



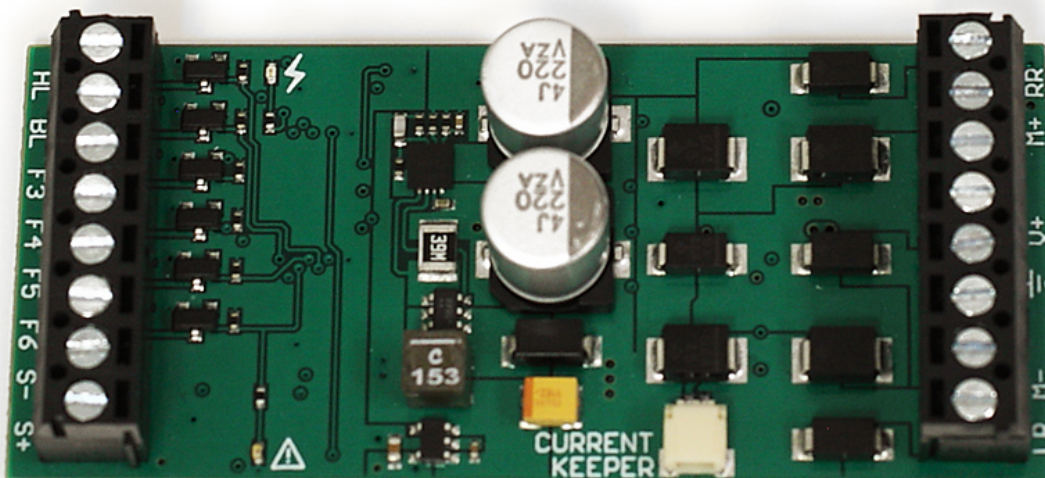
BRUCE PETRARCA MMR

Bruce Petrarca MMR answers a dozen DCC questions

My friend Geoff Bunza forwarded me a bunch of DCC questions that folks have asked him over time, thinking that I could use them to spread some light on DCC. Well, I thank him for that. Here I'll try to respond to what I perceive some of these questions to be asking.

I think they are frequently a result of misunderstandings of technology and terminology. There are some that I don't believe have answers as posed. I'll try to answer what I believe the questioner was asking. Let's see how clairvoyant I really am.

1. The SoundTraxx Econami ECO-400 mobile decoder is designed for larger locomotives, such as O gauge or garden. It is rated to drive a 4-amp motor. *SoundTraxx photo*



First a bit of background on decoders.

There are two basic variants of DCC decoders: mobile and stationary.

The majority of DCC discussions revolve around mobile decoders [1], as they are the most prevalent, being used in locomotives and in some cars.

Mobile decoders have their own address space in the world of DCC. In fact, they have three different address spaces, which I'll discuss later.

In most cases, mobile decoders operate a motor to drive the locomotive. They also usually have several "functions" which are designed to activate lights, smoke generators, uncouplers, etc.

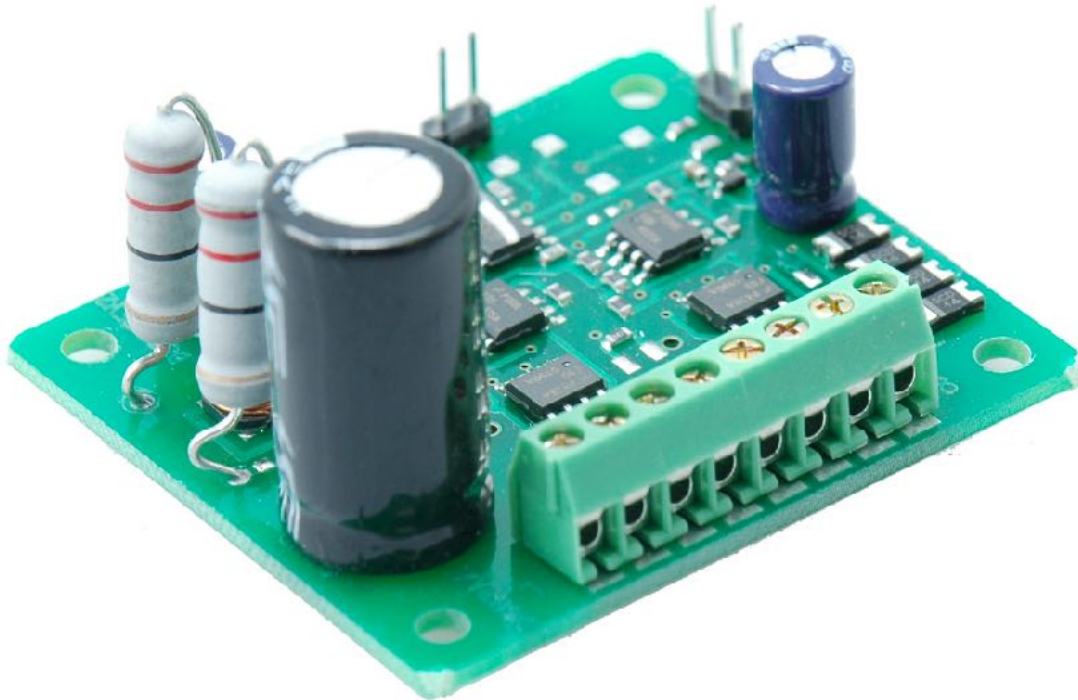
Sound decoders are a variant of mobile decoders that are designed to provide sounds in concert with the motion and lights provided by a basic mobile decoder. Yes, there are some sound-only decoders (no motor and few or no functions). But they are going the way of the dinosaurs.

Accessory decoders [2] are usually found as part of the electronics in the layout. Since they don't move, they are frequently called stationary. I gave them their own column, mrhmag.com/magazine/mrh-2015-06-jun/di_dcc-stationary-decoders.

Stationary decoders live in their own address space within the DCC world. Stationary decoder addresses may seem numerically identical to mobile decoder addresses, but they are indeed different.

Thus, you can have a locomotive on address 152 and a turnout addressed 152 on the same layout. More on this later, too.

2. Digitrax DS52 stationary decoder designed to throw snap and stall turnout motors, but not servo motors. There are other stationary decoders designed to actuate servos. Bruce Petrarca photo



With that introduction, let's get on with the questions Geoff sent me.

1. What are multi-function decoders vs. accessory decoders?

Hopefully a reader can answer this question by themselves at this point.

The questioner seems to be asking about the difference between mobile and stationary decoders.

Mobile decoders usually have multi (two to eight) functions. Stationary decoders, while they may activate one or several items, such as turnout motors, do not have what are called functions in DCC parlance.

2. What are the essential differences between using functions, setting speed vs setting switches open/closed?

Some cabs will control accessory (stationary) decoders, some won't.

Think of the prototype functions. The mobile decoders cover the things that the engineer can control: speed, direction, lights, horn (whistle) and bell. Stationary decoders control things that are prototypically handled by a brakeman or conductor, like turnout direction; or a dispatcher or CTC system, like signals.

A simple cab, like the Digitrax UT4 [3] covers the engineer's needs but won't access stationary decoder addresses, so it won't throw turnouts.

3. The Digitrax UT4D is an example of a simple (engineer's) cab. *Digitrax photo*



The Digitrax DT500 [4] is a full featured throttle that will, in addition to running two trains on two knobs at the same time, throw turnouts via accessory decoders.

Pressing SWCH tells the DT500 that the next things that you are going to tell it relates to a stationary decoder. Note that any time during this process, you can adjust the speed or direction of a locomotive with either knob without losing your place in the turnout process.

4. The Digitrax DT500 cab allows control of two trains (one on each knob) simultaneously. It will also control turnouts that are connected to stationary decoders with the t and c buttons in the bottom row. *Digitrax photo*



Next, press the number keys of the turnout you wish to control, say 152. At this point, the button with the lower-case t next to it (also labeled OPTN) will throw the turnout. Conversely the c (also labeled CLOC) button will close the turnout.

The DT500 will remain in the SWCH mode until commanded out by pressing either the EXIT or the FUNC key. Thus, you can spot a car at an industry with a minimum of button presses. Once you identify the desired turnout, pressing t will throw it. After you back the car in and run the loco out, pressing c will close the turnout.

While the DT500 is in the SWCH mode, the operator cannot control functions on the mobile decoder that is being addressed by the DT500. Pressing the FUNC key will return the DT500 to function mode. Functions can then be controlled normally.

3. Why are CVs used only for mobile decoders?

This is not totally correct.

All mobile decoders use CVs to set the personality of the decoder, by NMRA standard.

Stationary decoders are not as strongly mandated in the NMRA standards, so the designer has some latitude in how the decoder is designed to be set up. Most use some sort of CV to set the address(es) for the turnout(s) and other features of the decoder. These CVs are frequently adjusted by Programming-On-the-Main (POM). Rarely do they use a programming track.

4. Why are there short and long addresses?

The simple answer is that Bernd Lenz didn't expect DCC to expand to the level that it has when he filed the original patents. The NMRA codified the basic patents into standards when the patent rights were transferred to them. As DCC expanded, the NMRA standards expanded, too.

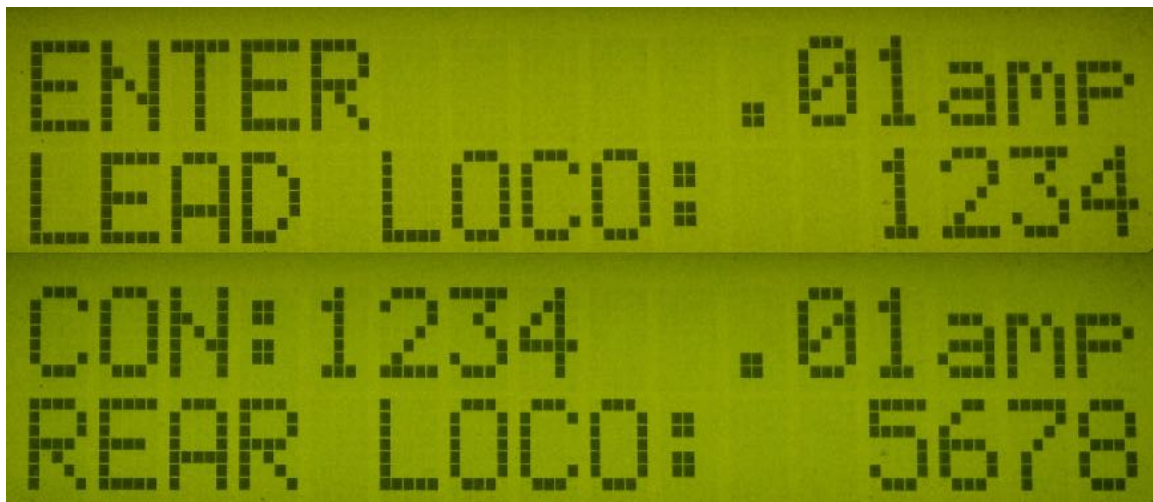
Originally decoders only had a handful of "registers" to store information. The address was limited to a range of 1 to 127. Later, the "register" that held this address was codified as CV1. Even today, this is the only address mandated by the NMRA standard.

As it became evident that more addresses were needed, the long address, using CV17 and CV18 was introduced. Allowed addresses for this mode are

from 0 to 10239. That said, I know of no DCC system that will address this entire range. Many won't address 0. There is frequently an upper limit of 9984 (Digitrax) or 9999 (NCE). This address is optional per the NMRA standard, but virtually all modern decoders include it.

There is a third address, called the consist address which is stored in CV19. This address can be in the range of 1 - 127. Adding 128 to the address, making it in the range of 129 to 255, will cause the locomotive to run in the opposite direction of normal. This address is optional per the NMRA standard, but virtually all modern decoders include it.

5. Setting up a consist with an NCE ProCab. The NCE system will choose the consist address that it will put into CV19. In the top screen, locomotive 1234 has been selected. In the bottom screen, locomotive 5678 has been selected to be added to the consist started with 1234. To make the consist work, locomotive 5678 will probably have to run in reverse. Thus, the value written into 5678's CV19 will be 128 larger than the value stored in 1234's CV19. Bruce Petrarca photos



This feature is used, for example, to create ABA consists where the first A and the B unit run normally, but the trailing A unit runs reversed. If this were consist number 1, CV19 would be 1 for the first two units and 129 for the third. Frequently this CV manipulation is done by the command station in a “set consists” type of operation and is transparent to the user [5].

The snafu with CV19 comes when a user sets up a consist and forgets that he has done so. Here is locomotive number 1234 and it won't run on 1234 (long) or 34 (short) address. Reading CV19, the user finds a non-zero value

for the consist address. That is the address that the locomotive will respond to. Setting CV19 to zero will return the locomotive to its planned address.

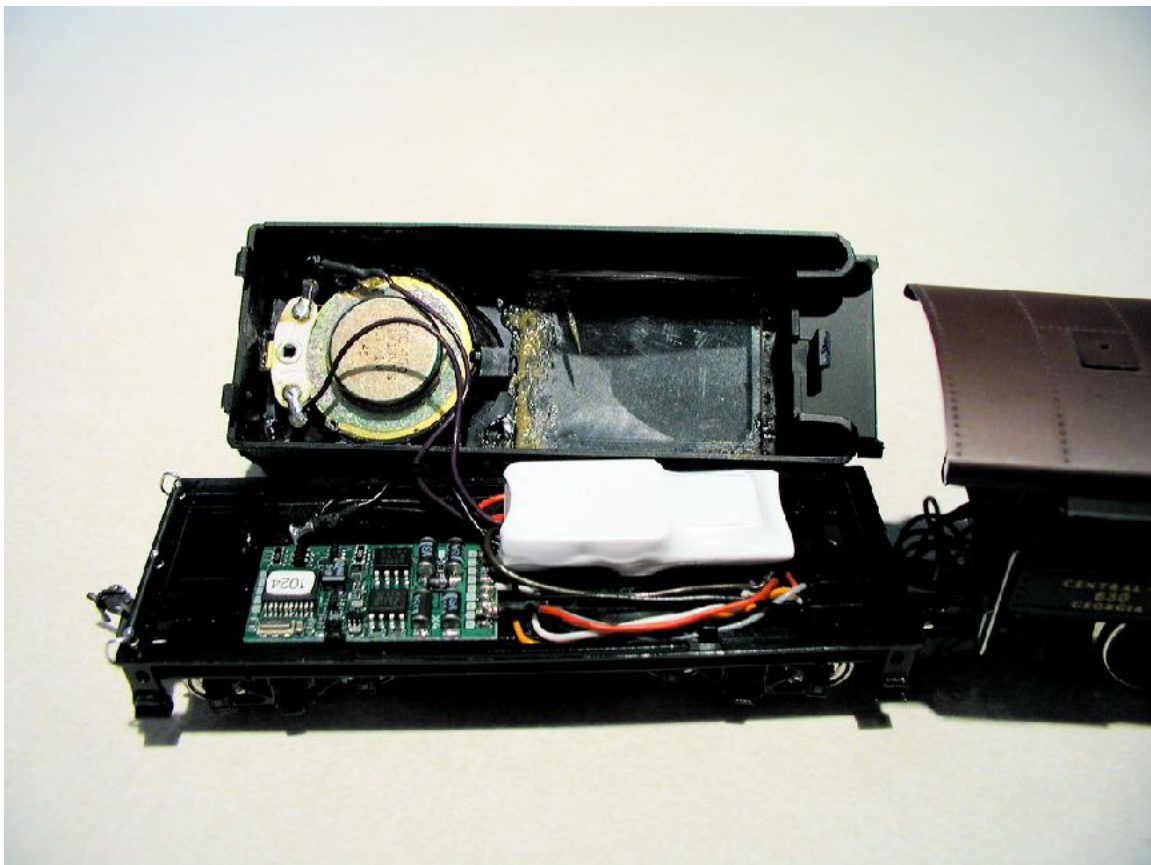
For more information on addresses, see my column: mrhmag.com/magazine/mrh-2014-02-feb/di_unraveling-dcc-addresses

5. What happens when two decoders have same address on a DCC track?

Since the question mentioned track, I'll talk about mobile decoders first.

They run together.

6. Two decoders in a steam locomotive tender, circa 2003. A Lenz for motor and lights and a SoundTraxx DSX (white) for sound. They run on the same address. *Bruce Petrarca photo*



In fact, that is one way to consist locomotives that is totally DCC system independent. On our club layout, we have through trains that have addresses in the 100 to 107 range. We create these consists by putting two locomotives

(or more) on an address (either consist or short) in that range. When we purge the cabs (Digitrax system) between operating sessions, we don't lose the consists.

This, too, was the traditional way to deal with two decoders in the same locomotive [6], for example a motor and lights decoder and a sound-only decoder.

Expanding this to stationary decoders, the same thing is true – they will operate together. If you can set two decoders to the same address, they can be used to coordinate a crossover, throwing or closing simultaneously.

6. What are the max addresses for different decoder types?

As I mentioned, locomotive decoders can have addresses as high as 10239, but addresses above 9999 are rarely accessible.

Stationary decoder addresses are limited by the manufacturers. Frequent maximum values are 512, 1024 or 2048. The user needs to check to see if his system and decoders have compatible maximum values or limit his usage to the lesser of the two maximums.

For example if the decoders have a maximum of 2048 and the system 1024, it makes no sense to set the stationary decoder addresses above 1024, as you won't be able to talk to them. I'm not even sure you could set them beyond the system capabilities.

Yes, it is okay to mix stationary decoder types. And, yes, they may have different maximum addresses. Just be aware of the limitations of your decoders. If you need 1024 addresses and your system will talk to them, it is okay to have some decoders with a maximum of 512 and others with a maximum of 1024. Just make sure you don't try to name one of the 512 group something above 512.

7. What is indexed CV addressing?

Again, the expansion of DCC comes into play. Many command stations cannot set CV values above CV256. Sound decoder manufacturers were the first to be hampered by this limit. The NMRA defined an "Indexed area" (CV257 to CV512). This uses CV31 and CV32 to create a command to set values in these higher CVs.

Confusing? Yes. Get DecoderPro, as I discussed in a recent column and let it do the work for you.

8. What is consisting and how is it used -- not the "How" but the "What"?

I'm embarrassed. I did a column on consisting and never answered this question.

A bit of history. Steam locos had one engineer and one fireman to each locomotive. To run together, the two engineers needed to synchronize their locomotives to the same speed and direction. Along came diesels and one of the sales points was that they could be run as Multiple Units (MUed), by connecting a cable from the unit with the engineer to a bunch of unmanned units. One engineer could run the entire front (or rear) end of a train. Later, radio MU capabilities allowed the single engineer to run the entire train, no matter how many units were somewhere in the train.

Consisting is a DCC term for the same idea: One engineer running multiple units, be they steam or diesel. Various manufacturers have used names like MU, double-header, etc. It's all the same concept. Except, sometimes different names have different capabilities. For example, Lenz breaks out double-heading (two units) and MU (more than two units) and treats them differently, just to be confusing.

If you want to have a real hoot, don't consist two steam locomotives and have them on the head end of a train. Give two operators each a cab for one of the locomotives and tell them to run from here to there together.

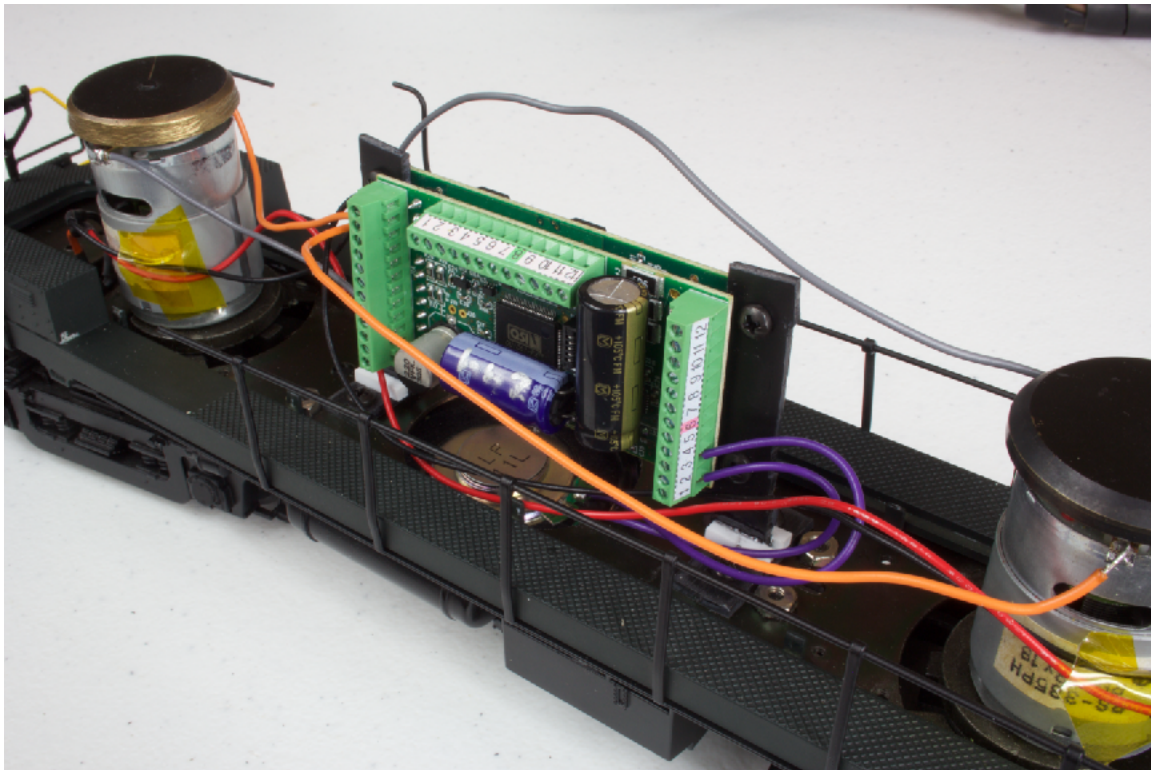
9. Can I power two motors with one decoder?

Yes, but ...

Make sure the two motors don't exceed the capabilities of the decoder (draw too much current), especially if they are wired in parallel (drawing twice as much current as one motor alone).

The motors must run together well: the same voltage has each motor turning at the same speed.

7. One decoder feeding two identical motors in parallel in a Weaver O-gauge RS3. *Bruce Petrarca photo*



If the two motors are in two different locomotives, they should to be ones that you will never want to run independently of each other. For example, drawbar-connected diesels make more sense than coupler connected units.

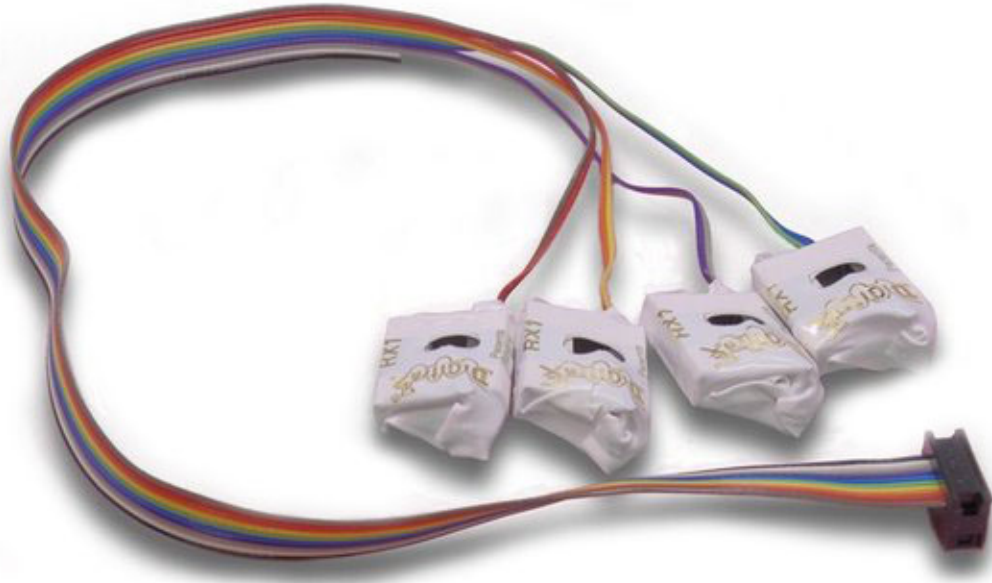
10. Are communications with base station and a DCC decoder 2-way?

Generally, no, for mobile decoders.

The command station (base) sends data along the DCC bus(es) and then into the track. There, the decoder picks up the data and responds to commands directed to it by name. Usually the response, such as a headlight coming on, is the feedback. There is no mechanism inherent in DCC for a mobile decoder to talk back to the command station.

Yes, but ...

8. The detector portion of the Digitrax Transponding system, the RX4 4-zone Transponding Receiver add-on for BDL series detectors. *Digitrax photo*



There are two bi-directional DCC communications protocols available to allow feedback from the decoder to the command station. Each has their place in the sun.

Installing either system is a big deal with lots of technical components and special wiring techniques. They are not for the beginner.

The original was the Digitrax Transponding [8]. Transponding is available from all recent Digitrax decoders to allow them to talk to Digitrax command stations. The SoundTraxx SurroundTraxx system understands Digitrax Transponding to locate its sound field where the locomotive is currently located.

Lenz created their RailCom system and licensed the patents to the NMRA, just as they did with the original DCC patents. There are several decoder manufacturers and a few system manufacturers who support RailCom.

That said, unless folks care a lot about being able to read their decoder CVs on the main, or are using some form of external control, or are doing some exotic operating, they tend to forget bi-directional communication. Very expensive in terms of equipment, time and effort to generate a rather small return. The cost benefit ratio doesn't trip the trigger of most model railroaders.

For stationary decoders, many are designed to report their status to the command station via a DCC network, like Digitrax LocoNet, or the NMRA LCC network. Generally this takes the higher end stationary decoders.

11. What is assumed in decoders at power up as far as function states, turnout states, and CVs?

CVs are stored in non-volatile memory in the decoder. That means that, absent external trauma, the decoder should remember the CV states forever.

This external trauma can be as simple as a short occurring on a marginally wired layout. The voltage spike when the short is removed can do damage that ranges from scrambling the decoder's memory to completely frying the decoder, with or without allowing the magic smoke to escape.

The command station should remember function states. However, most layouts don't query mobile decoders (see question number 10). That means that the command station will expect the functions to be set as they were when it was last operated with the locomotive that has that address.

But there are times that it seems to not remember function states. Here are a couple of scenarios to consider.

It could be that someone else had a locomotive on the layout with the same address as one you are just bringing. Even though their locomotive is gone, the command station may still remember what they were doing when they left.

Or, the command station may have been reset intentionally or inadvertently since you last ran your locomotive.

I'm sure that you can think of others.

Switch states depend on several things.

If the layout has feedback from stationary decoders and the command station queries the decoders on start up, then the system should correctly know the status of turnouts. However, there are many stationary decoders without feedback or not connected to a system with the appropriate communication. These decoders won't know the status of a turnout until you command it. Then they should keep accurate track for the rest of the session.

12. How do decoders power bulbs and LEDs?

The track power comes into the decoder and is converted to a DCC voltage about 1 volt less than the track voltage in a power supply, the blue box in [9]. This positive voltage comes out on the blue wire.

The function driver (lower orange box in [9]) connects a function lead, such as the yellow for the rear light, to the negative side of the power supply.

Thus, when the function is on, power can flow from the track through the power supply and the external device, bulb, or LED.

Since this voltage is polarized DC and LEDs are polarity sensitive, care must be taken to connect their anode (longest lead on discrete parts) to the blue wire.

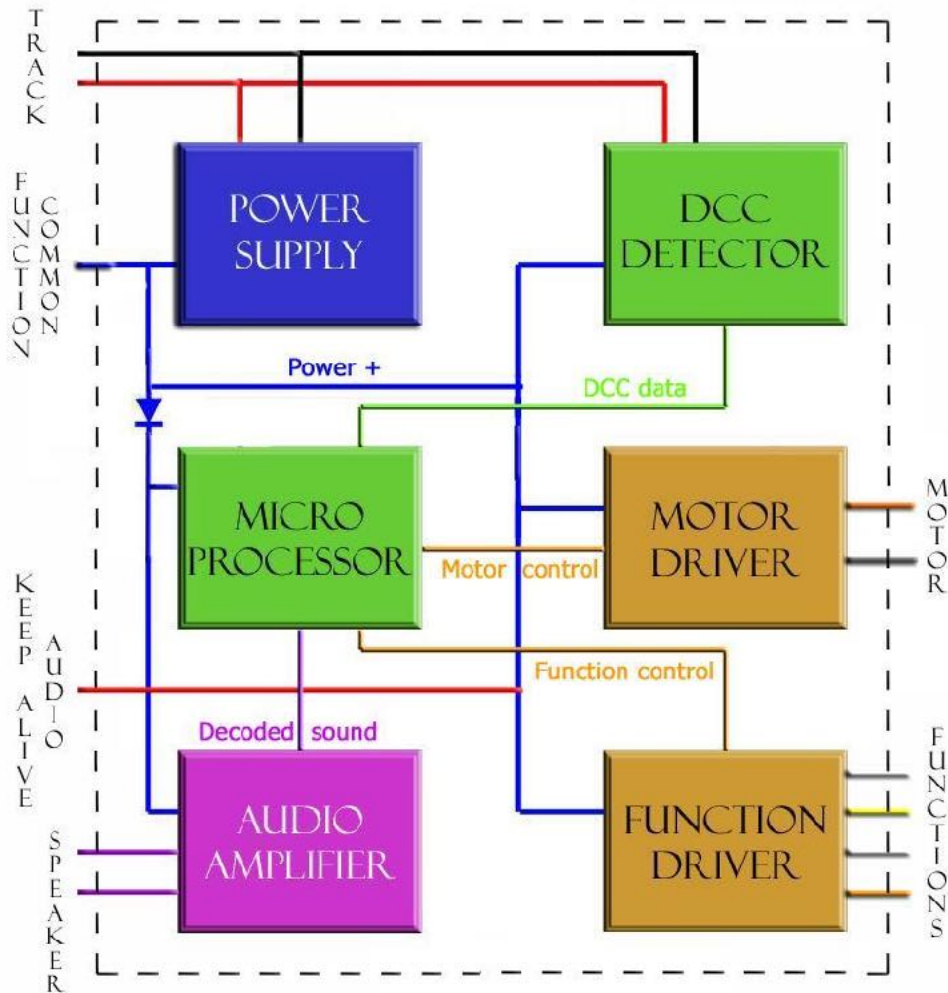
Also, the bulb or LED must be able to handle the full voltage (commonly about 12 to 14 volts) provided by the power supply. LEDs must have a series resistor to limit the current flow and control the voltage applied. One thousand ohms (1000 ohms or 1K ohm) is a good starting point for LEDs that don't come with a built-in resistor.

There you go, a dozen questions asked and answered, I hope. Probably conjures up more questions. Send them to me and I'll try to answer them in a future column.

Please share your ideas with us all. I'd love to hear what you think. 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.

9. Anatomy of a DCC decoder showing the power supply (blue) and function driver (lower orange). The power supply provides DC to drive functions and the driver turns them on and off. Bruce Petrarca diagram



Power supply negative is internally connected to all modules.