



American Hobby Helpful Hints



Digitrax DCC System Hints and Tips

These notes are an evolving tip sheet on operation of Digitrax DCC systems. The source of these tips comes from customer questions, personal experience, the internet and the Digitrax manuals and technical information.

Digitrax has been producing a their popular DCC system since the 1990's. There are now three starter systems available from Digitrax. On the low end is the all-in-one Zephyr, in the middle is the Super Empire Builder and on the top is the Super Chief. This family of products will all interconnect thru the LocoNet LAN connection. The LocoNet links the command station to boosters and the handheld throttles. Even the low cost Zephyr has the LocoNet connection and can be used with the handheld throttles. If you start with a Zephyr and later expand your system the Zephyr can be used as a power booster. Digitrax also makes a long list of decoders for different scales.

The NMRA standard applies to the signals that are on the rails. In practice this means that it is up to the manufacturer to build a system to generate the signals. This is why you need to buy handheld controller, power stations (booster) and other components by the same manufacturer. Since the DCC signal on the rails is standard any manufacturer's decoders must respond to this standard. This is why some parts of a system may not be interchangeable, but you can use a mix decoders from any manufacturer.

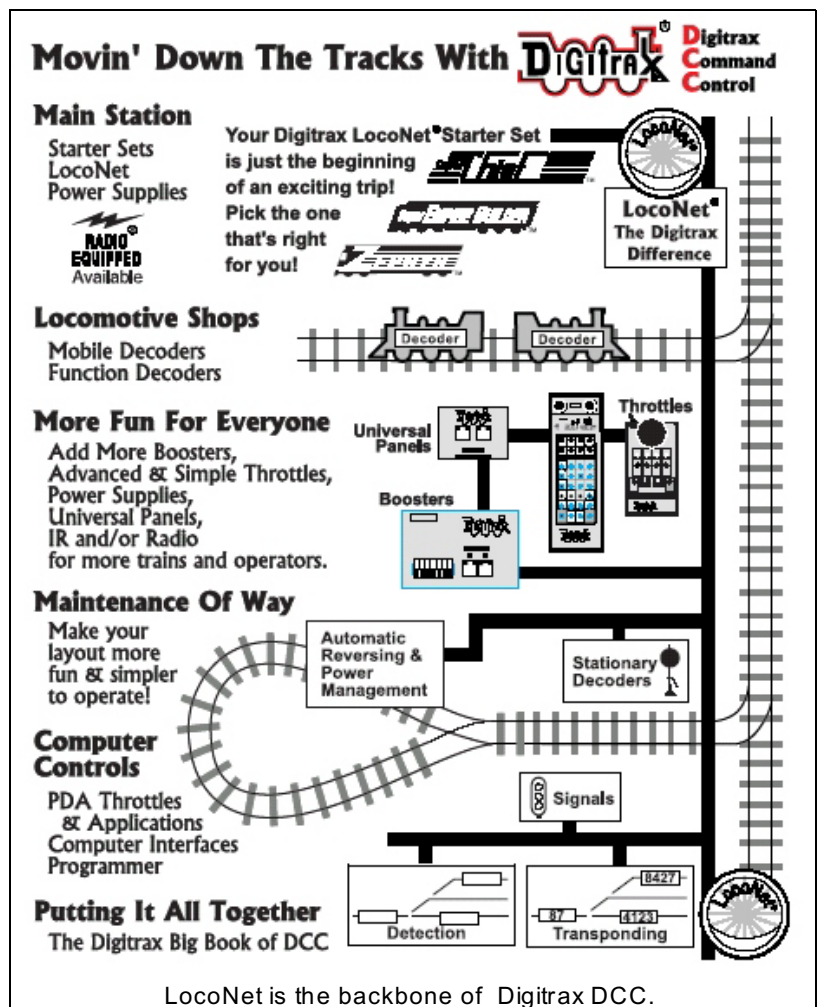
Choosing a System

With the choice of three different starter sets, the one that is right for you depends of how the system will be used. Things to consider include number of operators, scale and number of locomotives running. All three systems will program basic, universal and advance consists. All three use LocoNet connections to allow use of handheld throttles. The throttles can be linked by tether, radio or IR. For the amount of power needed look at *Layout Power Requirements* later in this document. Additional power booster also connect to the LocoNet.

ZEPHYR-(DSC50)

For a small home layout the Zephyr will work and can run up to 10 locomotives. The Zephyr is a stationary unit, but with the LocoNet you can add handheld throttles around the layout. The amount of power from the Zephyr is only 2.5 amps. This may limit the number of locomotives that can be run in your scale. On the positive side the Zephyr is full function and can read back CVs with a

program track. Has function output for F0 to F8. The Zephyr can be programmed to be a 2.5 amp booster if you up grade systems. The Zephyr is the only system that has 2 novel JUMP Ports which allow a dc power pack to run DCC decoders.



One of the local clubs has obtained a Zephyr to determine if their existing dc layout wiring will work with DCC. A bigger system will be needed once converted. After conversion the Zephyr can then be used at the work bench to program decoders without interrupting layout operation or as an additional booster..

SUPER EMPIRE BUILDER- (DB150)

A step up from the Zephyr with the ability to run up to 22 locomotives and throttles. Available with a 5 amp power booster. This system has function outputs for F0 to F8. The Super Empire Builder does have one limiting item as it does not have a separate output for a program track.

SUPER CHIEF- (DSC100/DSC200)

This is the top of the line system with the ability to support up to 120 locomotives and throttles. A good choice for large home or club layout. This system has function outputs for F0 to F12. The Super Chief supports an output for a program track. Also available with a 5 amp (DSC100)or 8 amp (DSC200) power booster.

Digitrax Upgrade of Older Chiefs

Older DCS100s that cannot access Functions 6 and higher can send their DCS100 to Digitrax for an upgrade. Cost for the upgrade is \$35, which includes return shipping. Contact Digitrax for more information.

Layout Wiring and System Setup

Layout Wire

The 22 AWG wire may be OK for the program track, but is too small for the mainline. Wire has resistance and the longer the wire the higher the resistance. Smaller wire has more resistance per foot. Resistance causes a loss of voltage. More current equals higher voltage loss resulting in loss in train speed and dimming lights. It is best to keep the voltage loss to under one volt. To add to the loss in wiring, nickel-silver rail is not a good electrical conductor. Wire should be installed in parallel to the rails and a drop from the rails to the wiring at least every 6 to 10 feet. Here is a chart listing wire size, currents and lengths. A good source of wire is the *speaker wire* from Radio Shack. Be sure to get the stranded wire.

Length	Feet for 1/2 volt Drop			
Wire Size	1 Amp	2.5 Amps	5 Amp	8 Amp
8	796	318	159	100
10	501	200	100	63
12	314	126	63	39
14	198	79	40	25
16	124	50	25	16
18	78	31	16	10
20	50	20	10	6

Chart for 1/2 volt drop. This would equal a one volt drop for a wire to the layout and back to the base

To determine the voltage drop of an existing layout wiring you can use an RRampMeter. Put one end of the meter on the rails and put a load on the other end to get a reading under load. You can make a simple load from an automotive lamp. Measure the voltage with the load and then without the load to determine the amount of loss. The 1156 lamp will give little over a 2 amp load, a 1141 is about 1.5 amps and the 912 lamp near 1 amp. The RRampMeter is a versatile handy tool to have for testing and monitoring the electrical system of a layout.

Blocking the Layout

With only two wires connected to the main track connection a single short circuit will shut down the layout. To prevent a single short from shutting down the entire layout, the layout should be divided into sections known as districts and subdistricts. A *district* is a section of the layout that is powered by a single power booster. A *subdistrict* is a section of track or block that has a separate circuit breaker. Another type of block or subdistrict is a reversing loop or reversing section like a turning wye.

Common or House Wiring

There are two ways to wire to rails of a layout. One is the "House Wiring" where two wires are used to feed each block. Called house wiring because it is like the wiring in your home. The other is "Common Wiring" or sometimes called "Common Rail" wiring. This is where a heavy wire is round around the layout and a single wire used for each block and then the other rail wired to the heavy wire. This is like a car is wired where one wire is connected to the frame. Most



Checking voltage drop with an RRampMeter. Automotive lamp used as a load.

modeler use house wiring, but the common wiring will work with DCC. There is one rule-of-thumb that applies to either style of wiring. *Only one item can be wired in common.* For common wiring the return wire is the common item. With house wiring you can use a common transformer. But even with house wiring it is *still best to use separate transformers* for each the command station/booster and each booster.

Layout Power Requirements

Digitrax supplies a either a 5 amp or 8 amp booster with the command station. The 5 amp is ample power for most small to medium size layouts in N thru S scales This will even work well with newer O scale locomotives. (I've run 2 newer O scale locomotives on a 2.5 amp Zephyr system.) Power boosters are connected thru the LocoNet bus. For older O scale and G scale the 8 amp unit should be used.

The 5 amp power booster should handle the requirements of most layouts. To determine if you will need additional power here are some figures you can use for planning. If you have a consist, add the number of powered locomotives in the consist.

To find out whether the maximum current of the system used is sufficient for the supply of your model railway system, simply add up the power consumption of all locomotives running at the same time as well as that of all other items that consume power. The following approximate values can be used to determine layout power requirements.

Running locomotives - depending on gauge and attached load, the power consumption ranges from 200mA to 2000mA. Calculate per locomotive 300mA for N gauge, 600mA for HO gauge and 2000mA for larger gauges. This ensures that you still have some reserve left.

Standing locomotives - not illuminated 5mA, illuminated approx. 50mA for each bulb. 15mA for each LED, illuminated passenger cars - each bulb approx. 50mA.

If the calculated sum exceeds the maximum current available from the Power Booster you need to split your layout into multiple power districts and install additional power boosters to provide power for each of these power districts. The Digitrax family includes three power booster models depending on the current needs and scale of your railroad. . Remember to plan for the future.

There are two power boosters available from Digitrax plus the Zephyr. The Zephyr is rated at 2.5 amps and boosters are available at 5 or 8 amps. Output voltage of the Zephyr is fixed at about 13 to 14 volts. The 5 amp power booster is the most common and the 8 amp power booster should be reserved for G and O scale. Some of the booster have a three position SCALE switch to set the output voltage. The positions are N for 12 volts, HO for 15 volts and O/G for 20 volts. Regardless of your scale you should use the lowest setting that works. There is also an internal voltage adjustment on some of the booster. Check your manual for more information on voltage settings.

Transformer Requirements

The command station and power boosters require a transformer for power. If a transformer is used that has an amp rating less than the output of the power booster there may not be enough power to trip the over-current protection. For most applications a 16 to 18 volts ac transformer works best. Digitrax specs call for an ac voltage input of 12 to 20 volts or a dc input of 12 to 28 volts .Exceeding these voltages can cause damage. Current ratings should be the same or slightly higher than the booster output.

COMMAND STATION/POWER BOOSTER

Zephyr (DCS50)

Super Empire Builder DB150 (5 amp)
Super Empire Builder DB200+ (8 amp)

Super Chief DSC100 (5 amp)
Super Chief DSC200 (8 Amp)

SUGGESTED TRANSFORMER

Supplied with the Zephyr

MF615 16VAC 6 Amp for HO to On3
XFR10 18VAC 10 Amp for O and G scale

MF615 16VAC 6 Amp for HO to On3
XFR10 18VAC 10 Amp for O and G scale

Circuit Breakers and Accessory Decoder Wiring

One of the most common causes of short circuits is running into a turnout that is set the wrong way. If you power an Accessory Decoder from the rails the short will cut the power to the decoder and you can not throw the switch the clear the short. This situation can be avoided by wiring the power directly from the power booster to the Accessory Decoder. A

short circuit will trip the circuit breaker while the accessory decoder continues to receive power via the base unit and allows you can throw the switch to clear the short.

Even without Accessory Decoder(s) using circuit breakers will allow sections of the layout to continue to operate with a short circuit in one of the other subdistricts. On-Guard (OG-CB) circuit breakers are available. There is also an On-Guard (OG-AR) for reverse loops which also has a integrated circuit breaker and can automatically operate the switch at the throat of the loop with a Switch-It.

Reversing Loops

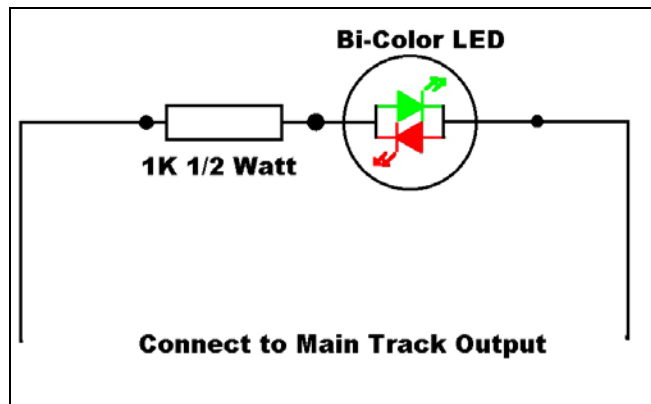
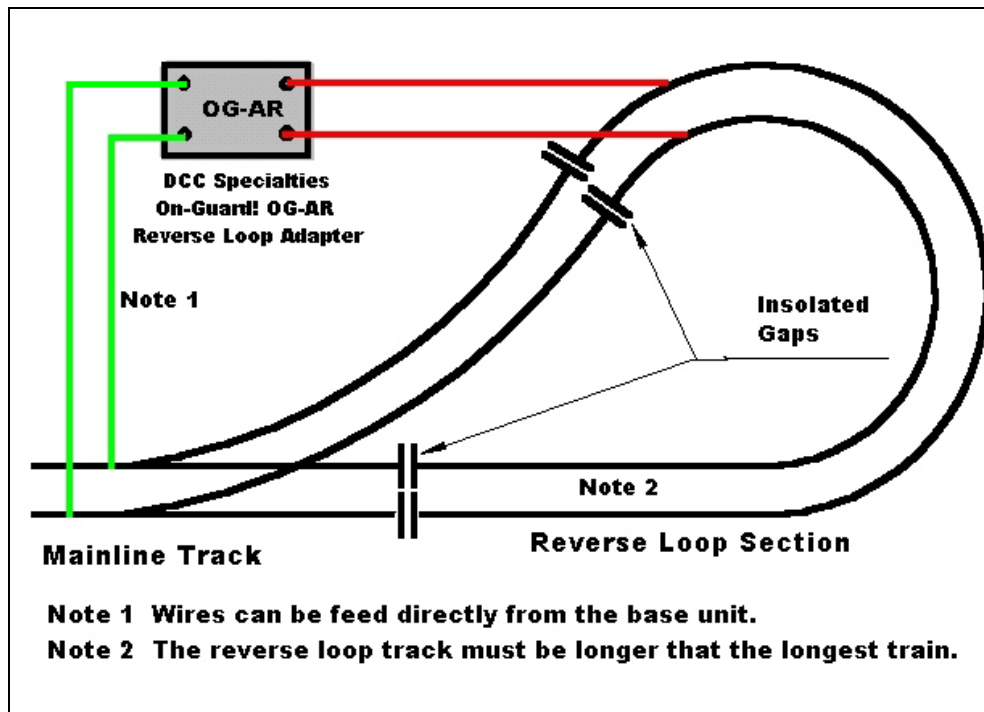
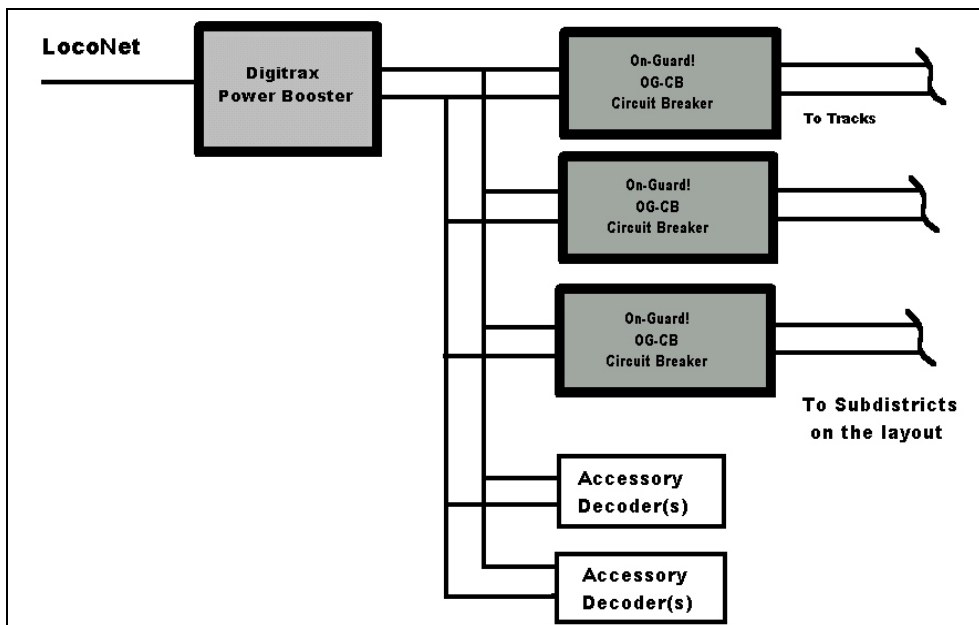
A reversing loop is a section of track that allow the train to turn around and reverse directions. Reverse loop wiring and operation is much simpler with DCC than dc. On dc the reverse loop was wired so the you could flip the polarity of the mainline while the train was in the loop. On DCC it is done the opposite way. With DCC the polarity of the train can be reversed under the train while it is in the loop. Polarity can be automated with a reverse loop adapter. The On-Guard Reverse Loop Adapter (OG-AR) is a solid state electronic device. Two wires are connected to the mainline or power booster and the other two wires to the isolated loop. When the metal wheels cause a short either entering or leaving the loop the adapter automatically switches the loop polarity.

Output Track Status Light.

Track Status Light on the command station/booster is normally an amber color. If it is either shifted to red or green it can mean one of two things. Either a fault in the output of the booster or you have run an engine using the 00 address feature.

If you put a non-decoder equipped engine on the layout and set it to full speed in one direction or the other it can leave the output biased. To fix this you need to select address 00 and turn the throttle to zero speed setting for that address. Then dispatch address 00! If you had a large layout with lots of engines you will find that this feature can slow response and be sluggish.

You can use a bicolor LED to monitor the status of the track power. Here is a simple circuit that will give you the information. Normally it is a **yellow/amber**, a distinct **red** or **green** indicates

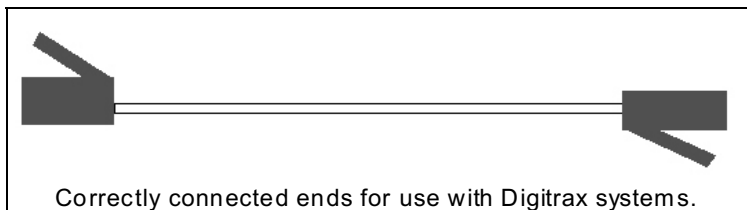


a DC output bias and may be indication of a malfunction.

System Cab Cables

If you need to make or buy cab cables to run from the base unit to remote locations on the layout they should be correctly wired. Correct wiring has the same wire connected to the same pin on both ends of the cable. The connectors are **6 pin** phone type connectors and the supplied cables have all 6 wires connected. If you buy cables be sure they are the 6 Pin type! If you make your own be sure to use a *good* quality crimper that will handle 6 pin connectors. Some cheap crimpers don't apply enough pressure to adequately connect the wires to the pins. (The cost of a good tool is soon forgotten, the problems with a cheap tool linger on!)

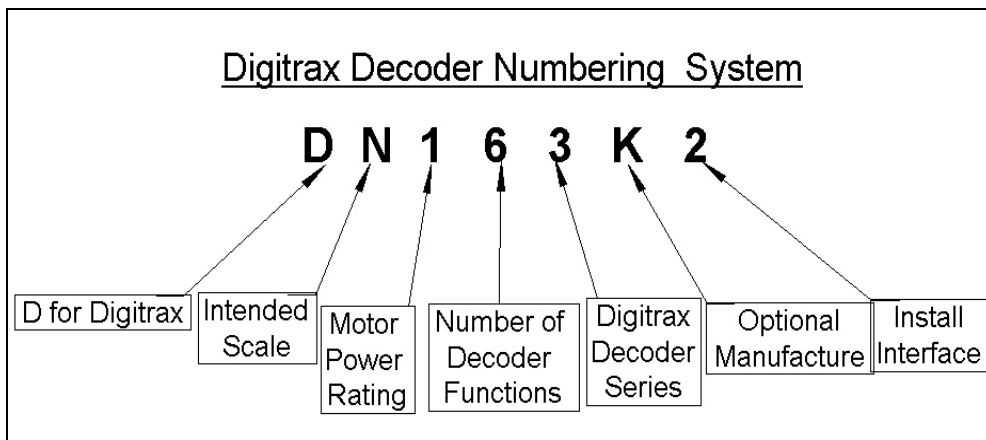
Parts to make your own cables are also available along with a crimper. The UTP (Universal Throttle Panel) cab bus panel is also available that provides additional throttle connections around the layout. The UTP has two RJ12 connectors in the front for connecting two throttles and two in the back to allow you to "daisy chain" to the next UTP.



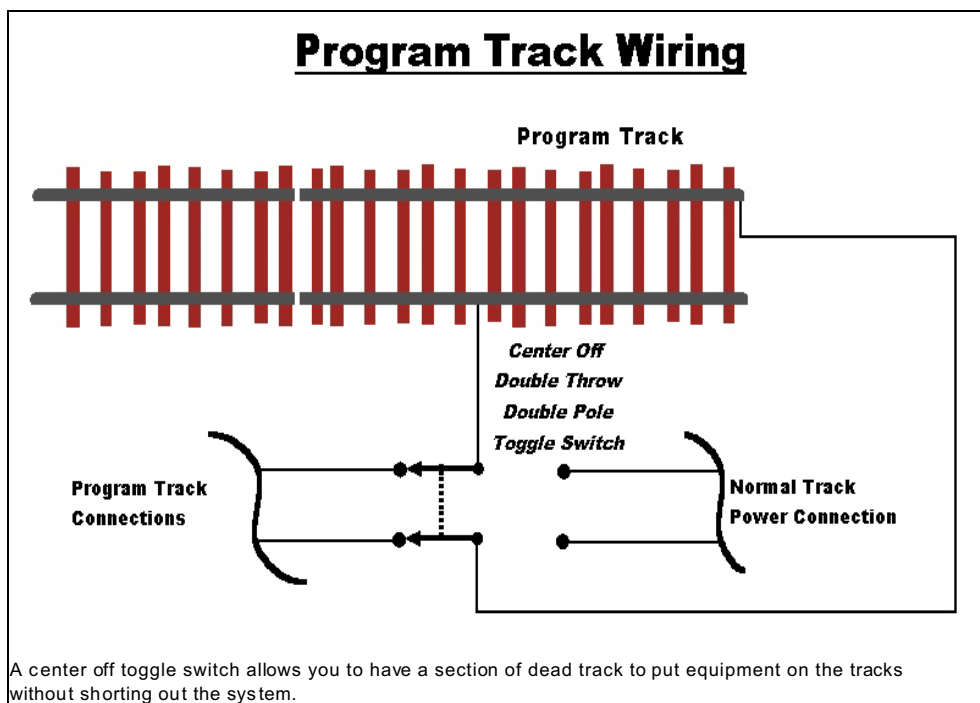
You should not connect the **command station or power station** to any device even if other devices use the same connectors. The fact that the connectors are similar does not automatically mean that the device is designed to work with the Digitrax. This is true even if you are dealing with other model railroad DCC control systems.

Digitrax Mobile Decoders Defined

Digitrax supplies decoders for most scales. The decoder part number is used to define the model tells a lot about the decoder's use and features. Starting with the 4th generation decoders here is some information on the code used. Start with the decoder ID "DN163K2". They always start with a **D** for Digitrax. The next character is the scale. In this case the **N** is for N scale. The third is the motor current rating. The number is one digit and in this case is 1.5 amps, but rounded down to a single digit. The next digit, a **6**, is the number of functions available on the decoder. The fifth character is a series designator and may run from 0 to 9. The next two characters are optional. In this example the **K** is for Kato and the **2** is the second style for Kato or interface used. For a more complete definition see the Digitrax Mobile Decoder Manual. This manual is kept up to date and available from Digitrax or a free download over the internet from the Digitrax website. (www.digitrax.com) This website has the manuals of present production and most of the out of production equipment.



Just because a decoder is intended for a one scale does not mean that is the only scale that it will work



with. I've seen an N scale decoder used in an On3 Shay. Why, because it fit! It is the motor rating that is important not the scale.

Programing with Digitrax

Program Track

The Zephyr and the Super Chief have outputs for a program track. This track can be a siding off the mainline. This section of track **MUST BE ISOLATED** with gaps on both rails. If you use a center off toggle switch the program track can be setup to select the track for programming or use for normal operations. With the center off the track can be used to put equipment on the rails without affecting operation or shorting out the rails.

The new BLI locomotives with the QSI sound decoders require more startup power to charge the capacitors. This can cause a problem programing on the program track. If you have a problem the PowerPax can fix it. The PowerPax is an adapter that is wired in between the command station and the program track. The PowerPax is guaranteed to fix this problem.

Decimal, Binary or Hex

. The Zephyr system uses decimal notation and some of the other systems have information in hex. (Hex is short for hexadecimal.) A knowledge of the hex, binary and decimal numbering system is a big help when you start setting up some of the special lighting or sound settings CVs. The values stored in a CV runs from 0 to 255 (0 to FF in Hex). There are conversion charts available to convert from one numbering system to any of the other number systems. There is a decimal to hex chart in the back of the Digitrax decoder manual.

DCC or dc Settings

Bit 2 of CV-29 permits some decoders operate when d.c. in on the rails. This bit should be left *off* unless you have a real need to operate between DCC and dc. Leaving this bit off can reduce the possibility of runaways. Some decoder do not support dc operation. Check with the decoder manual.

CV-29 Settings Here is a chart showing the standard decoder functions of CV-29.

Bit	Weight	Function (When on)	Purpose
0	1	Normal Direction of Travel (NDOT)	To correct direction problems so forward is forward. Reverses the normal direction of travel.
1	2	14 or 28/128 speed steps	Sets use of 14 or 28/128 Speed Steps. Should be on unless you have an old decoder(14 speed step is obsolete and rarely used)
2	4	Power Source Conversion	Allows the decoder to operate on dc or DCC. Not supported by all decoders. Best left off.
3	8	Advance Decoder Acknowledgment	This is a feature in some newer decoders Leave this bit off unless you have the function.
4	16	Use Speed Alternate Table	Used for speed matching. Leave off unless you set up the speed table at CV67 to CV94.
5	32	4 Digit Addressing (Off for 2 digit)	Sets 4 digit addressing. (2 Digit in CV-3 and 4 digit in CV-17 & 18.)
6	64	Reserved for Future use	Not used at the present time.
7	128	Defines Accessory Decoders	On if an accessory decoder/Off for mobile decoder.

Addressing VS. Other Systems.

The Digitrax system used addresses 1 to 127 as a two digit address and 128 to 9983 as four digit addressing. Address 00 is used to operate a single locomotive without a decoder. There are some address ranges that can be setup in other DCC systems that may not work on a Digitrax system. Addresses from 9984 to 9999 are not addressable with Digitrax systems. Some systems can setup address 0001 to 0128 as **four** digit addresses. This range of four digit address are also not addressable with the Digitrax systems. Problems with these address ranges only occur when locomotive decoders have been setup with non Digitrax systems.

Another area of addressing conflict is the two digit addresses and the addresses used for consists in CV19. A decoder can not tell the difference between a two digit address and a consist address of the same number.

Four Digit Addressing

Most system automatically setup 4 digit (long) addresses. These systems put the correct values in CV-17 and CV-18 based on the locomotive address. CV-29 bit 5 (weight 32) also needs to be set for 4 digit addresses. If your system does not automatically setup 4 digit addressing here is a way to do it manually. The basic idea for this came from a QSI manual. The following way uses a calculator.

A. Start with the locomotive address and divide it by 256.

$$\text{Sample } 4449 \div 256 = 17.3789....$$

B. Take the whole number (17) and add it to 192.

$$\text{Sample } 17 + 192 = 207$$

C. Program the value (207) in step B is into CV-17.

D. Multiply the whole number from step A by 256.

$$\text{Sample } 17 \times 256 = 4352$$

E. Subtract the locomotive address from the computed value in step D. $\text{Sample } 4449 - 4352 = 97$.

F. Program the value (97) in step E is into CV-18.

G. To activate 4 digit addressing a value of 32 (bit 5) needs to be added to CV-29.

Consisting

Consisting or MUing (multiple unit) is the ability to run more than one locomotive together as a single unit. Three methods are available, Basic Universal and Advance. **Basic** is addressing more than one decoder with the same address. With Universal the command station keeps track of the locomotives in a consist. The advance consisting is a newer way and uses CVs in the decoders to control the consist. The Digitrax systems can setup any of these type of consists.

With the **Universal** type of consist the base unit can only run one consist with up to four locomotives. Any functions are controlled by entering the locomotives number and using the function keys. The lead locomotive number is used for the consist number. With the old type of consisting the base unit sends out a separate commands to each locomotive for each change in speed or direction. When you enter a locomotive number and the locomotive is headed in the reverse direction from the other units push the direction key after entering the address. This tells the system to send this locomotive commands that are in reverse of the other units.

The **Advance** method uses CV-19 of each locomotive of the consist to hold the consist number. Any value in CV-19 other than zero tell the decoder it is in a consist. Advance consists use the 1 to 127 address range. This is the same as the two digit addressing range. A conflict can be setup if you use a 2 digit locomotive address the same as a consist address. When in a consist the decoder will not respond to any speed or direction at its normal address. A value of 128 is added to CV-19 when a locomotive is reversed in the consist. In a consist with the an address of 10 in CV-19 a locomotive in reverse would have a value of 138 in CV-19. There is a group of CVs that allow even more control of features while in an Advance consist. CV-21 to 24 are used for these controls.

Programming on the Main Track

Programming on the Main Track is sometimes referred to as "OPS Mode Programming". This allows you to change the value in a CV while out on the mainline. Functions like lighting, sound levels, acceleration/deceleration rates can be changed on-the-fly while operating a locomotive. The change will only apply to the address shown in the display. With a little practice you will appreciate what this feature can do for you in train operation. The value in a CV can not be read back in OPS mode.

Operation with the Digitrax DCC systems

Function Keys

The Zephyr and Super Empire Builder have a function key range of F0 to F8. The Super Chief range is F0 to F12. F9-F12 are accessible on the DT400 and the UT-4 throttle when used in conjunction with the Super Chief command station.

The new SoundTraxx Tsunami and QSI sound decoder use the function keys higher than F8. Below is a sample of the

function keys and actions. Functions can be re-mapped if you need a function that is not in the range your system.

Function Key	Typical Function	Tsunami Steam*	Tsunami Diesel*	QSI Steam*	QSI Diesel*
F0	Head/Backup Light	Head/Backup Light	Head/Backup Light	Head/Backup Light	Head/Backup Light
F1	Bell	Bell	Bell	Bell	Bell
F2	Horn /Whistle	Whistle	Horn	Whistle	Horn
F3		Short Whistle	Short Horn	Coupler Sound	Coupler Sound
F4		Steam Release	Dynamic Brake	Steam Blower	Fans
F5		Function F5	Function F5		Dynamic Brake
F6		Function F6	Function F6	Doppler/Startup	Doppler/Startup
F7		Light Dimmer	Light Dimmer	Brake Squeal	Brake Squeal
F8	Sound Mute	Sound Mute	Sound Mute	Sound Mute	Sound Mute
F9		Water Stop Sound	RPM +	Cruise/Shutdown	Cruise/Shutdown
F10		Dynamo	RPM --	Short Air Let Off/ Pop Off	Speed Read out
F11		Brake Squeal	Brake Squeal	Short Air Let Off/ Boiler Blow Down	Number Board
F12		Coupler Sound	Coupler Sound	Short Air Let off	Hazard/Cab Light

* **Note--** The above chart is subject to change depending on the type of locomotive or decoder.

DCC Documents

DCC system and decoders all come with manuals or information sheets. When you buy DCC products you get a receipt from the supplier. **All of these documents should be retained.** You may need a receipt to prove when you bought a device when getting something repaired under warrantee. Manuals are needed for reference, like when a decoder gets amnesia and needs to be reprogrammed. It is a good idea to write down the programming of a decoder's CVs and keep the information with the decoder manuals. Even though many of the manuals are now available over the internet in time they get obsoleted and can get removed. Digitrax does a good job of keeping manuals of obsolete equipment on their website, many others do not.

Sources of Help

There are ways to get help or have questions answered. One of the best is to join the Digitrax Yahoo group on the internet. The Digitrax Yahoo Group Chat list has near 5000 members that can answer almost any questions you have. If you monitor the group you will find a lot of answers and many suggestions. Another source is Digitrax. If you still have questions after reading the operating manual, you can contact Digitrax at Sales@Digitrax.com or call Digitrax at 1-770-441-7992. Their address is Digitrax, 450 Cemetery Street, Norcross, GA USA 30071.

Don Fiehmman 18Feb05