bd20a.pdf>). Personally, I would buy the commercial version and save my time for more interesting things to do on my layout.

Where to locate resistor wheel sets?

“Okay, these little wheel sets are pretty expensive. Do I need to put one on every car?”, I hear you cry. The answer is a definite “maybe”.

Some things are for certain. Since you want the end of the train to be known, then an unlighted caboose needs one – preferably on the last axle. A lighted caboose will be detected.

If you model a newer era, you have lighted FREDs on the end of your train, don't you? If they are track powered, they may make sure that the end of the train is detected. One popular FRED is made by Ring Engineering. It flashes on and off automatically. It draws about 4 mA when on. However, during the 1 second that it is off, it draws less than 1 mA, less than most detectors need to be activated. This can be overcome by adding a resistor wheel set to the truck on the other end of the trailing car.



4: Ring Engineering FRED – photo courtesy Ring Engineering

Now, how good is your planning? On our club layout, we set a train limit of 15 cars plus two locos and a caboose. Why? Not because we were being arbitrary, not at all. Our shortest passing siding was designed to accommodate a train that long.

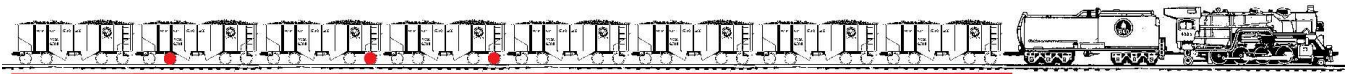
Following in that thinking, if your shortest detection district is longer than your longest train, you don't need resistor wheel sets on any other cars. The caboose will be in the detection district before the loco leaves. If this fits your layout, you can jump to “Types of detectors”, if not, continue to read this section.

If you want every car to be 100% detected, then the answer is “Yes, one axle per car.”

However, there is a price to be paid if you put one resistor wheel set on every car on your pike: both the dollars spent and the power drawn by all the resistor sets. Say you have

500 cars on your layout. Even if you can use the highest value resistor (40 kohms), you will draw almost $\frac{1}{4}$ amp just in the detection resistors.

Look for the shortest track length detection district on your layout. Think about the locomotive having just left that district. What's the car that will have just come into the detection district? How many cars are between there and the locomotive? Say the eighth car back will have come into the district. Okay, if you can assure that exactly every eighth car in your consist has a resistor wheel set, you will know that you will continue to detect the entire train. Do you want to be building your consists by both destination and whether they have resistor wheel sets? I don't think so.



5: An 8-car train with 3 cars having randomly assigned resistor wheel sets

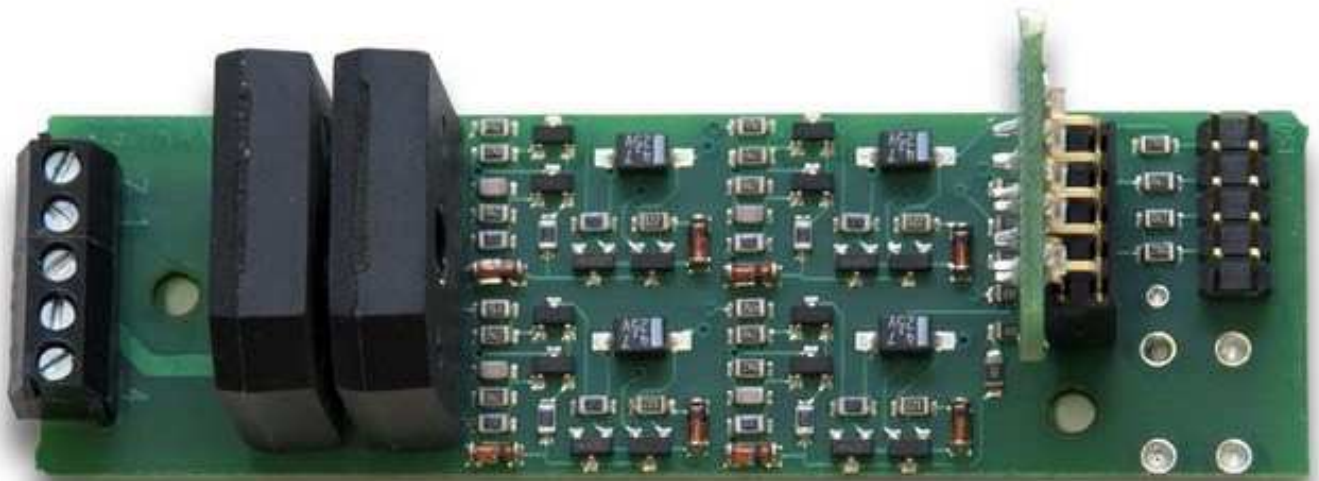
So, like so many things in model railroading, a compromise is needed. Given a random mix of cars that have resistors and those that don't, I'd feel pretty confident that one with a resistor wheel set is in the detection district, if we give a two or three times fudge factor. That translates into every third or fourth car for this example. Okay, this cuts the price down by a factor of 3 or 4 from putting one on every car. Also, it cuts the current draw down by the same amount.

Figure 5 shows an 8 car train with three randomly assigned wheel set locations (red wheels). The red line is used to designate the detection district. Now that the loco has left the district, there are three places that will keep the detector satisfied. By the time the last resistor wheel set is the only one in the block, the caboose (not shown) will be in the district. The entire train will be detected.

Types of detectors

There are two designs of detectors.

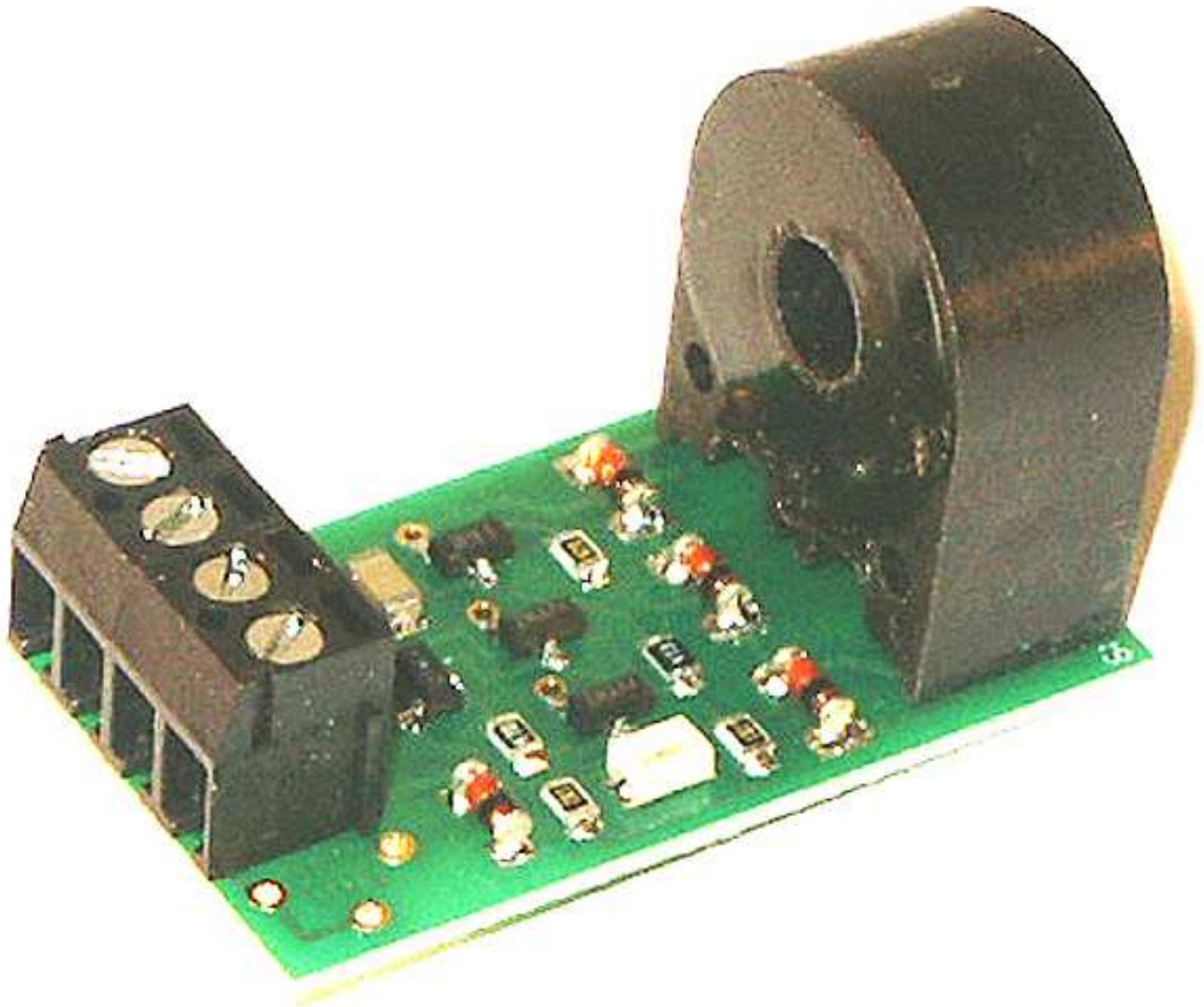
Digitrax implements the diode detector format. Their extensive detection and signaling offerings are on their web site (<http://www.digitrax.com/products/detection-signaling>). The signal between the input and the output is run through a set of diodes, dropping about $\frac{3}{4}$ of a volt when some DCC signal current flows. The detector senses this voltage drop as an indication of occupancy. The advantage is that, with some detectors, the remote diode modules can be located where the wiring to them is easy and the detector board can be located in a more convenient location. The disadvantage is that the diodes suck up some of your DCC voltage and power.



6: BD-4 detector board from Digitrax – photo courtesy Digitrax, Inc.

The BD-4 is Digitrax' simplest detector board, detecting up to 4 districts. The detection diodes are the two black components on the left of the board. This detector does not support remote sensor diodes.

The NCE BD-20 uses a torid (doughnut) of ferrite as a signal transformer to sense the current flow. Okay, what does that mean? There is a little ring on the board. You wrap one of the wires between the booster bus and the detection district bus through the ring a few times (see the manual for how many). The advantage of this design is that it doesn't drop any of the voltage going to your track. The disadvantage is that you need to locate the detector where you can conveniently wrap the wire through it.



7: BD-20 detector board from NCE – photo courtesy NCE Corporation

The BD-20 board from NCE will detect one district. You can see the toroid in the photo.

Other manufacturers use these two basic themes. Once you see the photo of each, you should be able to recognize which design is being used, based on a photo of the board.

What resistor value?

Ideally, you want the highest resistance possible for your resistive wheel sets, to keep the current draw to a minimum.

Digitrax says that it needs 10,000 ohms or less for positive detection. So, I'd recommend that value for all your wheel sets.

The sensitivity of the NCE BD-20 is adjustable, based on how many times you loop the wire through the toroid.

As shown in the BD-20 manual, a 10-amp set can only have two wraps, resulting in the need for less than 5 kohms to achieve the minimum 4 mA detection current. So, I suggest using 5 kohm resistor wheel sets and doubling the number of cars with resistors on them.

However, a 5-amp booster district can have 4 wraps, so 5 kohms would work out fine!

If you really want to be covered, put a 40 kohm resistor wheel set on every car and accept the ¼ amp current drain.



8: PCMR control panel – block detection tells the operator where to look for his train. See two yellow LEDs illuminated on the left side of the panel – track 2 and track 6. Photo by the author.

Okay, now what

You have the district detected, then what?

You can use the output to light LEDs and tell you on a panel that the track is occupied. This is what we have done with the hidden staging at the PebbleCreek club layout (<http://www.pcmrc.org>), as shown in figure 8.

You can connect through an interface module designed specifically for your DCC system (DS-64 for Digitrax or AIU for NCE) and report back through the command station to a computer for control or panel indications.

You can build a signaling system, as we will touch upon in a later column.

Which train is where?

Okay, we now know that there is a train in a specific detection district. But what train is it? The answer is important for computer control (where the computer runs the trains). This requires what is known as bi-directional communication.

The first folks to market bi-directional communication were Digitrax with their system, which they call Transponding (<http://www.digitrax.com/products/transponding>). Lenz has their system, called RailCom (<http://www.lenzusa.com/1newsite1/RailCom.html>), which was embraced by other manufacturers and became the basis of the NMRA standard for bi-directional communication. Lenz has donated their patents to the NMRA to allow multiple vendors to participate without royalty payments.

Both systems allow the decoder in the locomotive to respond back with the decoder address, allowing the computer or whatever is connected to know which train is where.

There are lots of other aspects of these two systems, in terms of capabilities, implementation, etc. An in-depth discussion of these variants is way beyond this column. Sufficeth it to say, the technology is out there, if you wish to delve that deeply into the realm.

In an extreme implementation, for example, the decoder can track fuel usage and report back fuel level, perhaps necessitating a fuel stop during the course of an operating session.

On a side note, bi-directional communication is the only way that you can read back a decoder while programming on the main, or as Digitrax calls it, Ops Mode.

Each system requires a compatible decoder to send the proper signals back.

SurroundTraxx

SoundTraxx utilized the Digitrax Transponding system in the initial design of their SurroundTraxx system (<http://www.soundtraxx.com/surround>). This system utilizes the

loco information from Transponding decoder to tell it what loco is where. Then the SurroundTraxx system makes the appropriate sounds from the speaker located near where the loco is running.



9: SurroundTraxx control box, an example of a use of block detection and Transponding – photo courtesy of SoundTraxx

So there you have a bit of a quick dip in the pool of block detection.

If you liked this column, 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.

Until next month, I wish you green boards.

From Mr. DCC's workbench

Model Railroading Rules to Live By

I got an eMail a while ago with these rules. I'd like to share them with you.

1. The object of this hobby is to have fun.
2. Buy some freight and passenger cars to go with your gross of engines.
3. Never ever tell a fellow modeler your scale is better than his.
4. At some point stop planning and start building the layout.
5. Never put perfection in front of running the trains.
6. Pay close attention to the track work; it can kill the fun.
7. Meet and bring your favorite engine and have your friends bring their favorites.
8. Have a plan, and an era, so you don't buy a lot of stuff you don't need.
9. Listen to the critics and weigh their suggestions, and then do what you think is best.
10. Never argue with a rivet counter, you will lose.
11. Good running engines and dependable rolling stock are required to really have fun.
12. You don't have to agree with your fellow modelers to be friends
13. Have a spare of all tools, for when you lose the first one.
14. Keep the lubrication supplies handy and use them sometimes.
15. Clean the track and wheels before the trains stop running.
16. Know your economic, time, and space resources and plan accordingly.
17. In this hobby, "do overs" are a fact of life.
18. If you are a perfectionist, lighten up and cut the other people some slack.
19. If you are not a perfectionist, lighten up and cut the other people some slack.
20. Never ever forget rule one.