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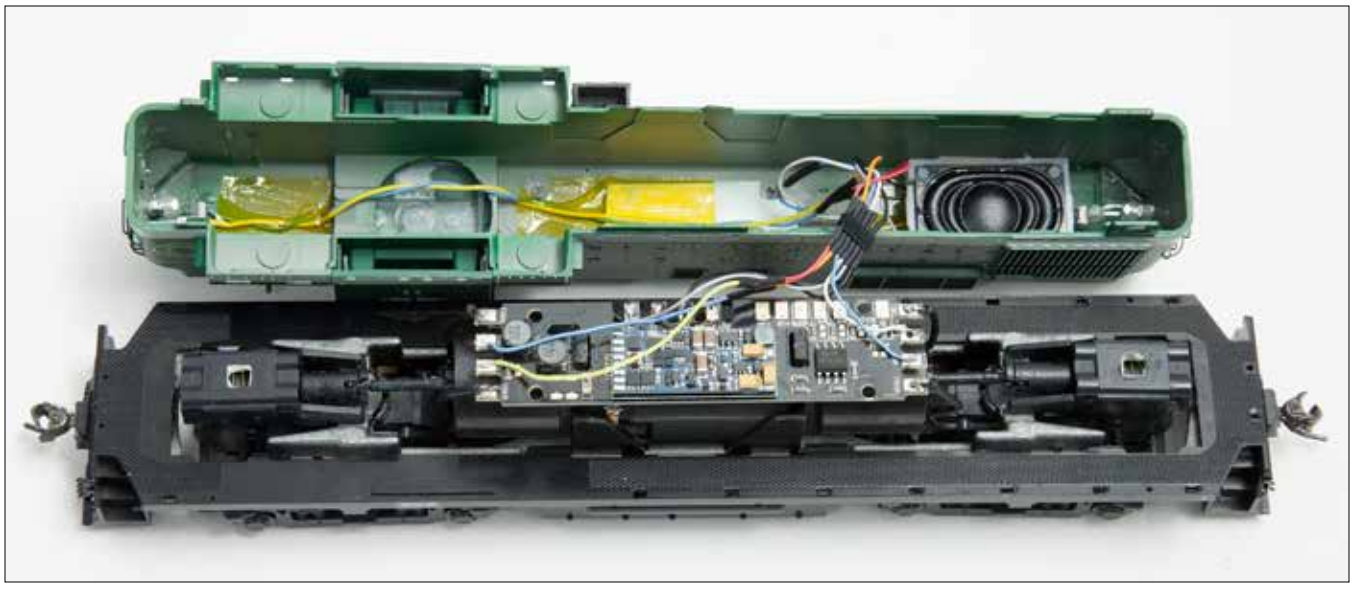


1. Decoder installations are still a key area of interest for modelers. This is an ESU LokSound decoder that Larry Puckett installed in an older HO scale Atlas Alco RS-11. You can see details of the installation on page 66.

Model railroading and Digital Command Control (DCC) are constantly evolving as the pace of technological advancement speeds up and subsequently trickles down to our hobby. In volume 4 of *DCC Projects and Applications* we'll be looking at how some of these advancements have added to the enjoyment of model railroading since Volume 3 was released in 2015.

Most of the articles in Volume 4 were originally published in my DCC Corner column in *Model Railroader,* which I took over in 2015. Some other authors have contributed to this volume; we have noted those items with bylines along with their titles.

To begin, I'll bring you up to date on many of the new advances and products from DCC manufacturers over the last four years—and there are a lot of them. As always there have been major enhancements in decoders, especially where sound is concerned. Manufacturers have also taken advantage of technological advancements to provide new features to command stations, and some new systems have entered the fray. We also have seen the industry borrow from other technologies to introduce new options in WiFi-based wireless throttles, speakers, and devices to help us get over dirty track and dead frogs.

In section 1 we'll review some of the basics of DCC and the advantages it offers us over standard DC power-based control methods. After that we'll go over some of the things to consider when selecting a DCC system.

Wiring a layout for DCC operations is very important, since there are concepts to be aware of that are DCC specific. Section 2 will provide detailed information on selecting the correct size wire, installing power buses, planning power districts, dealing with short circuits, and trouble-shooting in general. A special area of interest to many will be the material on differences between power-routing and all-live turnouts and guidelines for using them with DCC.

Although many model locomotives being manufactured today are offered with factory-installed DCC decoders, many model railroaders still prefer to install their own, especially sound decoders, **1**. This has become increasingly important as model manufacturers use decoders from a variety of different companies. In the long run many modelers have found it less confusing if all their locomotives have the same brand decoders. In section 3 we will show how to install a variety of decoders in steam and diesel locomotives. We'll also explore the very important topic of choosing a sound decoder and the right speaker and the correct way to install it.

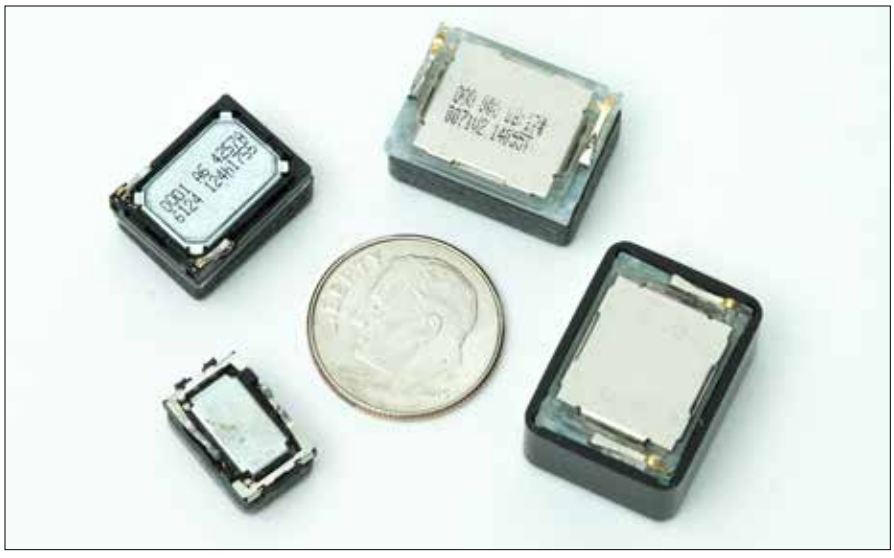
Programming decoders is a subject that scares many model railroaders but can be very simple, and in section 4 we'll provide some guidance and lessen the potential anxiety. While many never find it necessary to change much more than the decoder address and sound volume, some will want to do more to enhance the enjoyment of their sound-equipped locomotives.

To help with that we'll discuss making up consists of multiple locomotives, changing which buttons control the various functions, and which ones play automatically. We'll also provide some information on using the free computer program DecoderPro to tackle the more complex aspects of sound decoder programming.

Finally in chapter 5 we'll talk a little about using accessory decoders to enhance operations.

What's new in DCC

I want to give my innovation award to the unknown person who decided to see how cell phone and tablet computer speakers would sound in a model locomotive. These tiny devices, which can be as small as your pinky fingernail, **2**, have made it possible to install sound decoders in models I previously never would have attempted. And the



2. So-called "sugar cube" speakers, designed for use in cell phones and tablets, are compact, provide good sound quality, and are easy to fit into many locomotive shells.

amazing thing is they provide excellent sound. My first experience with these came in 2015 when I installed one in an HO Atlas RS-1 (page 55). The 11mm x 15mm speaker fit nicely in its hood and is still functioning perfectly over three years later.

The speakers themselves are only a couple millimeters thick, but require a sound box or enclosure which usually adds about 10mm to the thickness. Streamlined Backshop sells enclosures in a variety of configurations that must be glued to the speaker, while the enclosures from TCS and Tony's Train Exchange provide a drop in fit. Sugar cube speakers have become my go-to choice for diesel installations, but I still prefer a larger high-bass speaker in my steam locomotives.

Stay-alive devices

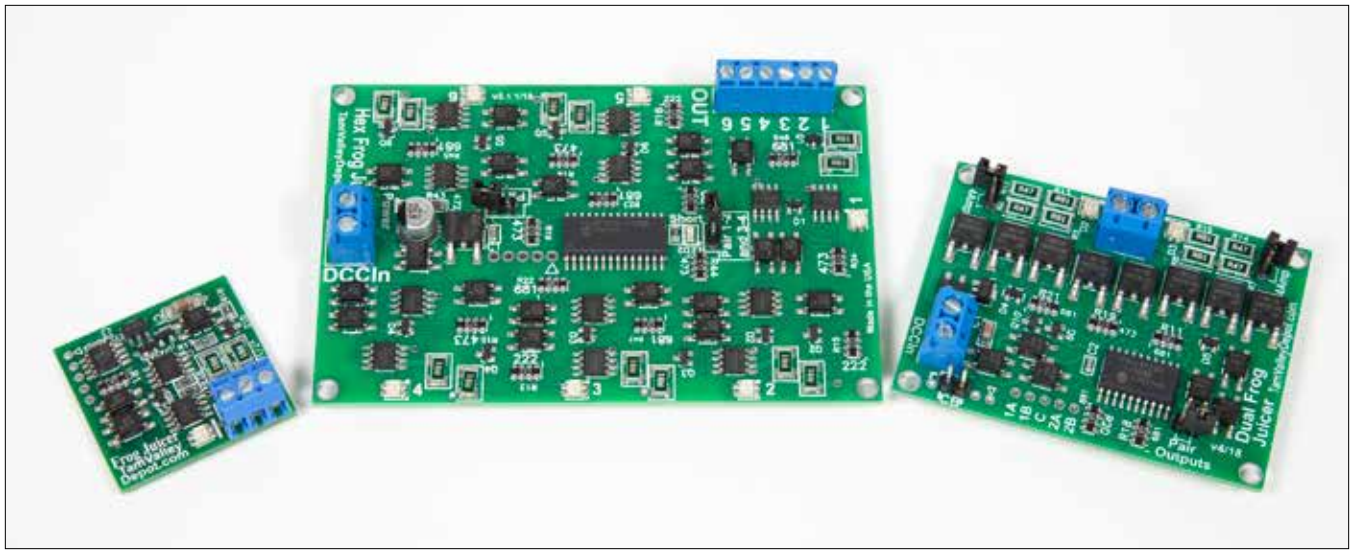
Although stay-alive devices have been available since about 2005, they have become increasingly popular in the last few years and almost all major decoder manufacturers have added a version to their product line. These basically consist of capacitors, voltage regulators and associated circuitry that provide backup power for decoders. This backup power is usually enough to keep a decoder operating for several seconds.

The popularity of these devices has greatly increased along with that of sound decoders, because they prevent annoying sound interruptions. They are especially useful for preventing locomotive shutdowns and jerky operations due to dirty or uneven track and unpowered turnout frogs. Recently, manufacturers like Bachmann have begun including stay-alives along with factory-installed sound decoders in locomotive models such as the ACS-64 electric and Pennsylvania K4 streamlined Pacific locomotives.

Powered frogs

For many years modelers have used auxiliary electrical switches on turnout switch machines to control the polarity of their turnout frogs. Several manufacturers including Micro Engineering and Peco make turnouts with built-in spring mechanisms that hold turnout points against the stock rails, eliminating much of the need for switch machines.

However, it's still desirable to power the frog and control its polarity. Tam Valley Depot makes circuits called Frog Juicers, **3**, designed to automatically detect a short at the frog and correct it in only about 150 microseconds, long



3. Tam Valley's Frog Juicers are electronic circuits that detect short circuits at turnout frogs and automatically switch the polarity before the command station or booster shut down.

4. Digitrax began revamping its line of command stations in 2016 with the Digitrax DCS240. The system includes the addition of a USB port to allow a computer interface.

before your DCC system shuts down. Frog Juicers are available in mono, dual and hex versions with one, two, and six individual circuits on a board. They offer a quick and easy way to prevent annoying shutdowns due to turnout shorts during operations.

Command stations, throttles, and decoders

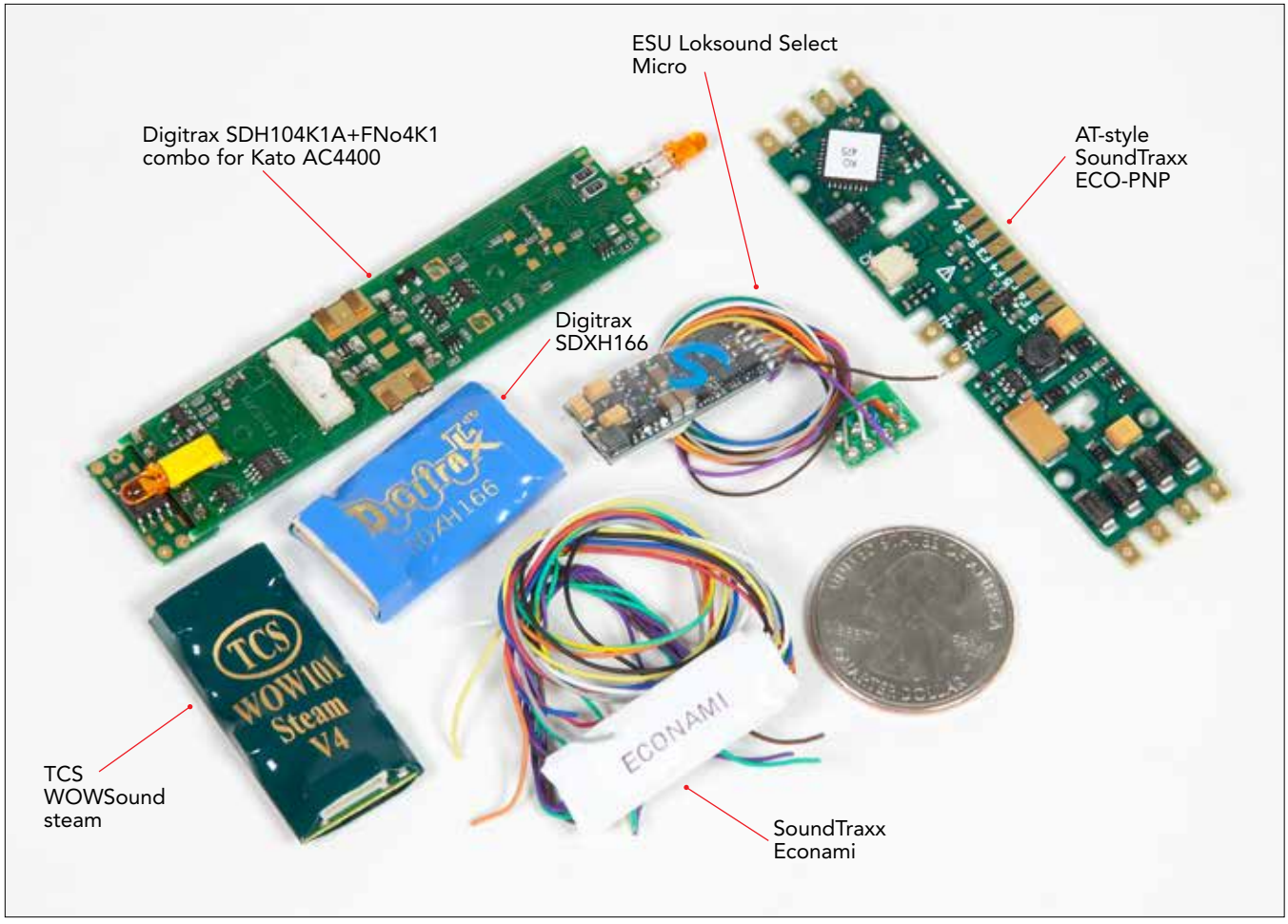
As a result of technological advances, manufacturers have been adding new features to their DCC command stations and other equipment. Beginning in the fall of 2016 Digitrax began an overhaul of much of its product line, releasing a command station upgrade with their DCS240 advanced command station, **4**.

One great feature of the DCS240 is the built-in USB computer interface. This greatly simplifies connecting the DCS240 to a computer for use with JMRI DecoderPro or other computer programs. Other important features include the ability to supply either 3, 5, or 8 amps of track power depending on the power supply. This feature is also present in the new DCS210 command station as well as the DB210 and DB220 boosters. The DB220 booster has dual outputs, meaning that with an adequate power supply it can supply up to 8 amps to each of the two track outputs.

As with many of Digitrax's new products, the firmware can be downloaded and installed using your home computer. This capability offers the ability of keeping your DCC command station, boosters, throttles, and other accessories up to date as new features are added.

One of the most interesting new systems, the Digikeijs DRS5000, **5**, appeared in 2018 and offers throttle

5. The Digikeijs DRS5000 was introduced in 2018. It provides a computer-based throttle and accessory interface compatible with several systems (laptop is not included). *Bill Zuback*



6. Sound decoders continue to increase in features and decrease in size.

and accessory interfaces from Digitrax, Lenz, and any systems compatible with these. For example, EasyDCC wireless receivers can be plugged into the Lenz ExpressNet port to allow use of their wireless throttles. The system also has a built-in WiFi/LAN port and relies on either a Windows 7 or 10 computer system for operation.

Modelers often lament the fact that their throttles are not compatible with other DCC systems, but that is changing. WiFi-based interfaces are now being offered and developed that allow modelers to use different brands of throttles as I just described for the Digikeijs DRS5000 system. Companies like Model Rectifier Corp. and Digitrax (LnWi) offer WiFi interfaces that allow modelers to use their Android and iPhone cell phones to control trains. Cell phone apps like Engine Driver and WiThrottle provide a graphical interface that can control locomotive speed, direction, sounds, and lights. WiFi-capable throttles made by Piko (and soon to be released by TCS) offer the option of a more-conventional handheld device.

Several companies have totally overhauled their sound decoder selections since 2014, **6**. SoundTraxx replaced its Tsunami decoders with the lower-priced Econami decoders along with the upgraded Tsunami2 decoders. The Econami decoders provide a limited selection of sounds and features while the Tsunami2 is available with a wider array of prime movers and features. All are available in an assortment of formats and power ratings.

While the TCS WOWSound steam decoders became available several years ago, the company released a diesel version in 2015 and has greatly expanded the selection of sounds and features on a regular basis since then. The exciting aspect of these decoders is the large number of sounds available on each decoder type. Whistles, bells, horns, and specific diesel prime movers make it a simple matter to find just the right combination to match your prototype.

Just as we were about to wrap up this book, LokSound announced the release of its version 5 decoders. While maintaining similar sizes and formats, LokSound 5 will be available in two different versions—one for the North American and Australian market, and another that will also support Motorola, Selectix, and MFX/M4 digital systems. Among their many features are 10-channel simultaneous playback, 128MB sound memory, 16-bit processor, 3-watt sound output amplifier, and 4 to 32 ohm impedance speaker support. They will be offered with an 11mm x 15mm sugar cube speaker and enclosure.

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Before sending your model back to the factory, try resetting the decoder. Here, the decoder's configuration variable 8 is being set to "8."

Problems with devices and locomotives

When a locomotive stops working, go through this checklist:

• Is there an open circuit? If so, a quick push on the locomotive will determine if it was a contact problem.

• Is there power to the rails? If power to the rails is OK, try another engine.

If a device has voltage and still fails to work, be sure the return (ground) wire and connections are OK and the circuit is complete.

On decoder-equipped engines, test the headlight. Is CV19 set to "0"? Try short address 03.

If all else fails, reset the decoder back to its factory settings (CV8 to 8 on many decoders).

• Is there a short circuit? If it's a short circuit, check for a derailment or a turnout lined the wrong way. If lining the turnout doesn't fix the short, remove cars and locomotives from the track to see if that clears the short (metal wheels sometimes bridge gaps or touch multiple rails at turnouts).

• Did you test the decoder installation? If you install a DCC decoder or work on an engine with a decoder, always test it on the programming track before running it on the main line. If you put an engine on the main that has a short circuit, it may damage the decoder.

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The tethered Digitrax UT4 throttle can be set up for infrared wireless operation (left), while the CVP9000E (right) uses a radio frequency.

Wireless hints

There are two types of wireless connections: infrared (IR) and radio frequency (RF). Infrared is like a TV remote. With IR, you need line-of-sight between the remote and the receiver. Sometimes the beam can be bounced off a wall. Radio frequency is much more reliable.

Working with radio waves turns out to be more of an art than a science. Here are a couple of suggestions when installing a wireless system.

• Radio waves don't propagate well through the human body. When installing the DCC transmitter, it should be located in front of the operator. Choose a high location like the ceiling.

• Concrete walls can also be a problem. It's not the concrete itself but any steel rebar in the concrete that can attenuate the signal.

Metal objects near the transmitter will also absorb some of the RF energy. Sometimes just moving a few feet one way or the other will improve the signal. If all else fails, try installing a second receiver.

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The Electronics and DCC section of the *Model Railroader* forums provides a way for hobbyists to find solutions to problems on their layouts.

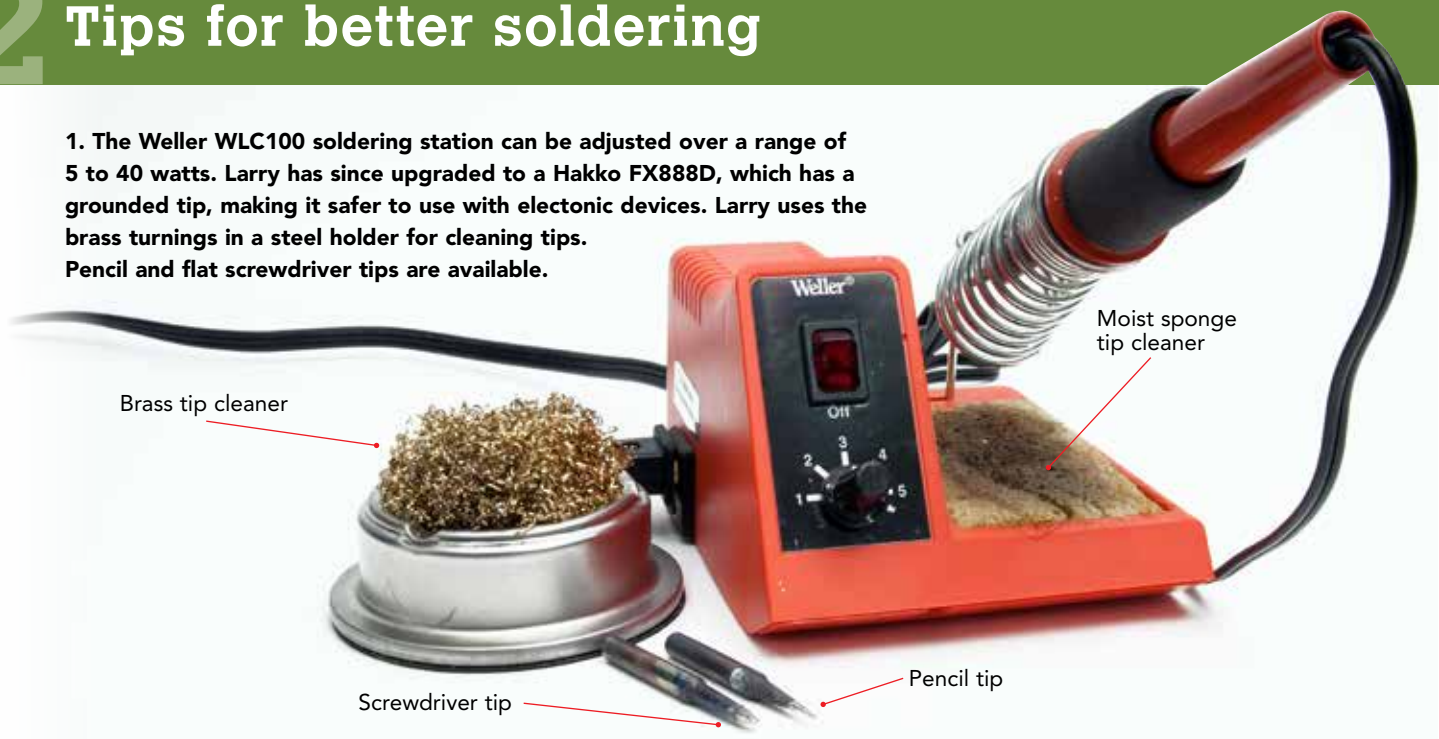
Worldwide solution

The Internet is a great source for solutions for model railroad problems. The *Model Railroader* forums and DCC Corner columnist Larry Puckett's website (www.dccguy.com) are two places to start. In addition, Yahoo has many groups that can help with most questions. There are groups that focus strictly on wiring and DCC. Some groups specialize in one DCC manufacturer.

To find a group that matches your interest, do a search in Yahoo Groups (groups.yahoo.com) or in the newer www.groups.io. Most groups are open to new members, but some have restricted membership.

These groups span the world. I've seen someone with a problem in Denmark helped by a modeler in Australia. You can search past topics for previously discussed problems and answers.

2 Tips for better soldering



1. The Weller WLC100 soldering station can be adjusted over a range of 5 to 40 watts. Larry has since upgraded to a Hakko FX888D, which has a grounded tip, making it safer to use with electonic devices. Larry uses the brass turnings in a steel holder for cleaning tips. Pencil and flat screwdriver tips are available.

Soldering is a skill every model railroader needs. When building a layout, soldered track feeders, rail joiners, and electrical connections are necessary for reliable DCC operations. In addition, most decoder installations require soldering at some point to add lights, speakers, connectors, and extra functions. Let's take a look at some of the tools that will make your job easier, followed by some tips on their use.

Iron and solder

The most obvious tool is a good soldering iron. Fortunately we have a wide array of electronic soldering irons to choose from, but how do you choose? As with most situations, you need to match the tool with the job. Small electrical components and delicate 28AWG wires call for small, low-wattage irons. However, soldering track feeders and rail joiners works best when you can put a lot of heat on the spot and get out before your ties turn into a pile of molten plastic or charred wood.

While you can purchase two or more irons of different wattages, I prefer a more flexible approach—an adjustable soldering station. The photo in **1** shows my Weller WLC100, but I have since upgraded to a Hakko FX888D. The Weller, although it worked well, had issues with leaking current at its tip, which could damage electronic components. The Hakko has a grounded tip which will not leak current. Like the Weller, the Hakko allows setting a specific temperature depending upon the type of solder and size of wire/connector being used.

Most soldering stations like these have interchangeable tips. I typically use a small pencil tip for delicate work and move up to a larger flat screwdriver tip for rail joiners and other projects requiring a lot of heat.

Solder varies in composition, with tin and lead in a 60:40 ratio commonly used for most model railroading purposes. However, 63:37 solder is also popular. An important distinction between these two formulations is that 60:40 solder has different temperatures at which it becomes a liquid and a solid, existing as a paste between these two points, whereas 63:37 solder passes from liquid to solid at 361 degrees F.

This is important, since if a 60:40 solder joint is moved while cooling, it might not form a solid connection, whereas the 63:37 solder solidifies immediately.

Hard solders, which often contain silver, are also available. They have higher melting points, near 900 degrees F. These are good for projects like building turnouts and adding details to brass locomotives. Some people also prefer lead-free solders.

You can find solder in strips, bars, and wire rolls of varying diameters; only the latter is suitable for most model railroading jobs, **2**. For years I've been using a 1 pound spool of Kester 60:40 rosin core solder with a diameter of .022". The small diameter makes it suitable for any job from soldering small electrical components to rail joiners and track feeders.

Because of the higher cost of solder containing silver (less than an ounce can cost as much as a full pound of 60:40 solder), I purchase silver solder as a small roll in a clear plastic dispenser.

Flux is an important component of any solder job. Flux prevents the formation of metal oxides during heating and allows the solder to make a solid, electrically conductive joint.

There are two basic kinds of flux: acid and non-acidic. Acid fluxes typically contain zinc chloride or other compounds that can leave corrosive residues that are difficult to remove.

These residues can corrode solder joints long after the job is completed and lead to failure months or even years in the future. That's why acid fluxes (or acid-core solder) should never be used in any electrical work or model railroading in general.

The flux I recommend for model railroading is a non-corrosive rosin flux. Rosin flux is available in both liquid and paste formulations and leaves

Adding sound to an N scale steam locomotive

1. Larry Puckett's friend wanted sound added to his N scale Bachmann Baltimore & Ohio EM-1 2-8-8-4. Larry took on the project, twice.

Installing sound decoders in N scale locomotives can be challenging unless the model was designed with this in mind. In some cases even when there appears to be plenty of room, there may not be room for extras like a stay-alive capacitor or a large speaker.

I ran into this problem installing a sound decoder in the Bachmann N scale Baltimore & Ohio 2-8-8-4 I used for this project, **1**. I'm going to show you two ways to do this installation, one that's relatively easy but doesn't produce the loudest sound, and a second approach that gives more sound by using a speaker in an enclosure.

My friend Bill Dye is a B&O fan who has several of the popular EM-1 2-8-8-4 models. These locomotives come with large tenders. When I offered to install a sound decoder, I figured it would be an easy drop-in project. After scanning the various decoder sound packages available, I ran across one for the EM-1 in the Digitrax sound depot.

I chose the Digitrax SDXN136PS sound decoder and PX108-6 Power Xtender stay-alive capacitor, **2**, and downloaded the EM-1 sound package, which is available from the Sound Depot on the Digitrax website (www.digitrax.com/sound-depot/list).

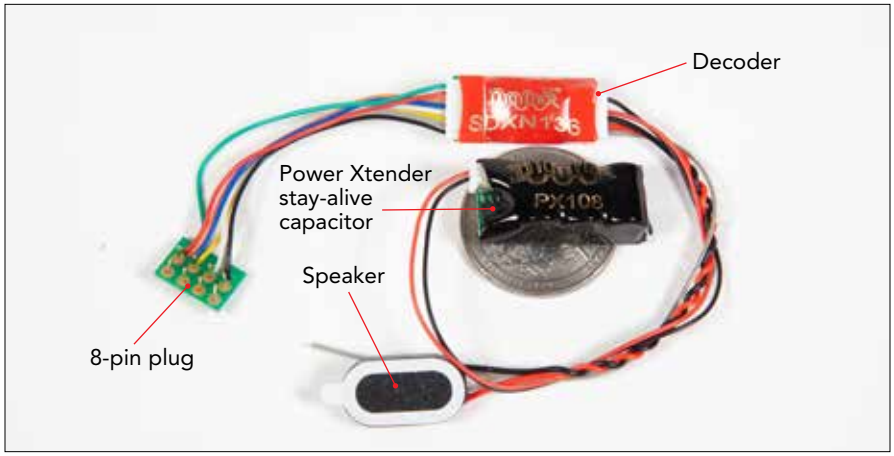
Preparation

Removing the tender body is easy. I backed out four screws and lifted off the shell, revealing a circuit board that runs the length of the inside and carries the motor-only decoder. A bundle of six wires from the engine terminate with a socket that mates with a six-pin plug on the circuit board.

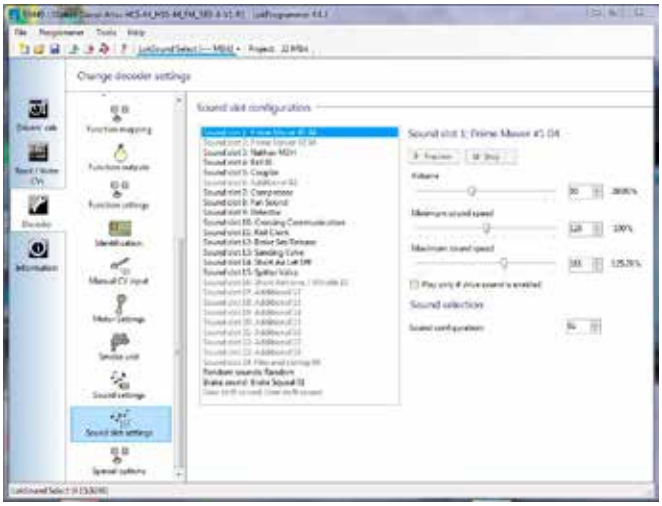
Let me warn you about this socket. Printed on one side of this socket is the word "Up." However, as I later found after wasting a lot of time trying to figure out why the locomotive ran backwards and the headlight wouldn't work, "up" was actually "down."

At any rate, make sure to note which way the socket and the word "Up" are facing before disconnecting. Matter of fact, it's always a good idea to take a photo of a factory installation before doing any work on it.

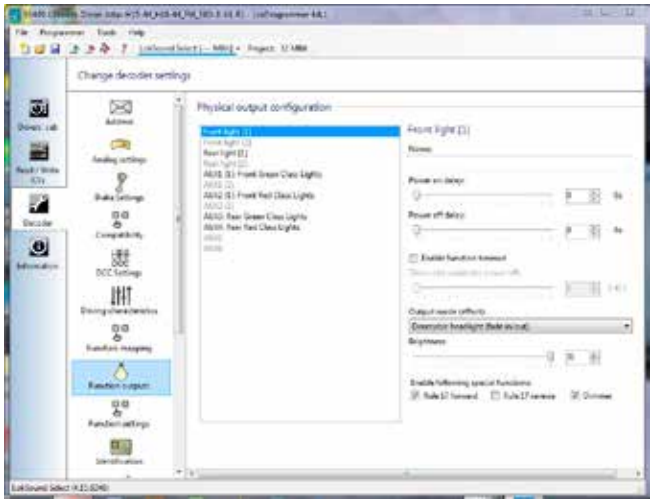
With the wires disconnected, I was able to separate the engine from the tender. I removed the two small screws that held the circuit board to the tender



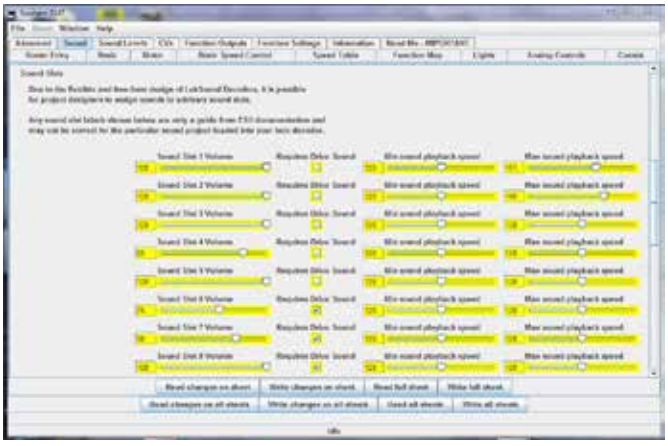
2. The Digitrax SDXN136PS sound decoder and PX108-6 Power Xtender stay-alive capacitor looked like a good fit. Try as he might, though, Larry couldn't fit the Power Xtender into the large tender. Larry also found the speaker too large, and the 8-pin plug wasn't used in this installation.



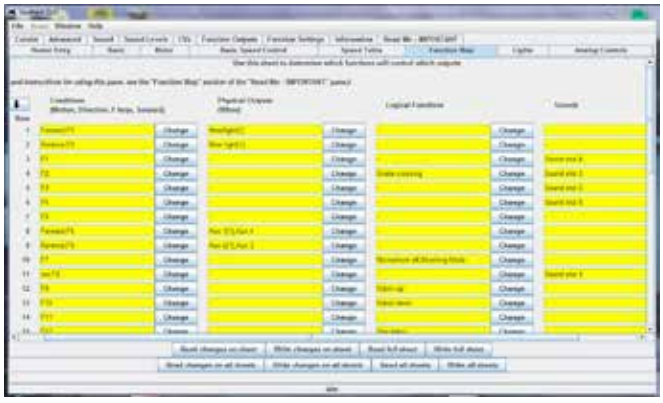
3. On the LokProgrammer Sound Slot Settings screen you can change things like volume, minimum and maximum playback speed, and whether the sound plays when the locomotive is moving or stopped.



4. The LokProgrammer Function Output screen is where you control wired outputs like the lights. For each output you can control the type of light effect, whether it's dimmable, and whether Rule 17 applies.



5. In DecoderPro the sound slots are edited in the lower portion of the Sound pane. It has controls similar to the LokProgrammer sound slot screen.



6. The DecoderPro Function Map pane allows you to assign functions to specific buttons, designate the characteristics of each, and assign sound slots.

The alternate option is to install the LokProgrammer software and use it without the interface hardware. You don't need the hardware interface to examine and edit sound projects.

As I described above, open the LokProgrammer software and read in the file you downloaded from the ESU website. Now, using the Tools option, export a CV list file.

Open DecoderPro, create a new locomotive entry selecting the LokSound Select decoder you have, and open the comprehensive programmer. Using the File > Import > Lokprogrammer CV List File option, read in the CVs from the LokProgrammer CV list file. You will now have all the CV settings loaded into DecoderPro.

Once you get all your CV settings into DecoderPro, it's equally easy to edit them as I've described for other decoders (page 86, for example) and in a series of videos on my website (www.dccguy.com).

The sound slots are edited in the lower half of the Sound pane, **5**, giving you control over volume, Min and Max playback speed, and a checkbox to set whether the sound plays with or without the locomotive moving.

More advanced controls in the Function Mapping pane, **6**, allow you to assign sound slots to specific function buttons, as well as physical and logical output controls.

If you don't have DecoderPro, you can still make all the edits using the LokProgrammer software. Then, using the Tools > Show Changed CVs tab, save these changes to the computer's clipboard, and enter them in the decoder manually using your DCC system's programming throttle.

Page 52 shows the installation of a LokSound decoder in an HO scale Atlas H16-44.

4 Basic, universal, and advanced consisting

SD40-2 no. 1027 leads a unit coal train through Williams Bay on the Milwaukee, Racine & Troy club layout at the Kalmbach Media offices. Using DCC consisting you can operate multiple locomotives just as the prototype does.
Bill Zuback photos

The process of coupling together and operating two or more locomotives as a single unit is known by several names. Multiple-unit operation or MU-ing (pronounced "em-you-ing"), also called consisting, has been used by railroads since the early years of the 20th century, first with electric locomotives and then with diesels.

For prototype diesels, once a group of locomotives is coupled together and set up for multiple-unit operation, all the control operations in the lead locomotive are simultaneously sent to the other locomotives so they operate as a single unit. To accomplish this, both air and electrical lines are connected between locomotives to control the throttle, brakes, lights, dynamic brakes, and sanders. This capability gave diesels a big advantage over steam, as double-headed steam locomotives always required individual crews.

When it comes to our model locomotives, we can easily imitate prototype multiple-unit operation with DCC. This is accomplished using one of three methods referred to in Digitrax literature as basic, universal, and advanced consisting.

Other sources and manufacturers may refer to these methods by different names. For example, I've seen universal consisting referred to as basic, brute force, and old-style consisting. To avoid confusion, I'll describe what each does and you can use whatever name suits you.

Using these three methods we can control the speed, direction, lights, whistles, bells, and other functions that we normally use with a single locomotive. Let's take a look at each of these methods and their pros and cons.

Basic consisting

Basic, or address, consisting is the simplest form of multiple unit control. All that's required is setting the decoder address in each locomotive to the same value. Since all locomotives in a basic consist have the same address, they'll all respond simultaneously to throttle commands—there will be no delays. Another point in favor of basic consisting is only one address slot is required no matter how many locomotives are in the consist. This can be an important consideration when using DCC systems having a small number of available slots.

For example, if your system has only 10 address slots, and you have three universal consists with three locomotives in each, that will use up nine of your slots. However, with basic consists, you would only use three slots. Another advantage is that since all the decoders in the consist have the same address, you can easily move the locomotives to another layout without having to re-create the consist.

There are some limitations to basic consisting. All the locomotives in a consist must be facing the same direction, unless you change configuration variable (CV) 29 so a locomotive you want to run backward is set to "reverse" for normal direction of travel. This will allow the lights to automatically reverse in sync with the consist, although in prototype practice, the lights on a trailing unit wouldn't be on.

The real issue in basic consisting is with sound effects, since you can't control the functions in each locomotive separately. If you blow the horn, ring the bell, or activate other sounds, all the locomotives will respond. This isn't very realistic, and can create quite the cacophony especially if you have three or more locomotives running together.

Universal consisting

Universal consisting is probably the most popular. This method, also known as command-station-assisted consisting, works by having the command station keep track of each locomotive in the consist. To do this, it uses a memory slot for each locomotive address.

All the DCC systems I've used have some way of initially setting the direction of the locomotive so no special reprogramming or rewiring is

4 Speed matching for DCC consists

1. A pair of Southern SW1 switchers passes through the Model Railroad Technologies Accutrack II speedometer at 4.1 scale mph. The Accutrack II makes speed matching quick, easy, and accurate, and doesn't require permanent installation on your layout.

On page 74, I showed how I installed decoders in a pair of Walthers SW1s to be operated as a two-unit consist. Any time two or more locomotives are operated in a consist, you should first must make sure they run at about the same speed across the throttle range. Speed matching is the process of adjusting the decoder output to achieve this goal, **1**.

Depending on the type and age of the locomotives, you may not need to make any adjustments. For example, locomotives from the same manufacturer may run at essentially the same speeds, whereas models from different release dates or from different manufacturers may need major adjustments.

Locomotive models may also run at noticeably different speeds when operated in different directions. This can be corrected using forward and reverse trim decoder settings. Some decoders only support using forward and reverse trim with 28-step speed curves.

Back-electromotive-force control (back-EMF) is another potential complication. It allows a decoder to monitor and control speed based on load, and can contribute to smooth running. Any time two or more locomotives are operated in a consist with back-EMF on, they may end up fighting other locomotives in the consist that don't have back-EMF. Dealing with this may require turning back-EMF off or reducing its intensity.

When speed matching I generally recommend using a three-step speed curve approach. This is fast and easy and works with most locomotives and decoders. I use DecoderPro in the Java Model Railroad Interface (JMRI), a free download at www.jmri.sourceforge.net.

You can also use a DCC throttle to enter values into the configuration variables (CVs). Three-step speed curves use configuration variables 2, 5, and 6 to set the starting speed, top speed, and mid-point speed, respectively, **2**. Some older decoders don't support CVs 5 and 6, in which case you will need to use a 28-step speed curve, **3**, and some don't support the use of CV2 in some cases.

2. The Basic Speed Control pane in DecoderPro allows you to enter values for CVs 2, 5, and 6 either by keying them in or with the sliders.

3. Using the Speed Table pane, you can create a three-step curve by designating speeds for steps 1, 14 and 28 and straight-lining the steps between.

Programming

I usually do three-step speed curve entries with ops mode programming using either a throttle or DecoderPro, **2**. This allows me to quickly optimize the settings for CVs 2, 5, and 6. For more complex programming, I generally use DecoderPro. This program organizes tasks by function, making it easier to figure out how to do more complex tasks. You can also use a 28-step speed curve to mimic a three-step speed curve by setting steps 1, 14, and 28, then straight-lining the intermediate steps, **3**.

Proceed in consistent steps and keep notes as you make changes. This will help you keep track of what works and what doesn't. Here's my process:

1. Turn off back-EMF if possible, or reduce the intensity. This may not be desirable with some decoders because of complex speed control algorithms and interactions.

2. Set momentum (controlled by