DCC Impulses Column
by Bruce Petrarca
photos by the author, unless otherwise specified

Keep minor track power disruptions from stopping your loco.

DCC users have long been aware of the need for good continuity between the loco and the rails. Having the control signal and the motive power supplied together makes the track connection doubly important.

As I discussed last month, Lenz came up with a way to enhance the reliability of the DCC signal being received through dirty track. To my knowledge, no other manufacturer has adopted the Lenz Uninterruptible Signal Processing technology.

Ok, so let's look at the other side: keeping the loco moving. What keeps the loco moving down the track without applied power is stored energy. The most direct method to store energy is a flywheel. Once the flywheel is moving, inertia keeps it moving. A loco with a flywheel will run over "bad" spots that will stall a loco without a flywheel. This is, by the way, the only energy storage option available for DC operation. You don't want a huge flywheel, even if you could fit one in the locomotive, as you would have a hard time stopping it when you want to.

What causes power dropouts?

The most frequently discussed cause is dirty track or wheels. But this is not the only reason for loss of power.

You can't build a turnout without isolating the track somewhere or you will have a rail-to-rail short. These breaks can range from a few thousandths of an inch up to several inches. No matter how big or small the breaks, they are a dead spot. Some turnouts provide a way to connect most of the frog to external power, which can be switched, depending upon the direction of the turnout. While powering the frog will restore much of the lost electrical contact, there will still be an insulated area at each end of the frog.

1: Insulated frog turnout – Atlas HO Code 83 #8
Frog is insulated between the two black bands.
Copper ring nearest the camera is provided to electrify the frog.

Variations in track height can pick wheels off the track and disrupt power, as can out-of-gauge wheels or track.

The problem is enhanced if your loco doesn't have all-wheel power pickup. Sometimes the wire to a truck breaks, leaving those wheels not connected to the decoder. Some locomotives are designed with only a few wheels picking up power: for example, brass steamers, where the loco usually picks up the right rail and the tender the left.

What about opposite rail pick up?

Personally, I recommend adding pickups to locos that are not designed for all wheel pickup. Nothing beats having all wheels bringing power to you. However, even then disruptions can happen.

Figure 2 shows what I did with an O-scale brass steamer to pick power off the drivers. The axles pick up off the right-rail and keep the frame at the right-rail voltage. I installed a printed circuit board that was insulated from the frame of the loco and added phosphor bronze pick up wires to rub on the tires of the drivers. The tires were in contact with the rail, but were insulated from the rest of the wheel.

2: Opposite rail track pickup added to an O-scale locomotive

As you can see, I didn't try to pick up off all 5 drivers, but just the middle 3. The tender originally picked up off the left rail only. Similar wipers were added there to pick up off the right rail, too. These additions were enough to keep the loco running smoothly without adding any energy storage.

Enhancing the pick up on your loco is always a good thing, in my mind. Once the loco itself is as good as it can be, then it is time to look at onboard energy storage.

Evolution of decoders and NMRA recommended practices

Before sound, decoders had pretty simple power supplies. There was a bridge rectifier to make the DCC waveform into DC and a small filter capacitor to smooth the DC out and, perhaps, a small capacitor to suppress the spikes coming from the DCC waveform. Energy storage was left to the flywheel, just like in the DC world.

Then along came sound decoders. Early versions had a bit more storage in the decoder to keep the sound processor running when the track voltage varied a bit, but nothing fancy.

Manufacturers began to realize that, when the processor ran out of power, the result was not realistic. While the flywheel kept the loco moving, a diesel, for example, might go through the start-up sequence while running down the track. UGH!

The manufactures responded by added slightly larger storage capacitors to their sound decoders. SoundTraxx, for example, even provided a way for modelers to add a capacitor to their venerable DSX series of sound-only decoders (www.mrdccu.com/curriculum/soundtraxx/dsx.htm).

Even the few hundred microfarads (μF) that were used early on exceeded the NMRA recommended practices for the programming track. A change to RP-9.2.3 in 2006 relieved some of the programming track issues and created a new market in Programming Track Boosters (www.mrdccu.com/curriculum/ptb.htm) to interface older command stations with decoders that meet the new RP.

Some boosters see the increased in-rush current drawn by the larger capacitors in the sound decoders as a short and shut down, sometimes refusing to restart until the loco is removed. The use of circuit breakers designed for sound locos, such as the PSx series, can frequently fix this.

But modelers continue to demand smoother operation. So, let’s look at how to get additional energy storage in your locos. Like other things in life, there is no single answer that fits all and changes have consequences.

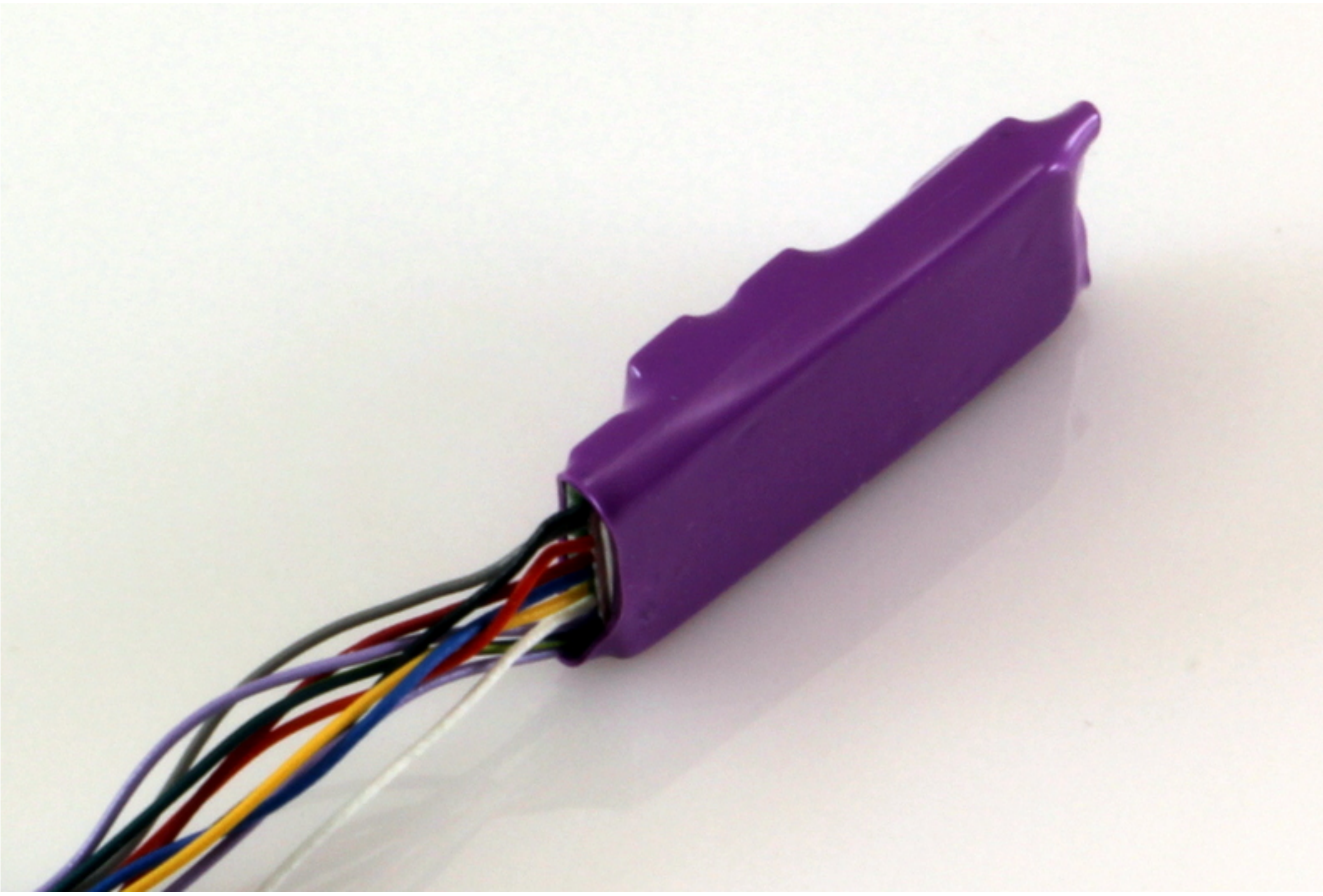
Do I need special decoders?

The basic answer is “no”. However there are some issues.

To add any form of electronic energy storage, you need access to both the decoder positive and negative leads. Positive is easy, as it will be the function common. This is the blue lead, assuming the decoder meets NMRA Recommended Practices in color selection.

Most non-sound (and even some sound) decoders don’t bring out the power supply negative lead, as I discussed last month (http://model-railroad-hobbyist.com/magazine/mrh-2013-02-feb/di_anatomy-of-a-decoder). If you are intent upon adding electronic energy storage to one of these decoders, you will need to bring out that negative lead yourself. Please understand that these modifications will void your warranty. Marcus Ammann has a wonderful page on his web site dedicated to finding the negative lead (http://www.members.optusnet.com.au/mainnorth/alive.htm). The negative lead is shown in green in figure 4.

I'll have some recommendations for connections to specific decoders later in this column.



3: Decoder with internal heat sink -
SoundTraxx Micro Tsunami TSU-750

A decoder with an internal heat sink will have a very flat side as shown in figure 3. Removing the heat shrink from these decoders will dislodge the heat sink. Once the heat sink is loose, it is beyond the scope of most modelers to get it back well enough to prevent damage to the decoder. I recommend against opening decoders like this. Fortunately, many decoders of this ilk already have the negative lead brought out.

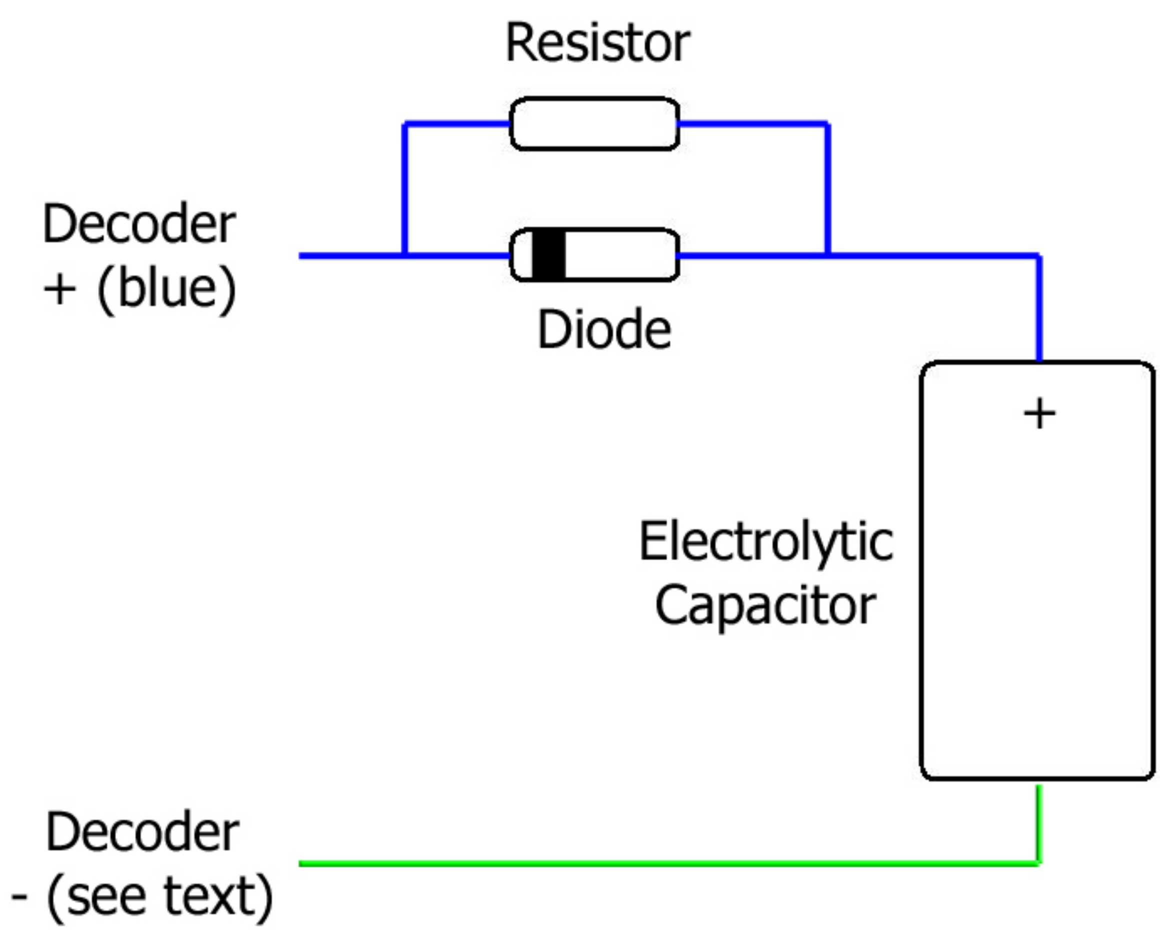
Kinds of energy storage

Since most modern models have just about maxed out on flywheel storage, there is probably little to gain here. However, if you model doesn't have a flywheel or two, I'd recommend adding one or two, if possible. Test the resulting loco before looking at electronic energy storage.

Capacitors

Frequently I hear: "Well, if 220 µF comes with my decoder, why not add another 10, 000 µF? I've got the room."

This approach is effective and inexpensive. I recommend the circuit in figure 4. It is slightly more complicated than just adding a big capacitor in parallel with the existing ones. It adds a resistor and diode to the mix. Why? The resistor limits the inrush current, reducing the load on the DCC system. The diode bypasses the resistor when the track voltage drops so the capacitor can supply power to the decoder.



4: Circuit to add more capacitance to any decoder
See text for component values and connections

Here's how to select the components for figure 4.

NMRA DCC standards allow track voltage as high as 27 for scales larger than N and 24 for N scale decoders. Thus, the capacitor should have a working voltage of 35 volts or higher to fully comply with the standards, especially for O and G scales. I find that most folks run their smaller scale track voltage in the teens and can get by with 25-volt capacitors. Size and cost both go up with working voltage. There is a compromise.

The "capacity" of the capacitor is measured in microfarads (µF). The more microfarads, the more energy stored. I usually find 2200 µF to 4700 µF the most useful range.

If you need, say 1000 µF, and a capacitor that size won't fit into your space, look at several smaller capacitors. In this case, two 470 µF capacitors wired in parallel will give you about 1000 µF and may have a more manageable form factor. Be sure to that you keep the polarity consistent (wire all the + leads together and all the – leads together). Insulate your connections.

The resistor should be ½ watt with the value determined by the size of capacitor.

Capacitor Value	Associated Resistor Value
Up to 2200 µF	100 ohms
Up to 4700 µF	220 ohms
Up to 10,000 µF	470 ohms

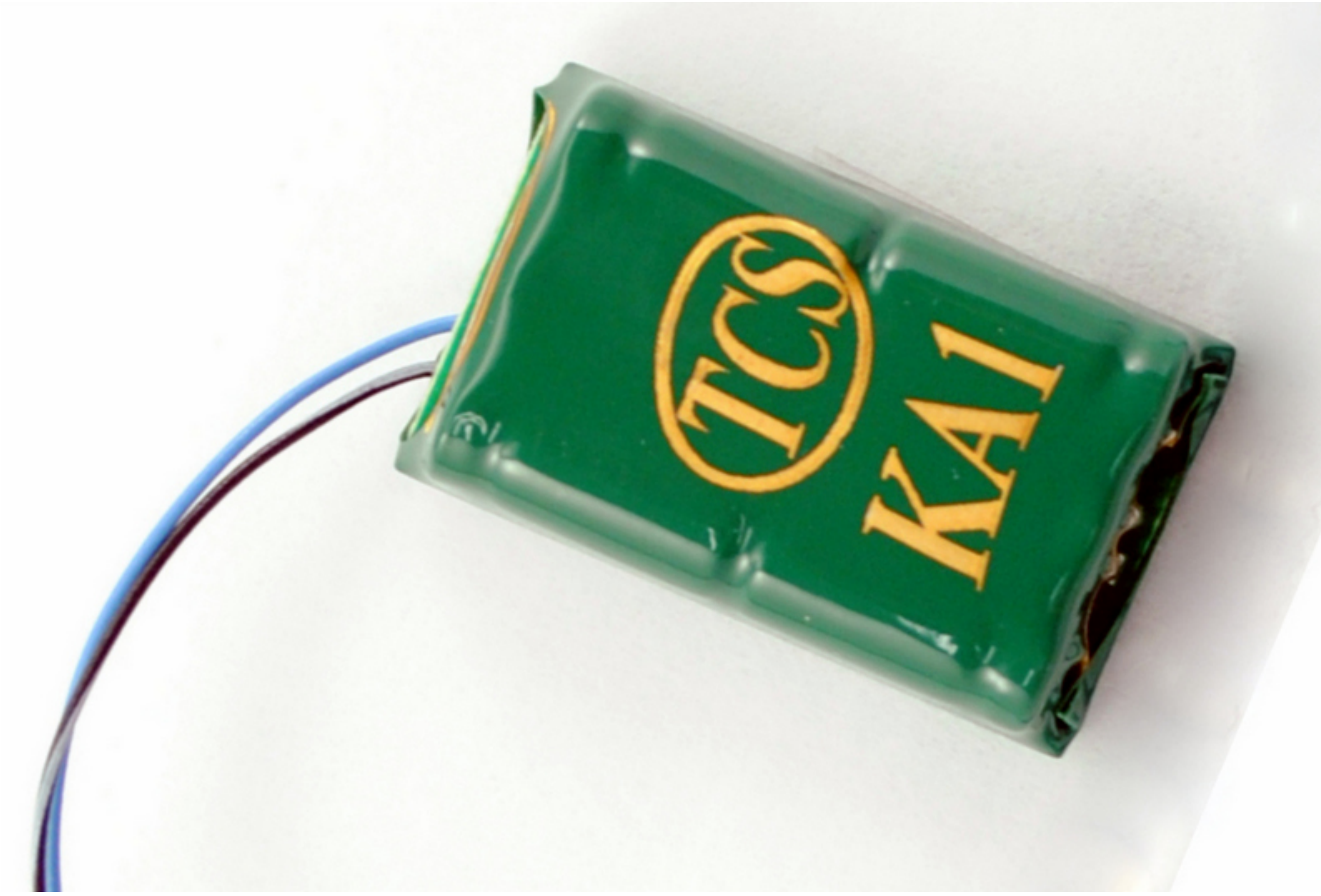
The diode should have a working current rating equal to or larger than the decoder's current rating. Its voltage rating should be 30 volts or higher. For common 1-amp decoders, the 1N4001 diode is just fine. Frequently I order 1N4001 diodes and actually get 1N4005 or some such. Don't worry. The 1N4001 is rated at 100 volts. As the last number gets larger, so does the voltage rating. Overkill here doesn't cost either in money or size.

If you need more than 10,000 µF, I recommend the Keep-Alive™ from TCS instead of larger electrolytic capacitors.

Keep-Alive™ from TCS

Train Control Systems recently introduced two Keep-Alive™ modules that store way more energy than the simple circuit from figure 4.

They claim that the KA1 (about $25) will keep an HO-scale locomotive at speed step 10 (out of 128) running for 2 to 5 seconds with the headlight lit. Under the same conditions, they suggest that the KA2 (about $40) will keep going for 6 to 15 seconds. That would indicate that the KA2 has three times the energy storage. My rough testing seems to bear these numbers out.



5: KA1 Keep-Alive™ Module, about the size of typical HO-scale decoders
Photo courtesy Train Control Systems

So, I decided to test them out on our most finicky locomotive at the PebbleCreek Model Railroad Club (www.pcmrc.org). This loco is a Proto 2000 RS-27 that originally had a QSI decoder. It was changed out for a Tsunami about 5 years ago. We had tried to use the RS-27 in our large Hammond, IN, yard, but it continuously stumbled on the Atlas code 83 #6 turnouts. The addition of a Tam Valley Depot Hex Frog Juicer to power the frogs helped, but didn't eliminate stalling.

For this test, I disconnected the power input to the Hex Frog Juicer board, giving totally dead frogs. The video in figure 6 starts with the loco stalled on a turnout and only responding after a couple of nudges. I took the loco home and removed the shell. I then disconnected the SoundTraxx external capacitor and connected a KA2 to the capacitor black (power supply negative) wire and the blue (power supply positive) decoder connections. I taped the KA2 down on the loco with double sided tape for a quick check. I let the loco rest on powered track for a few minutes to assure that the KA2 was charged up. The second segment of the video shows the loco running smoothly through the yard ladder. After resting a bit more to assure a full charge, I shot the third segment of the video where I removed the running loco from powered track and set it on plastic running beside the track. It ran about a full loco length on plastic – no power applied. When the charge in the KA2 was depleted, the loco stopped gracefully and the sound quit. Nothing dramatic.

6: Keep-Alive™ video: a TCS KA2 module on an HO locomotive with a SoundTraxx Tsunami decoder – running on the PCMRC layout

The TCS literature tells the installer to set CV182 = 2 on TCS decoders. I called TCS and talked with JD about that. TCS has a “stop on DC” mode enabled by default. That is, if a TCS decoder sees no DCC waveform, but has power to run, it assumes that it is on a DC section and will stop. Well, that’s exactly what it will see with track power dropout and a KA module connected. Setting CV182 will override that condition for TCS decoders. JD confirmed that KA modules have been used on almost every sort of decoder with no ill effects. CV changes were only needed on TCS’ own decoders.

Here have been reports of the KA2 units taking so long to charge up (several minutes) that they would prevent the decoder to which they were attached from being programmed on the programming track. Either program on the main (remember, no read back on the main) or disconnect one wire of the KA unit when programming.

What’s in one of these modules? The heart is a bunch of Super Caps, as I discussed in my December 2012 column (model-railroad-hobbyist.com/magazine/mrh-2012-12-dec/di_basic-electronics-for-dcc). They are low voltage, requiring about five to make up DCC track voltage. The module also has the necessary electronics to prevent over-voltage from damaging the capacitors. They will not stand being hooked up backwards, so be watchful with your wire colors.

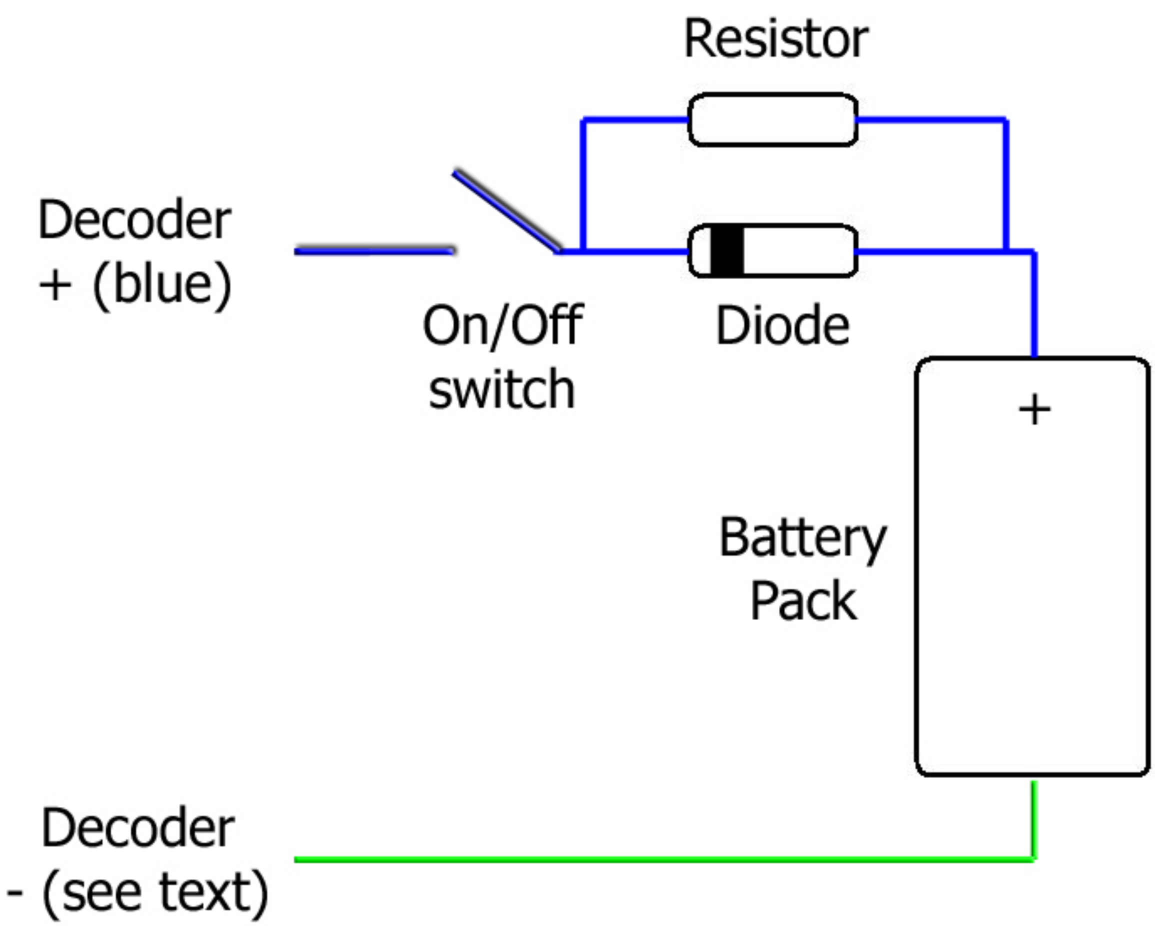
Multiple KA modules can be connected in parallel for even greater storage capacity.

The only caveat I've seen is most important to large-scale users. Although they will stand any input voltage allowable in the NMRA standard, their output voltage when supplying power to the decoder will be about 14 volts, maximum. So, if you are using a KA on a layout with the track voltage set for 18 volts, there may be a noticeable reduction in speed and light level when track power is interrupted.

I'll be trying the KA2 on my Fn3 locomotives on the brass-tracked Rocky Mountain Pacific (mrdccu.com/layouts/RMP.htm). I'll report back later.

Thanks to Jack of Litchfield Station for the Keep-Alive™ modules for this column.

Hybrid Drive



7: Hybrid Drive Circuit diagram
Connect it just as you would a capacitor

Stan Ames, one of the founders of the NMRA DCC committee, pioneered a hybrid of track power and batteries to keep the locos running on his Fn3 layout many years ago.

This technique is most useful in garden railroading where there is enough room for a pack of AA or so rechargeable batteries and the on/off switch.

You will notice that it looks very much like the capacitor circuit, except that there an on/off switch. Since batteries will hold more energy than even the Keep-Alive™ module, the switch is needed to prevent unneeded discharge of the batteries. It can be mounted in the bottom of the loco. Just throw the switch and run your loco on track DCC power. When you are done, switch the battery pack off. If you forget and leave it on, there will be a long charge-up time before you will have full energy storage the next time.

Stan also has a circuit, using a relay and a transistor to automate the turn off. This way, no external switch is needed.

Hybrid drive allows the loco to run on track with a lot more dropouts than even the KA modules. It also allows you to add more cells to the battery to match higher track voltages. Since this technique is aimed at a very limited audience, rather than spend more time here, I refer you to Stan's web site (www.tttrains.com/dcc/hybriddrive).

Can you overdo it?

Just like the overly large flywheel would store so much energy that controlling the loco could be problematic, you can have too much on-board electronic storage.

Capacitors will run a loco without applied power for a second or so. Keep-Alive™ modules will work for several seconds. Hybrid drive can run for minutes.

If your loco derails, you will have no DCC signal getting to the decoder. So hitting **emergency stop** or dialing the speed to zero won't make any changes in the loco's speed.

Consider how far you want the loco to run without power and select your energy storage accordingly.

If you, or your guests, frequently run locos on the ground, you may want to go the low end of energy storage, at least to start. That way, even though you may still have a stumble or two, you won't drag a complete train across the layout on the ground.

Where do I connect to my decoder?

Due to some variations in internal decoder design, you cannot get consistent results by connecting an energy storage system in parallel with an external capacitor. Here is where to hook them up on various decoders.

Many open-board decoders today are marked as to power supply positive and negative. Use these contacts, if available. Just connect the positive of the energy storage system to the plus terminal (labeled things like V+ or +14V) and the negative terminal to the minus terminal (labeled things like V- or GND or the ground symbol ⏚). I suggest testing with a voltmeter before you connect your module. Look for correct polarity and a voltage a couple of volts below your selected track voltage.

For SoundTraxx wrapped Tsunamis:

- TSU-1000 –connect the positive from the energy storage system to the blue wire, and connect the negative to the capacitor black wire, not the black track wire. If you connect the system where the external capacitor was connected, you will only store energy for the processor and amplifier.
- TSU-750 – Connect the energy storage system to the blue and yellow/green wires, just as the instructions show for the external capacitor.

For TCS decoders – observe the color-code – TCS is consistent throughout their product line. If the decoder has a black/white stripe lead, that is your power supply negative. If the decoder doesn't have a black/white stripe lead, there is no power supply negative brought out. I don't recommend digging into the decoder to find the negative. But that's your choice.

Digitrax sound decoders – just connect the energy storage in place of the external capacitor.

I know this list isn't comprehensive, but that should lead you in the direction you need to go. When in doubt, dig out the voltmeter and test.

Until next month, I hope that you have green boards. If you liked this article, please click on the Reader Feedback icon and rate it ***awesome***. While you are there, join in the discussion of this column. Thank you.

From Mr. DCC's workbench

The best DCC tester

I recommended this to a customer. After he used it, he eMailed me, "That's the best DCC tester I've ever seen."

So, I had to share it with my readers.

It doesn't come from a hobby store.

Look at your auto parts store or online for an "automotive 12 volt tester". The one my customer bought was about $3 from Harbor Freight (http://www.harborfreight.com/6-12-volt-circuit-tester-4288.html), as shown in the photo. I've even found them at "dollar" stores.

They are the cat's pajamas for sorting out dead frogs and track wiring errors. Clip to one track and probe the opposite track for power.

Checking out power district or auto-reverse section wiring? Just clip to one rail at the district boundary and probe the two rails on the other side of the boundary. It will light when you have opposite polarity between the two sections.

Want a quick check of a function output on a decoder. Clip this between the blue lead and the white (or whatever function you are testing) lead.