Digitrax
Command
Control

Mobile Decoder Manual
&
PR-1 Decoder Programmer Manual

Includes:
Decoder Selection & Installation Basics
Programming & Configuration Variables
Real FX & FX^3 Set Up & Use
Scaleable Speed Stabilization (Back EMF) Set Up
SuperSonic Operation (Silent Operation)
Loadable Speed Tables
Transponding™
Troubleshooting

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Please visit www.digitrax.com for the latest version of all manuals.
This manual was updated 04/04

Digitrax Mobile Decoder Manual

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1.0 Introduction

Congratulations on your purchase of a Digitrax Digital Command Control Decoder. It is engineered to give you exciting DCC control features at a reasonable price. Digitrax mobile decoders work with DCC compatible systems. Many Digitrax decoders also go beyond DCC compatibility to offer additional non-DCC features like real FX effects, analog mode conversion, speed stabilization, Transponding™ and more.

Digitrax offers many decoders that are plug 'n play, making installation a snap. In some cases decoder installations are more challenging and may require soldering. Most model railroaders have the common sense, judgment and skills needed to successfully install decoders. It is important to follow the directions included in this manual and on the decoder specific instructions you receive with each decoder to make sure your installation is successful. If you choose to have someone else install decoders in your locomotives, your local Digitrax authorized dealer can handle the installation or can refer you to someone who can do the job for you.

A word of caution: DCC offers many options that are not available with DC operation. We recommend that you begin by running trains at different speeds in forward and reverse as you did with DC control. Once you are comfortable with basic locomotive operation, then move on the more advanced options available with DCC. Before you know it, you will be running your model trains like the prototype!

Thank you for choosing Digitrax! Please feel free to contact Digitrax or your Digitrax Authorized Dealer with any questions or concerns you might have about our products. We are always looking for ways to make our products better so, let us know what you think!

2.0 Digitrax Decoder Features & Specifications

Digitrax mobile DCC decoders are just one part of your DCC system. When properly installed in your locomotives, they will receive the commands sent from your command station through the rails, decode the commands and control the motor and function operation of your locomotives.

Digitrax makes a wide variety of decoders with many different features. This lets you choose which decoder is best for each individual locomotive. All Digitrax decoders are robust, reliable and quiet running.

Digitrax builds economy decoders with fewer features, mid range decoders with more features and premium decoders with even more advanced features.

The Decoder Instruction Card included with your decoder lists the features of the decoder and includes specific information about how to install the decoder. This Manual explains most of the features available in Digitrax decoders. The latest versions of this Manual and the Decoder Instruction Cards is available at www.digitrax.com.

Spec sheets and instruction sheets for all Digitrax decoders past and present are available at www.digitrax.com

Digitrax Decoder Part Numbering System

Current production Digitrax decoders use the following numbering system:

The first character tells you it is a digital decoder. This is always a "D".

The second character tells you what size it is. This is based on the smallest "scale" the decoder is designed to fit. This will be a Z, N, H, or G.

The third character tells you the current rating of the decoder. This will be a 1, 2, 3, 4 or 5. We designate 1.25 & 1.5 amp decoders as 1s and 3.5 amp decoders as 3s for simplicity.

The fourth character tells you how many functions, including directional lights, are available on the decoder.

The fifth character is a Digitrax series designator. This is a number from 0-9. Series 1 Digitrax decoders have standard or configurable strobe function outputs. Series 2 decoders have FX function outputs, Scaleable Speed Stabilization (Back EMF) and Transponding™. Series 3 decoders with 6 functions have FX^3 function outputs, torque compensation, SuperSonic™ (silent operation), Scaleable Speed Stabilization (Back EMF) and Transponding™. Series 3 decoders with less than 6 functions have a modified set of features. See decoder descriptions for actual features embodied in each decoder.

Additional letters may be added to the decoder number to indicate which installation interface is used on the decoder. If the decoder number ends after the series number, then it is a wired decoder.

Designation	Installation Interface
Blank	Wired or Digitrax 9 Pin to Wires
W	Wired
D	Digitrax 9 Pin to Wires
IP	Integrated DCC Medium Plug
P	Digitrax 9 Pin to DCC Medium Plug Long 3.25" wire harness
PS	Digitrax 9 Pin to DCC Medium Plug Short 1" wire harness
AT	Digitrax 9 Pin to Athearn No Solder Harness for Standard Athearn Installations
AT	Athearn
K	Kato
A	Atlas
E	E-R Models
L	Life Like
L	Lionel AC Motors or DC Motors on 3 & 5 Amp Decoders Only
I	InterMountain

Manufacturer designations are followed by a design number, 0-9, and sub-design letter, a-z, when there is more than one version of a particular design.

Numbering Examples:

DH163 is a mobile decoder that fits in HO scale, is rated for at least 1 Amp & has 6 functions available. This decoder is actually rated at 1.5 Amps. This is a series 2 decoder.

DN121 is a mobile decoder that fits in N scale, is rated at 1 Amp & has 2 functions available with standard or configurable strobe functions. This is a Series 1 basic decoder.

DH163IP is a mobile decoder that fits HO scale, is rated for at least 1 Amp, has 6 functions available and uses the integrated DCC medium plug interface to plug into locos. This is a FX^3 decoder with FX^3, torque compensation, SuperSonic™ silent operation.

3.0 Decoder Installation

Decoder installation is not as difficult as you might think. Follow these simple steps carefully and you will be comfortable with the procedure in no time. Each Digitrax decoder comes with an instruction sheet that shows you the specifics of how to install it in a locomotive.

3.1   9 Steps For Successful Decoder Installation

1. Read the instructions FIRST and PLAN your installation. Have the proper tools on hand.
2. Choose a locomotive that runs well on regular DC.
3. Choose the appropriate decoder for your installation.
4. Test the decoder before installation.
5. Carefully disassemble the loco.
6. Isolate the motor!
7. Follow the decoder's wiring diagram or installation instructions.
8. Test the installation first on DC then on DCC. (If the lights are flashing the first time you apply power, remove the loco from the track and locate the short circuit in your installation.)
9. Customize your decoder by programming selected CVs.

3.1.1 Avoiding Heat Problems With Decoder Installations

Most HO, N & Z Scale model locomotive motors and lamps are designed by the locomotive manufacturers to operate at full speed at 12 volts DC on the track. Digitrax recommends running your DCC command station and boosters at the lowest track voltage possible that provides acceptable operation.The "N Scale (12V)" setting on Digitrax equipment works for most HO, N & Z scale layouts. Some DCC systems made by other companies supply more voltage to the track and are not adjustable. If the track voltage applied exceeds the operating parameters of the locomotive and its lamps, it is possible for overheating to damage your locomotive whether you use DC or DCC. For example, running an N Scale locomotive that was designed to run on 12-14 volts on a system that supplies 12 or more volts to the track may cause overheating and damage to the locomotive, its shell and your decoder.

3.2   Recommended Tools for Decoder Installation

You'll need a few simple tools when you begin installing decoders:

1. A soldering iron, preferably temperature controlled. Though many installations do not require soldering, you may still need to use a soldering iron to install extras like lamps for special lighting effects.
2. Solder.
3. A small screwdriver for disassembling your loco.
4. Small diagonal cutters for cutting & stripping small wire.
5. Tweezers to pick up small loco parts.
6. Heat shrink tubing for protecting wire connections, this is better than electrical tape.

7. Tape for securing wires and the decoder inside the locomotive.
8. Decoder installation should be done in a reasonably static free environment. We recommend that you do all installations on a non-metallic surface. Digitrax decoders are not overly sensitive to static electricity & with a little common sense, you won't have problems.

3.3　Choosing a Locomotive

Choose a locomotive that runs well on conventional DC power. Digital decoders cannot compensate for faulty motor operation, poor track pickup, etc. If you are not happy with the way your locomotive runs on regular DC power, installing a decoder will not make it run any better.

If there are any mechanical issues with your locomotive, fix them before you install the decoder. Since you have to open up the loco anyway, do a tune up to get it running really well before you put in the decoder. Digitrax recommends using a conductive brush lubricant like Aero Car Technology's "Conducta" brush lubricant to minimize brush noise in all locos. Be sure the brushes are making good contact and that the commutator is reasonably clean.

Decide where the decoder will fit inside the loco. Is there space to put the decoder or will you need to "make room?" Is there a plug 'n play decoder for the loco? Digitrax offers a variety of decoder sizes, form factors and current ratings to accommodate almost any locomotive. Decoders from other companies that make compatible DCC decoders may fit better in some of your locos, too. If there is just nowhere in the locomotive to install a decoder, you can run it on your Digitrax system as an analog locomotive on address "00."

3.4　Choosing The "Right" Decoder

4 Steps To Choosing the Right Decoder for Your Loco

1. Is there a plug 'n play decoder or other decoder made for your specific loco? Check www.digitrax.com for specific decoder recommendations for specific locomotives. If so, you can skip steps 2 & 3.
2. What is the stall current of the motor in the locomotive?
3. How much room do you have available inside the loco for installation?
4. Do you want a decoder that does more than motor control and headlights? Do you want special lighting effects (FX)? Do you want decoders with Scaleable Speed Stabilization (Back EMF) or Transponding™?

3.4.1　Is There a Plug 'N Play Decoder?

Digitrax maintains a list of decoder recommendations for specific locomotives on the web site www.digitrax.com. Most Digitrax authorized dealers can also

help you determine which decoder will work best in your locomotive. If you can't find a recommended decoder for your locomotive, then proceed to the steps outlined in 3.4.2 & 3.4.3.

3.4.2 What Is Your Loco's Stall Current?

For HO applications, most modern high efficiency can motors draw less than 1/2 Amp when running and less than 1 Amp when stalled at 12V DC. These motors are suitable for use with 1 Amp & 1.5 Amp decoders. Some older HO motor designs (older Athearn open frame motors, Pittman motors, etc.) may exceed these limits and you may need to use a higher current decoder in these applications for better long term reliability.

For N scale applications most modern high efficiency can motors draw less than 1/2 amp when running and less than 1 amp when stalled at 12V DC. However, we have found that many high performance N-scale locos actually draw more than this when properly tested. To ensure long-term reliability, Digitrax recommends that all N-scale decoders have a current rating of at least 1 amp. All current production Digitrax decoders are rated at 1 amp or more.

For large scale equipment, it is particularly important to test the specific loco you will use to determine the appropriate decoder to use. In many cases O, S, O-27 & G scale Digitrax 2 amp decoders will be just right. However, in other cases, especially where 2 motors are involved, Digitrax 3-5 amp decoders will be a better choice.

How to Determine The Stall Current Of A Locomotive

1. Place the loco (without the shell) on a track powered with regular DC at 12V for HO & N Scales (Use 16V for G Scale).
2. Attach a DC current meter (ammeter) in series with one of the track feeds. If you have one of the commercially available power packs that have an ammeter, it will work for this purpose.
3. Apply DC power to the track.
4. Stop the motor from rotating by holding the fly wheel or drive shafts for a couple of seconds and measure the current that the unit is drawing from the power pack while the motor is stalled.
5. Be sure that the power pack voltage remains at 12V (16V for G Scale) during this test to be sure you get an accurate stall current measurement.
6. Choose a decoder with at least the current rating determined with this test. Digitrax recommends using the decoder with the highest current rating that will fit in your locomotive to improve long term reliability.

3.4.3   Which Decoder Will Fit?

The space available inside the locomotive is a major factor in choosing which decoder to use for your installation. Many sizes & form factors are available.

For N scale, there are replacement frames available to simplify your installation in locos that don't have plug 'n play solutions. For milled N scale frames contact Aztec Manufacturing directly. For cast N scale frames, contact your local dealer for Southern Digital Frames.

For HO scale, there is the option of using N or Z scale decoders in tiny spaces as long as the current rating of the decoder is at least 1 amp.

The Digitrax web site, www.digitrax.com, has links to application notes for many different locomotives. Digitrax users have come up with some really creative decoder installations!

3.4.4   Other Decoder Functions and Features?

Once you have determined the current rating and decoder size needed for your loco, consider other things you want your decoder to do.

Functions are things like: lamps, sound units, smoke units, etc. All Digitrax decoders are equipped with two or more function outputs that are used to turn functions on and off.

Function outputs can be in the form of :
1. Leads (wires) attached to the decoder that are used to hook up external functions.
2. Pre-wired function outputs that hook up by just plugging in the decoder.
3. Solder pads on the decoder that allow you to solder wires to hook up functions to the decoder.

Some decoders have more than one form of function output. For example, the DN163K0a has two function outputs pre-wired to the white LEDs on the decoder and 4 additional solder pads available for adding wires to hook up more functions.

If you are planning to operate more functions in addition to headlight control you will need to use a decoder with more function outputs. For applications where you are using a sound module, you will want a decoder with at least 4 or 5 functions. Function only decoders, like the TL1, TF2 & TF4, are also available if you wish to add even more functions.

There are five types of functions available on Digitrax decoders:

Standard functions turn functions on and off. Digitrax decoders with standard functions offer head lights that can be set up to be either

automatically reversing or individually controllable.

Standard* functions turn functions on and off. These decoders offer automatically reversing head lights only.

Configurable strobe (CS) functions can be set up to run as simple on/off or as single or double pulse strobes.

FX functions incorporate generators for prototypical lighting effects, like Mars lights, ditch lights, Gyralites, random flicker, single & double pulse strobes, etc.

FX^3 functions incorporate FX generators with additional dynamic and static qualifiers. FX^3 functions are fully remappable so they can be controlled by any function key on your system. A master light switch can be set up to turn off all lights on a locomotive. Functions associated with advanced consists can be controlled, too.

Function outputs on Digitrax decoders are available in several current ratings depending on the decoder:

Function Current Rating	Application
125 mA	Typically in Z & N Scale decoders
200 mA	Typically in HO scale decoders
0.5 Amp	FX^3 decoders-N & HO
1.0 Amp	Typically in Large Scale decoders. On large scale decoders there is usually a combination of 200 mA & 1 Amp function outputs.

Scaleable Speed Stabilization (Back EMF): Some Digitrax decoders are equipped with this feature that lets you set up "cruise control" for your locomotives. This can be used to smooth out operation in the low end speed range, to run locos at the same speed no matter the track grade or to improve operation of steam loco mechanisms.

Torque Compensation for smooth as silk operation. This feature improves loco performance by adjusting for the loss of torque due to high frequency PWM associated with SuperSonic™ silent operation.

SuperSonic™ motor drive for silent operation. Digitrax SuperSonic™ is Transponding™ compatible and does not have to be switched off when transponding is in use on the layout.

Transponding™ This decoder feature let's you determine the zone location of

a specific transponder equipped loco on a layout that is equipped with transponder detectors. This feature is integrated in some Digitrax decoders. If your decoder does not have an integrated transponder, you can add a stand alone transponder to the locomotive later if desired. Transponders can also be added to rolling stock that does not have a DCC decoder. Digitrax transponding does not require any additional modifications or inductors to be added to your locos, rolling stock or system boosters

Multi-Format: This decoder feature let's you run your loco on other digital format layouts. The decoder automatically detects whether it is receiving DCC, Motorola Trinary or Analog commands and responds to the appropriate commands. This feature is very popular in Europe where many different digital command control formats are used.

3.5   LT1 LocoNet Cable & Decoder Tester

Once you have chosen the decoder you will use for your installation, Digitrax recommends that you test it before installation. The test procedure will familiarize you with how the decoder works and how to hook up the wires. Testing gives you verification that the decoder is working before you install it. Decoders leave the factory fully tested and ready to go, but it is always comforting to be sure they work as advertised before installing a decoder in your locomotive. This is especially true for anxious first time installers!

Use the LT1 that came with your Digitrax Starter Set to perform the test. There are other commercially available decoder testers made by third party manufacturers.

Digitrax will gladly repair or exchange any decoder that you are not convinced works correctly after performing the test procedure outlined. If there is a problem, please call or e-mail for technical assistance before returning the decoder for repair. Many times problems can be solved by phone. Do not install any decoder that does not pass this test.
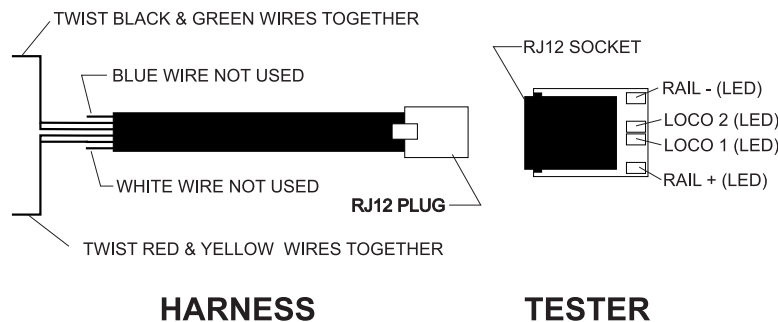
HARNESS   **TESTER**

LT1 LocoNet Cable Testing Instructions

1) Disconnect the harness from the LT1.
2) Plug one end of the cable being tested into the LT1.
3) Connect the other end to any Digitrax Booster LocoNet Connection Jack A or B. **Be sure you have at least one Digitrax throttle connected to LocoNet.**
4) All four LEDs on the LT1 will light if the cable is good. LEDs may not all have the same brightness, this is normal.
5) If any of the LEDs fail to light, remove the plug from the end of the cable and crimp on another plug and re-test.
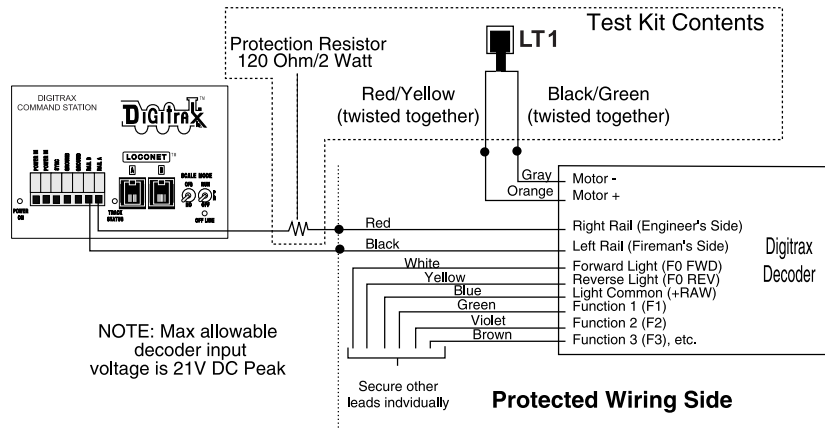
LT1 Decoder Testing Instructions

1. Strip the insulation from the red, green, black, and yellow wires. The blue and white wires are not used and may be cut off the harness.
2. Twist the red and yellow wires together. Twist the black and green wires together. (see above)
3. Hook up decoder as shown here.
4. Use your throttle to select the decoder and run it in the forward direction.
5. One of the two center LEDs will light as the motor voltage increases from the decoder. Change direction and the other LED will light.
6. Test the other decoder function outputs by connecting the LT1 to the blue decoder common and one of the function outputs.
7. Use your throttle to turn the function on and off . One of the two center LEDs will go on and off with the function. Do this test for all function outputs separately.

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3.6   Locomotive Disassembly

Each Digitrax decoder comes with an instruction card. Before you begin your installation, be sure to read the specific instructions that came in your decoder package in addition to reading this manual.

1. Disassemble your loco carefully.
2. Note how + and - motor connections & the left & right power pick up connections are set up.
3. Look carefully at the loco's wiring & determine where all the wires go and what they do before changing or disconnecting any of them.

The physical location of the decoder in the loco is important and may involve sculpting plastic and or metal parts to allow enough room for installation.

Install the decoder in the coolest part of the loco body. Recommended operating temperatures should be between 70 & 120 degrees Fahrenheit (20-50 degrees Celsius). The decoders will provide more power to your motors if they are installed away from heat sources inside the locomotive body, e.g., motors and lamps.

When making wire connections inside the loco, use the shortest length of wire that will do the job. After the wires are attached and insulated with heat shrink sleeving, secure them so that repeated removal and replacement of the locomotive shell won't pull the wires loose.

The biggest cause of decoder failure after initial installation is wires being pulled loose and shorted to the frame when the shell is removed or replaced.

3.7   Isolate the Motor

For DC permanent magnet powered locomotives, the decoder must be electrically inserted between the track power pickups and the 2 motor brushes.

The most important part of any successful locomotive conversion is proper electrical isolation of the 2 motor brush connections, so that they are driven only by the decoder. *Failure to isolate the motor will damage your decoder. Damage caused by failure to isolate the motor is specifically excluded from the warranty.*

Once you have the motor isolated, visually inspect the brushes again, just to be sure. Use a reliable continuity checker (beeper box) to be sure there is an OPEN circuit (very high resistance) from both brushes to any other part of the locomotive chassis or power pickups and wheels. Check both motor brushes. If

the circuit is not open, your beeper box will beep.

Only when you are satisfied that the motor is isolated, should you proceed with the decoder installation.

Some motor brush power connections may be tricky, like a spring to or interference fit with part of the chassis. Some locos pick up brush power from the chassis through a spring. In this case, after removing the spring connection to the brush, wire the corresponding decoder power input to the chassis. Examine the loco carefully to determine how power moves from the track pickups to the motor.

Decoders with FX^3 functions have motor isolation protection. If the decoder senses that the motor is not isolated, it will not run the motor. In this case, you will be able to control the loco's functions but the motor will not work.

Decoders with FX functions will blink the loco's lights when power is first applied to the decoder to warn you of a short circuit in your installation. If you see the lights blinking, immediately remove the loco from the track, locate the short circuit and correct the problem before proceeding. Do not leave the loco on the track with blinking lights because eventually, the decoder will become overloaded and be damaged. If a short occurs after initial installation, the lights will not blink so, it is important to secure the leads inside the loco once the installation is complete to prevent them from coming loose during normal operation and creating a short. For board decoders, it is important to follow the instructions for installing insulating tape inside the loco to prevent shorts during operation caused by the decoder board shifting inside the engine.

3.8   Decoder Interfaces

3.8.1   Plug 'N Play Interfaces

Many locomotives come from the factory with provisions for easy decoder installation. You can even buy some locomotives that are decoder equipped! Manufacturers use several terms for these locos.

DCC Ready Locomotives: These locomotives are usually equipped with a DCC medium socket, though you may find some locos where this terminology means that there is room for a decoder. Be sure to check this before purchasing the loco.
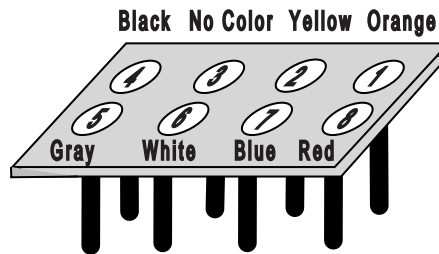
DCC Medium Socket: This diagram shows the DCC medium plug that is widely used with HO locomotives that come from the manufacturer with the DCC medium socket. The color code refers to the wire colors on a DCC wire harness. To install a decoder in a loco with a DCC medium socket, remove the dummy plug that comes with the locomotive and insert a decoder with a DCC medium plug in the socket.

Digitrax 9 Pin: The Digitrax 9 pin socket & plug is another commonly used DCC plug 'n play interface that is available in some HO locos.

Plug 'N Play Locomotives and Decoders: In this case specific decoders are designed for specific locomotives. Plug 'N Play installations require you to remove an existing circuit board and replace it with a plug 'n play decoder.

Solderless Decoder Installations: Solderless installations are the answer in some cases where the loco does not come with a circuit board, like Athearn standard locos. In these locos, a special harness is used with your decoder. To do this kind of installation, simply remove and reinstall clips at several locations inside the locomotive.

Decoder Equipped Locomotives: These locomotives are equipped with decoders at the factory. These pre-installed decoders generally have minimal features. If you want additional features, you may wish to replace the decoder that came with a loco with one that has more features. In some cases you have the option to purchase a loco with or without a decoder. You should evaluate the features offered before deciding which one best fits your needs. All DCC compatible decoders shipped with locomotives should work with your Digitrax system.

3.8.2 Digitrax 9 Pin HO Decoder Interface

Most Digitrax HO scale wired decoders come with a plug and socket on the decoder so that the wires can be unplugged from the decoder. This interface lets you share one or more decoders among multiple locomotives wired with Digitrax 9 pin harnesses. DHWH is the wire harness with a plug that attaches

to your DH series decoders and 9 wires that are soldered to the motor, brushes and functions on your locomotive. DHDP is a DC dummy plug available for DC operation of harnessed locomotives (without decoders). When you install a DHWH wire harness in your locomotive and plug a DHDP dummy plug into it, your loco will operate on any analog control system. When you remove the DHDP and plug in a decoder, the loco will run on DCC. The Digitrax 9 pin interface gives you a cost effective way for clubs and large layouts to share the decoders they have and run with Digitrax even if all locos can't be converted right away.

The DHWHP wire harness has a Digitrax 9 pin plug on one end and DCC medium plug on the other end. DHWHPS is the same with shorter wires. DHAT is a wire harness with Digitrax 9 pin on one end and clips for solderless installation in a standard Athearn diesel locomotive.

To separate a Digitrax decoder from the Wire Harness:

Firmly pinch all 9 wires between thumb and forefinger about 5/8" back from the plug. Grasp the decoder body on the sides right next to the socket to ensure no stresses are placed on components under the protective sleeve. Pull gently and evenly on all 9 wires simultaneously. It is important to distribute the force needed to separate the plug and socket EVENLY over all the wires to prevent damaging the plug by pulling a single wire out of the plug. It is easier to remove the plug if you gently rock it from side-to-side. After the first few times you connect and disconnect the plug, it will be easier to do. Be sure to keep the plug and socket free of dirt and debris.

3.8.3 Installing Decoders with Wires

In some cases, especially in older locomotives, brass locomotives and really tiny locomotives, there is no easy way to install decoder available. In these cases, you must install a decoder with wires. Refer to **TABLE I** and *Figure 1* and the specific instruction card that came with your decoder along with these instructions. Each decoder is equipped with the wires necessary to provide the functions available for that particular decoder. All decoders <u>do not</u> have all the wires described here. See *Figure 2* for lamp installation information.

TABLE I: Digitrax Mobile Decoder Wire Colors

What the wires are for	Wire Color
Power Pick-up Right (Engineer's Side)	Red
Power Pick-up Left (Fireman's Side)	Black
Motor + Right Brush	Orange
Motor – Left Brush	Gray
F0(Fwd)-Forward Light	White
F0(Rev)-Reverse Light	Yellow
Lamp Common	Blue
F1-Function 1	Green
F2-Function 2	Violet
F3-Function 3	Brown
F4-Function 4	White w/ Yellow Stripe
F5-Function 5	White w/ Green Stripe
F6-Function 6	White w/ Blue Stripe

Figure 1: Digitrax Decoder Wiring Diagram
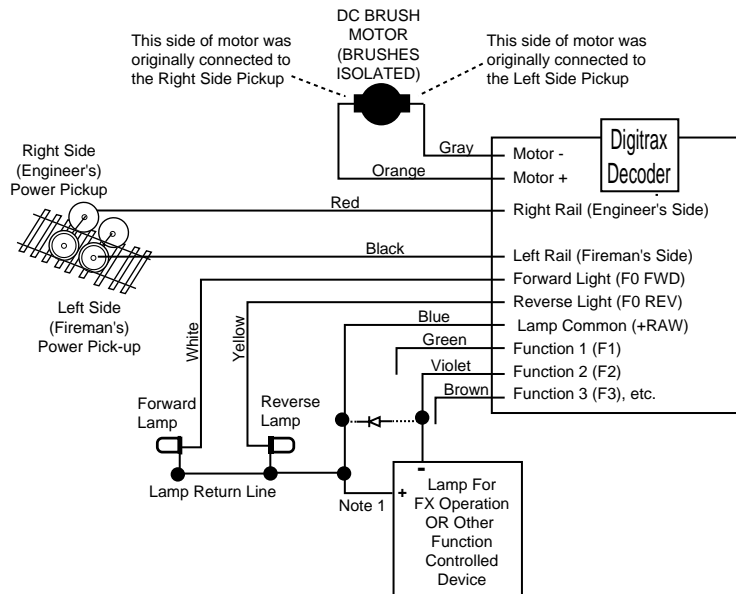
Figure 1 Notes:

Do not exceed the decoder's total function output current rating. If lamp common is not used, connect function power to either track power pick up. The directional light function "Lamp Return Line" can be hooked to lamp common as shown or to either track pick-up.

See *Figure 2: Lamp Wiring Specifics* for details of wiring 12-16V lamps, 1.5V lamps and LEDs for use with and without the lamp common wire.

Figure 2: Lamp Wiring Specifics

Operation with Lamp Common Connected

Lamp brightness won't be affected by operation of analog locos on the layout. This is the preferred wiring method but, in some locomotives (particularly in N-Scale and smaller HO units) it may not be convenient to wire the lights with lamp common.

Operation without Lamp Common Connected

Lamp brightness will change depending on the direction of the analog locomotive being operated on the layout. If you don't run analog engines on your layout, you won't notice any difference between these two ways of connecting the lights.

12V to 16V Lamps

Lamp Common Blue

Forward Lamp White

Reverse Lamp Yellow

Right Rail Pickup

Left Rail Pickup

Forward Lamp White

Reverse Lamp Yellow

1.5V Lamps

Lamp Common Blue

Forward Lamp White

Reverse Lamp Yellow

Right Rail Pickup

Left Rail Pickup

Forward Lamp White

Reverse Lamp Yellow
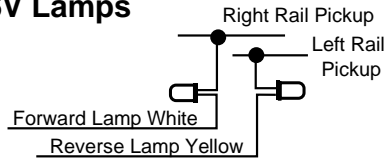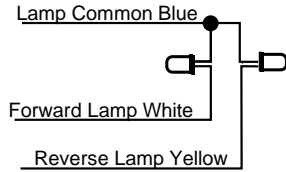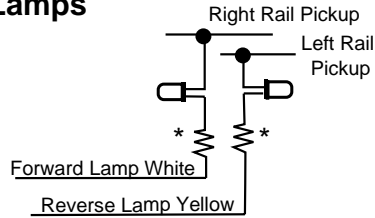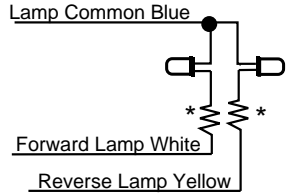
*Note: Current setting resistor to suit the lamp used. Typically 560 ohm 1/4 watt for grain of rice and 250 ohm 1/4 watt for grain of wheat. Lower resistance values will increase the lamp brightness, minimum value is 100 ohms.

LEDs

Lamp Common Blue

LED Cathode End

LED Cathode End

Forward Lamp White

Reverse Lamp Yellow

Right Rail Pickup

Left Rail Pickup

LED Cathode End

LED Cathode End

Forward Lamp White

Reverse Lamp Yellow
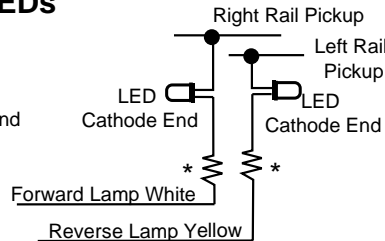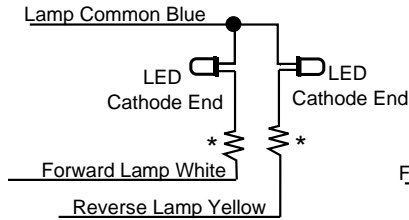
* Note: LEDs are sensitive to polarity when hooked up. Typical resistor 680 ohm 1/4 watt.

Transponder equipped decoders must be hooked up with lamp common connected for proper operation.

3.9 Installing Lighting Effects

Adding lights to your locomotives can bring an added degree of realism but there are a few things to consider.

Headlight and Rear Light Operation

Automatic headlight reversing: All Digitrax decoders are shipped with automatic reversing headlight operation as the default mode of operation.

Manual headlight operation: If you do not want automatic reversing headlight operation most Digitrax decoders can be set up so that the white lead (forward light) operates on F0 (Function 0) and the yellow lead (reverse light) operates on F4 (function 4) by programming CV61 to a value of 01 (or 03 if Transponding™ is also enabled).

FX & FX³ light operation: If you are using a decoder with FX functions refer to the Section 6.10 for details how to program the different FX effects.

Additional Lamp and Function Wiring Considerations

Lamps with current draw over 50 mA: For regular 12 to 16 Volt lamps that draw more than 50 mA when lit, we recommend that you put a 22 to 33 ohm 1/4 watt resistor in series with the lamp leads. This will ensure that the lamp "start-up currents" (which can be up to 10 times normal current draw) do not overload the outputs.

For decoders with FX³ functions, if you can control the functions but not the motor, this indicates that the motor is not properly isolated from the frame. Once you correct the problem, the decoder will work normally

For decoders with FX functions, the first time you apply power to a Digitrax decoder equipped loco, if the lights blink on and off, there is a short in the installation! Remove the loco from the track immediately. Review the wiring and correct the short before continuing with the installation.

Loco with only one lamp: If the locomotive has only one lamp, connect both directional light outputs (white & yellow) together. In this case the single light will be on if the F0, the light function, is turned ON.

Connecting additional function outputs: Connect F1-F6, the other function outputs to the functions you wish to control. Be sure not to exceed the total output current rating of the function outputs for the decoder you are using (125 mA for DZ & DN series & 200 mA for DH series and 1 Amp for DG series).

Transponder equipped decoders: When you install a wired transponder equipped decoder, you should also install a load resistor of between 270 ohms & 470 ohms between the blue and white decoder leads to ensure proper transponding operation. You may see a slight glow even when the forward light is turned off because of the way transponding works. See Section 6.15 for more information.

3.10   Final Decoder Test

Once the decoder is installed, you are ready for the test track.

For decoders with FX functions, if you notice the loco's lights flashing on and off when you first power up the loco, remove it from the track immediately. When the loco's lights flash at power on, it is an indication of a short circuit in the decoder installation which must be corrected before proceeding.

For decoders with FX^3 functions, if you are able to control the loco's lights but the motor will not run, this is also an indication of a motor short circuit that must be corrected.

1. Run your Digitrax decoder equipped locomotive on a regular DC track with the positive polarity connected to the right side wheels. The Digitrax decoder in the locomotive will recognize that it is not receiving DCC commands and automatically convert to analog mode.
2. Using your throttle, command the loco to move forward. If the loco moves in reverse, the input power feeds to the decoder are reversed. Power down, swap the decoder power input connections (red & black leads) and try again.
3. Next, run the decoder equipped loco with your Digitrax system. Follow the instructions in your Digitrax Starter Set manual to select and run the locomotive. Operate any other functions installed to be sure they can be turned on and off. Since you have not programmed the decoder yet, the decoder will use the factory default settings.

4. The decoder's address is set to 03, the headlights are set up to be auto-matically reversing and all other variables are set up so that the loco will run with no acceleration or deceleration.

5. If any problems are observed check your wiring and re-test.

4.0 Troubleshooting

4.1   The decoder won't respond

Is the loco on powered track? If the throttle is indicating that track power is off, turn track power on. For DT100, DT200 & DT300 press RUN/STOP and the + UP ARROW key to turn on track power. For DT400 press PWR followed by the Y+ Key to turn track power on.

Can you select the loco on your throttle? If not, the loco may be use by another throttle or it may be part of a consist (do you see a cn in the display when you try to select it). You will need to release the loco from other throttles or remove it from the consist to be able to run it on your throttle.

Do the settings in CV29, the configuration register, match the command station output? If your decoder is a 14 step decoder running on a system that is sending 28/128 speed step commands, status editing will be needed to make the commands sent by the system match what the decoder is expecting.

Have you reset any CVs since the last time you ran the loco? If so, go back and change them to their default values and then try to run the loco. It is possible to set acceleration so high that it will take 10 minutes for the loco to start moving.

Does your throttle say 'xFF' or "slot=max"? This means that the system's capacity to handle operating locos is full. The DCS50 that comes with the Zephyr can run up to 10 locos. The DB150 that comes with Super Empire Builder can run up to 22 addresses at the same time. The DCS100 that comes with Super Chief Sets can handle up to 120 addresses at the same time. The DCS100 is set for 22 addresses at the factory, consult your Super Chief Manual for information on changing this to 120 if you are exceeding the limit often during operations. If you have the FF or slot=max message, be sure that all locos that are not running are released from throttles.

During decoder programming, the FF or slot=max message may also be displayed if the loco you are trying to program has too many

loads attached. If this is the case, you need to remove some of the extra loads to allow the decoder to be programmed. This happens most often with locos that have many lamps installed or where the lamps are wired directly to the track pickups.

Was the loco running and then suddenly stopped? If the decoder is very warm it may be in thermal shutdown. Let it cool off and see if it starts again. Also check for localized track problems.

Are there burn marks on the decoder? You'll need to send it in for repair!

Is this the first time you powered up the decoder after installation? If it is a decoder with FX functions, are the lights flashing? If so, remove the loco from the track immediately and check your installation for motor isolation and short circuits.

Is this the first time you powered up the decoder after installation? If it is an FX^3 decoder, can you control the functions but not the motor? If so, remove the loco from the track and check your installation for motor isolation or short circuit problems.

If all else fails, reprogram the decoder's address
and reset CVs to default values.

4.2 The decoder runs for a while & then just stops

The decoder may be overheating. Is the decoder very warm to the touch? It is normal for decoders to warm up while in use but they should not be hot to the touch. Be sure the decoder is installed so that it can shed heat. Don't put decoders near the motor or lights.

4.3 Loco operation is jerky & erratic

Is the track clean and are the power feeds reliable? Are the locomotive wheel pickups and internal electrical connections reliable? The majority of intermittent operation faults can be traced to bad connections and poor or noisy wheel pickups on locomotives. Check track cleanliness and quality of wheel pickups.

4.4 "Strange" locomotive light operation

If you can't control the operation of the lights in your locomotive with your throttle (in default 128, or 28 speed step mode), be sure that the decoder is programmed for advanced 28 speed step mode. Your Digitrax decoder was shipped programmed to 128 speed step mode. You may have changed your decoder's programming when performing the decoder test procedure. In any case, if you are not able to turn the locomotives lights on and off, you will need

to change CV 29 to 006/x06 to have proper light operation when using your Digitrax system in its optimum 128 speed step mode. Do this by programming CV29 with a value of 006/x06 (See Section 6.2 for more information about CV29.)

If you can't turn the lights on and off or the lights blink when you run the loco, this is symptomatic of a Standard (14 speed step operation) decoder trying to process 28 speed step Advanced packets. Be sure that the decoder and command station are using the same mode by reprogramming the decoder or by changing the command station's operating mode.

4.5   The locomotive won't move at all

Does the locomotive have any mechanical binding problems?   Are any wires shorting or touching moving parts? We have had several locos in for service that actually had tape on the moving parts that prevented the engines from moving and nothing was wrong with the decoders.

When you are operating a Digitrax Command Station set up to run in 128 speed step mode, there are some decoders that only understand 14 speed step mode. If you are using one of these non-Digitrax decoders, you will need to status edit the decoder so that it will run.

4.6   Locomotive "buzzes"

Most noisy locomotive issues are caused by vibrations inside the loco's mechanism. For DCC equipped locos, try lubricating the locomotive's brushes and tuning up the loco's mechanism.

Analog locos (without DCC decoders) make a "singing" sound when sitting still on DCC layouts. This noise decreases as the analog loco is accelerated. The noise is caused by the DCC track signal. You can significantly reduce this noise by using conductive brush lubricants and by assuring that there is no vibration inside the loco that will add to the noise generated. When operating analog locos on DCC layouts, it is best to park them off the live track unless they are running. This will prevent heat build up, minimize the humming noise and lessen stress on the motors.

4.7   The Quarter Trick

If your track does not have adequate power supply to the locomotives, then the DCC signal won't get through either. Take a quarter or screwdriver blade and go around your layout creating electrical shorts every 10 feet. Your DB150 should beep and shutdown when the short is present. When the short is removed, the booster should return to normal operation. If this does not happen, then you need to add more feeders.

4.8   The LT1 tester

Check your LocoNet cables with the LT1 tester to be sure the cables are good. See Section 3.5 for complete instructions.

4.9   Getting Help

If you have installed a decoder, read the manual and still just can't seem to get it to work the way you think it should, let us know! Often your local Digitrax dealer will be able to help you work out any problems you may encounter. If not, please contact Digitrax directly. Our support staff is available Monday through Friday to help you with your questions. You can call (770) 441-7992, fax (770) 441-0759 or e-mail tech-support@digitrax.com. We also maintain a web site, www.digitrax.com, that has the answers to many commonly asked questions. So, don't suffer in silence! There is no such thing as a "dumb question!"

5.0   Decoder Programming

5.1   What are CVs?

Your Digitrax Decoder has many different configuration variables, or CVs, that let you set up many different operating characteristics for each decoder installed in each locomotive to give you prototypical operation.

Each CV controls an operating characteristic of the decoder based on the CV value that you program for the CV. You can pick and choose from among the CVs and program each one independently or you can use the default CV values that are pre-programmed at the factory. Once these CV values are programmed, they are "remembered" in the decoder until you reprogram it with a new value. Before you start programming your decoders, it's a good idea to run your decoders with the default values that come pre-programmed from the factory. This will let you get used to using DCC before you begin customizing. In many cases, you will find that you only need to change the address of the locomotive to have great operation. If you decide to use deceleration, in particular, keep the programmed CV values small so that you have time to adapt to the delays in deceleration you have set up without crashing your valuable locomotives!

5.2   Programming Modes: Paged, Physical Register, Direct & Ops

Digitrax systems default to the "paged" programming method. Paged programming is the most commonly used programming method and is the Digitrax preferred method for programming.

Genesis II, using a UT2 & DB150, supports paged programming exclusively. The UT2 throttle can program CVs 01-99 to values of 000-099. **All UT2 programming is done with decimal values. See Appendix B.**

Zephyr, Super Empire Builder, & Super Chief let you choose from paged, physical register or direct programming methods. This gives you maximum flexibility to program all DCC decoders. You can also access operations mode

programming which lets you program decoders that support this feature while the locomotive is on the mainline without having to put them on the programming track. **DT300 & DT400 series throttles can use either decimal or hexadecimal values for programming. See Appendix B.**

DT100 programming is done with modified hexadecimal numbers for selecting CV#s and hexadecimal values for entering CV Values. See Appendix B.

Note: You can program the decoder address with Ops mode programming with the DT300 & DT400 series throttles. DT100 series throttles cannot program the address with Ops mode programming.

Physical register mode is a very basic and somewhat limited mode for programming decoders. With "register mode" you can program CVs 01, 02, 03, 04 & 29 only. Paged and direct programming give access to all CVs and appear very similar to the user. They are just two different methods for programming. All of these methods are included in the DCC industry standards.

DCC compatible command stations made by different DCC manufacturers handle programming in many different ways. The NMRA's "Standards and RPs", which are a small part of the DCC industry standards, allow for several different programming modes. All of these may or may not be supported by your command station or programmer. For the specifics and mechanics of programming with your system, please check your command station or programmer manual.

5.3   DCC Outputs For Programming & Train Operation

The DB150 that comes with Super Empire Builder, has one DCC output that is used both to run the trains and to program decoders. For this kind of command station, you will have to shutdown layout operations to program. Both the DCS100 that comes with the Super Chief and the DCS50 that comes with Zephyr have two DCC outputs. This means that you can program and read back decoders without having to shut down the layout. Both single and dual DCC output systems require a programming track.

5.4   Reading & Writing CVs

The DB150 Command Station has a "write only programmer," it will program CVs to the values you choose. DB150 will not read back CVs and their values programmed into your decoders.

The DCS100 & DCS50 Command Stations are "read/write programmers," they can program decoders and read back their CVs and values.

Another programming option is to use a PR1 programmer and your computer to program and read back decoders. Other DCC compatible programmers are able to program Digitrax decoders as well. Consult the manual for the system you are using for complete programming instructions.

Digitrax FX^3 decoders have operations mode readback capabilities when used on layouts instrumented for this feature.

Note: According to NMRA "RP 9.2.3" you are "required" to use a low power setting for all decoder programming. Digitrax recommends that you use low power programming for initial decoder tests prior to installation in the locomotive. Digitrax does not feel that it is necessary to use a low power setting for decoder programming once you have successfully installed the decoder in the locomotive. If you are reprogramming an installed decoder, feel free to follow the steps presented here. If you wish to use a low power setting for decoder programming, please see the decoder initial test procedures which detail the use of a protection resistor to provide a low power programming option.

6.0 Configuration Variables

As discussed in Section 5.1, Configuration Variables or CVs are special storage locations or "pigeonholes" in the decoders. By programming CV values into CVs you can customize each decoder's performance characteristics. These characteristics are permanently "remembered" by the decoder even when the power is off! The CVs you program can be changed as often as you like. The meaning of most CVs is defined by RP 9.2.2. There are also some manufacturer specific CVs that are defined by each manufacturer to accommodate their own special features.

At first glance, you will see that there are many different CVs. This may seem confusing but, don't worry, Digitrax decoders are shipped with a set of pre-programmed factory default values that let you get up and running right away. As you begin to explore the possibilities with DCC, you will probably reprogram CV01, the decoder's address. This lets you run more than one locomotive at a time. You may need to make changes to CV29, the "configuration" CV to make your lights operate correctly. Next you may decide to set up acceleration (CV03) and deceleration (CV04) or you may wish to set up your FX options using CVs 49 through 63 As you explore more of the capabilities of your decoder and system refer to **TABLE II** as a guide.

Table II CVs Used by Digitrax Decoders

CV #	Used For	Found in	Default Value
CV01	Address	All	003/x03
CV02	Start Voltage	All	000/x00
CV03	Acceleration Rate	All	000/x00
CV04	Deceleration Rate	All	000/x00
CV05	Maximum Voltage	Gen 4+	000/x00 Max
CV06	Mid Point Voltage	All	000/x00
CV07	Version ID	All	variable
CV08	Manufacturer ID CV Factory Reset	All FX[3]	129/x81 008/x08 reset 009/x09 reset leave speed tables
CV13	DC Functions On Not available on FX [3]	FX	000/x00
CV17	4 Digit Address Hi Byte	FX	000/x00
CV18	4 Digit Address Lo Byte	FX	000/x00
CV19	Advanced Consist Address	FX	000/x00
CV21	Advanced Consist Functions F1 -F8	FX[3]	255/xFF
CV22	Advanced Consist Function F0, F9 - F12	FX[3]	063/x3F
CV29	Configuration Register: 14/28 speed step operation, analog operation, set normal direction of travel, & enable/disable speed tables	All	006/x06
CV33	Function(s) controlled by F0F	FX[3]	001/x01
CV34	Function(s) controlled by F0R	FX[3]	002/x02
CV35	Function(s) controlled by F1	FX[3]	004/x04
CV36	Function(s) controlled by F2	FX[3]	008/x08
CV37	Function(s) controlled by F3	FX[3]	016/x10
CV38	Function(s) controlled by F4	FX[3]	004/x04
CV39	Function(s) controlled by F5	FX[3]	008/x08
CV40	Function(s) controlled by F6	FX[3]	016/x10
CV41	Function(s) controlled by F7	FX[3]	032/x20
CV42	Function(s) controlled by F8	FX[3]	064/x40
CV43	Function(s) controlled by F9	FX[3]	016/x10
CV44	Function(s) controlled by F10	FX[3]	032/x20
CV45	Function(s) controlled by F11	FX[3]	064/x40
CV46	Function(s) controlled by F12	FX[3]	128/x80
CV49	Forward Light Effect, F0F	FX	000/x00
CV50	Reverse Light Effect F0R	FX	000/x00

Table II CVs Used by Digitrax Decoders (Continued)

CV	Description	Type	Default
CV51	Function 1 Effect	FX	000/x00
CV52	Function 2 Effect	FX	000/x00
CV53	Function 3 Effect (Use CV 113 for F3 Effect with FX [3]) Not used in FX [3]	FX FX[3]	000/x00 000/x00
CV54	Function 4 Effect (Use CV 114 for F4 Effect with FX [3]) Torque Comp/Switch Speed	FX FX[3]	000/x00 000/x00
CV55	Static compensation for scaleable speed stabilization	LX	000/x00
CV56	Dynamic compensation for scaleable speed stabilization	LX	000/x00
CV57	Intensity-scaleable speed stabilization	LX FX[3]	000/x00 006/x06
CV61	Directional Headlight, Transponding & Split Field Motor Set-ups	Gen 4+	000/x00 or 002/x02
CV62	FX Rate and Keep alive adjust	FX	000/x00
CV63	Ditch Light Blink hold time	FX	000/x00
CV65	Kick Start value	All	000/x00
CV66	Forward Trim	All	
CV67	First Speed Table Entry	All	
CV68-CV93	Speed table values	All	
CV94	Maximum Speed table step	All	
CV95	Reverse Trim	All	
CV105	User Private ID #1	All	
CV106	User Private ID #2	All	
CV113	Function 3 Effect	FX[3]	000/x00
CV114	Function 4 Effect	FX[3]	000/x00
CV115	Function 5 Effect	FX[3]	000/x00
CV116	Function 6 Effect	FX[3]	000/x00

6.1 Decoder Addresses

The decoder's address is the identification number programmed into specific decoder that lets that decoder recognize commands sent to it by the command station. Once you program the decoder's address, it will be remembered in the decoder until you re-program it.

Decoders can be set up with both 2 digit and 4 digit addresses but only one or the other will be in use at any time.

You can change the decoder address by reprogramming it at any time so, you can set up any numbering scheme you choose for your locos. Many people assign the last two numbers of the loco's road number as the decoder address. You can program more than one loco to the same address. This is useful if you want to set up a basic consist and run several locos on a single address.

The Range of Digital Addresses

Address "00" is reserved for analog operation. All Digitrax command stations give you easy access to analog operation so you can run a locomotive without a decoder on the same track where you run your DCC equipped locos.

Addresses from 001 to 127 (In hex, that's x01-x99 for addresses 01-99 and xA0-xC7 for addresses 100-127) are the two digit address range. All Digitrax decoders have two digit address capability.

Addresses from 0128 to 9983 are the four digit address range. All current production Digitrax decoders also offer four digit address capability.

Two digit decoder addresses are set up by programming CV01 & CV29. Four digit decoder addresses are set up by programming CV17, CV18 & CV29.

6.1.1 Decoder 2 Digit Address: CV01

The 2 digit address is the short identification number for a specific decoder. It is programmed in CV01. When you access CV01 with DT100 throttles, the display will show "Ad", instead of "01" when you dial up CV01 to program the 2 digit address. Ad stands for Address. Simply dial in the address number you want to program complete the programming sequence described in your starter set manual.

```
Ad2=???
CVNo P6 dAt
```
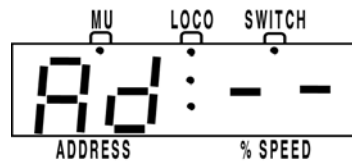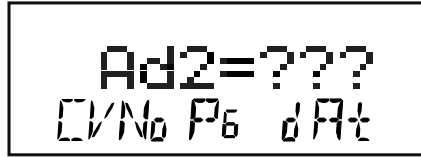
On your DT300 & DT400 throttles, the display will show Ad2 for two digit addresses and Ad4 for four digit addresses. All other CVs are displayed as numbers on Digitrax throttles. Be sure that CV29 is programmed to a value that has either "0" or "1" as the first digit to enable 2 digit addressing. See CV29 below for more information.

6.1.2   Decoder 4 Digit Address: CV17 & CV18

The 4 digit address is the long address for a specific decoder. It is programmed in CV17 & CV18. CV18 is the first two digits and CV17 is the second two digits of the address. Simply programming CV17 & CV18 will not enable 4 digit addressing. The DCS50, DB150 & DCS100 Command Stations that come with Zephyr, Super Empire Builder and Super Chief Sets provide automated programming that makes this process simple. See the starter set manuals for step by step instructions for setting up and enabling 4 digit addresses in your decoders.

6.2   Configuration Register: CV29

6.2.1   Characteristics Controlled by CV29

Configuration Variable 29 (CV29 for short) is a very special CV. The value entered for this CV controls several things:
1. 2 digit addressing or 4 digit addressing (as described above
2. Normal Direction of Travel (NDOT)
3. Speed step control: Advanced Mode (28/128 speed steps) or Standard Mode (14 speed steps)
4. Analog mode conversion On or Off
5. Speed table On or Off

The **Normal Direction of Travel, or NDOT** for short, lets you set up your locos to run either long hood forward or short hood forward. Because with DCC the decoder determines which way the loco will move independent of track polarity, you can set up either direction as forward depending on the prototype. (Not all decoders have this feature so be sure to check the card that came with your decoder.)

There are two modes for speed step control: **Standard or 14 speed step mode** and **Advanced or 28/128 speed step control**.

Because of differences in the capabilities of DCC compatible command stations and decoders, you may have to set CV29 in your decoders to different values to match the mode of the command station you are using. If your command station is sending standard 14 speed step mode commands, your decoders

must be programmed for standard mode in CV29. If your command station is sending advanced 28/128 speed step commands, your decoders must be programmed for advanced mode in CV29. All Digitrax decoders are 128 speed step capable and we recommend that for best performance you run them in 128 speed step mode. If you are using non-Digitrax decoders that are not able to be programmed for advanced mode and you want to run your command station in advanced mode, you can "status edit" the standard decoders so that they can be run with your command station. See your starter set manual for the specifics of status editing.

The **analog mode conversion** feature is very convenient if you plan to run your Digitrax decoded locomotive on regular DC layouts. With analog mode conversion enabled, the decoder will automatically begin operating as a DC locomotive when no DCC signal is detected by the decoder. This means that if you place your Digitrax decoder equipped loco, with analog mode conversion enabled, on a regular DC layout, it will run on the DC layout. Disabling analog mode conversion can be useful too as the following example illustrates:

Brake Generator Example: If you disable the analog mode conversion feature in a decoder, when DC power is present the locomotive will stop. This gives you a very inexpensive way of generating a "brake section" for stopping DCC locomotives in front of red signals. By NOT allowing analog conversion in the decoder, a relay can supply DC voltage to a track section in front of a red signal to slow and stop a locomotive in the brake section. When the signal turns green, the relay can restore the DCC track signal, and the locomotive will restart. The decoder will slow to a stop and restart at its programmed deceleration and acceleration values. In addition, if you are using a decoder with FX functions with CV13 programmed to keep functions running on DC, the loco's lights and functions will remain active when stopped on the DC brake section as long as DC power is supplied to the track while the loco is stopped!

You can use your DCS100's second DCC output to set up a braking section. See our website www.digitrax.com application notes and technical information page for instructions for setting up a braking section with DCS100.

Loadable speed tables can be enabled or disabled with CV29. Speed tables are used to customize the throttle response curve of each decoder equipped locomotive. The speed table values can be stored in the decoder and then the table can be turned on or off with CV29. See the section on CVs 65-93 below for a complete description of how speed tables work.

6.2.2   Determining CV Value To Program Into CV29
The value you will program into CV29 will affect many important decoder characteristics. Each of these characteristics is controlled by a "software switch." This switch is either on or off depending on the CV value pro-

grammed. Following are two methods to determine the value to program into CV29.

Look Up Table Method

The look up table below shows the effects of different CV values that you can program into CV29. CV values are shown in both decimal & hex.
The factory default value for CV29 is 06.

CV Value For CV29 Hex or Dec		Speed Steps/ Speed Table	Analog Mode Conv	Normal Direction Of Travel	2 or 4 Digit Adr
x00	000	14	OFF	Forward	2
x01	001	14	OFF	Reverse	2
x02	002	28/128	OFF	Forward	2
x03	003	28/128	OFF	Reverse	2
x04	004	14	ON	Forward	2
x05	005	14	ON	Reverse	2
x06	**006**	**28/128**	**ON**	**Forward**	**2**
x07	007	28/128	ON	Reverse	2
x10	016	14 Speed Table	OFF	Forward	2
x11	017	14 Speed Table	OFF	Reverse	2
x12	018	28/128 Speed Tbl	OFF	Forward	2
x13	019	28/128 Speed Tbl	OFF	Reverse	2
x14	020	14 Speed Table	ON	Forward	2
x15	021	14 Speed Table	ON	Reverse	2
x16	022	28/128 Speed Tbl	ON	Forward	2
x17	023	28/128 Speed Tbl	ON	Reverse	2
x20	032	14	OFF	Forward	4
x21	033	14	OFF	Reverse	4
x22	034	28/128	OFF	Forward	4
x23	035	28/128	OFF	Reverse	4
x24	036	14	ON	Forward	4
x25	037	14	ON	Reverse	4
x26	038	28/128	ON	Forward	4
x27	039	28/128	ON	Reverse	4
x30	048	14 Speed Table	OFF	Forward	4
x31	049	14 Speed Table	OFF	Reverse	4
x32	050	28/128 Speed Tbl	OFF	Forward	4
x33	051	28/128 Speed Tbl	OFF	Reverse	4
x34	052	14 Speed Table	ON	Forward	4
x35	053	14 Speed Table	ON	Reverse	4
x36	054	28/128 Speed Tbl	ON	Forward	4
x37	055	28/128 Speed Tbl	ON	Reverse	4

The Addition Method

The table below shows each switch and its value if it is on or off. Notice that if the switch is off the value is zero. To determine the value to program for your decoder just go down the list and add up the numbers for all the switches you want to set as ON.

Switch #	Characteristic If OFF	Value If OFF	Characteristic If ON	Value If ON
01	NDOT forward	000/x00	NDOT reverse	001/x01
02	14 speed steps	000/x00	28/128 speed steps	002/x02
03	Analog mode conversion off	000/x00	Analog mode conversion on	004/x04
04	Speed table off	000/x00	Speed table on	016/x10
05	2 digit addressing	000/x00	4 digit addressing	032/x20

CV29 Examples of CV Values:

All Digitrax decoders are shipped with a factory programmed value of 006/x06 in CV29. This gives the decoders the characteristics highlighted.

Switch #	Characteristic If OFF	Value If OFF	Characteristic If ON	Value If ON
01	**NDOT forward**	**000/x00**	NDOT reverse	001/x01
02	14 speed steps	000/x00	**28/128 speed steps**	**002/x02**
03	Analog mode conversion off	000/x00	**Analog mode conversion on**	**004/x04**
04	**Speed table off**	**000/x00**	Speed table on	016/x10
05	**2 digit addressing**	**000/x00**	4 digit addressing	032/x20
		Total "ON" Value to Program in CV29		**006/x06**

A value of 039/x27 programmed into CV29 will give you a decoder that has a normal direction of travel in reverse, operates in advanced 28/128 speed step mode, has analog mode conversion enabled, does not use a speed table and has 4 digit addressing.

Switch #	Characteristic If OFF	Value If OFF	Characteristic If ON	Value If ON
01	NDOT forward	000/x00	**NDOT reverse**	**001/x01**
02	14 speed steps	000/x00	**28/128 speed steps**	**002/x02**
03	Analog mode conversion off	000/x00	**Analog mode conversion on**	**004/x04**
04	**Speed table off**	**000/x00**	Speed table on	016/x10
05	2 digit addressing	000/x00	**4 digit addressing**	**032/x20**
		Total "ON" Value to Program in CV29		**039/x27**

With Digitrax decoders with FX functions, when the loadable speed table is

active and 128 speed step information is received from the command station, the table is interpolated to generate 4 in-between steps to give full 128 step resolution. Note that with some older Digitrax decoders, if 128 speed steps are sent by the command station then the 14/28 speed step and Loadable speed table selections are not used.

6.3   V-start: CV02

The start voltage, V-start, is the extra voltage added to the motor drive voltage at the first speed step. This adjustment allows you to compensate for the loco motor's efficiency. The range you can program for this CV value is from 000/x00 to 255/xFF. Each value increment represents an increase of approximately 1/2% of the total motor drive voltage, when a "straight-line" throttle response curve is used. The value of 255/xFF represents 100% motor voltage. In advanced 28/128 speed step mode, the V-start value is interpolated from the first speed step to the middle speed step or "mid" step, 15.
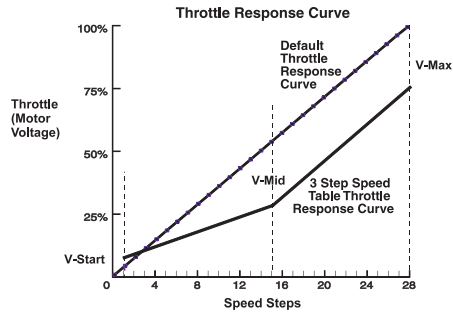
NOTE: Digitrax FX and later model decoders use V-start in 128 speed step mode and run loadable speed tables in 128 speed step mode. Other standard and most non-FX decoders disregard V-start in 128 speed step mode and run loadable speed tables in 14 or 28 speed step mode.

6.4   Acceleration Rate: CV03
Acceleration is the rate at which the decoder increases from one speed step to the next in response to a new command to increase speed. CV03, acceleration, lets you simulate train weight or inertia. The range of values for acceleration is 000/x00 to 031/x1F. Setting CV03 to a value of 00 generates an immediate response to a new command to increase speed. As you increase the CV value programmed into CV03, the rate of speed step change is approximately 1/10 second per increment in acceleration value.

For example, a value of 01 programmed to CV03 will cause the decoder to change at 1/10 second per speed step (using the 28 speed step range). This means that it would take about 2.8 seconds for the loco to go from stopped to full speed if you command the loco to go immediately to full speed by cranking up the throttle.

6.5   Deceleration Rate: CV04

Deceleration is the rate at which the decoder decreases from one speed step to the next in response to a new command to decrease speed. CV04, deceleration, lets you simulate locomotive braking action. The range of values for CV04, deceleration, is 000/x00 to 031/x1F. A value of 00 causes an immediate response to a new command to decrease speed. As you increase the CV value programmed into CV04, the rate of speed step change is approximately 1/10 second per increment in deceleration value.

For example a value of 01 programmed to CV04 causes the decoder to change at 1/10 second per speed step (using the 28 speed step range). This means that it would take 2.8 seconds to decelerate from full speed to stop if you commanded the loco to go immediately to stop when it was moving at full speed.

6.6   V-max: CV05

Setting CV05, V-max or maximum voltage, specifies an exact voltage that is applied to the motor at the highest speed step Setting V-max to a lower value than 255/xFF allows you to limit the top speed of a locomotive. The range of available V-max CV values is 000/x00 to 255/xFF. A value of 128 applies 50% of total voltage to the motor at the highest speed step. A value of 255/xFF applies 100% voltage at the highest speed step.

For backward compatibility, CV05 values of 000/x00, 001/x01 & 255/xFF all mean 100% voltage at step 28. If V-Max is accidentally set below V-mid, the decoder will use the V-mid setting as V-max.
V-max is not available when loadable speed tables are in use. In this case, set the maximum voltage by programming speed step 28 as the max voltage.

Note: Some Digitrax decoders are not able to set V-max in 128 speed step mode. If you encounter this problem, status edit the decoder to run in 28 speed step mode and you will be able to set up v-max.

6.7   V-mid: CV06

Setting CV06, V-mid or mid point voltage specifies an exact voltage that is applied to the motor at speed step 15 (or speed step 7 in a 14 step system). The range of available V-mid CV values is from 000/x00 to 255/xFF. A value of 128 applies 50% of the total voltage to the motor at step 15 (28 speed system). A value of 255 applies 100% voltage at the middle speed step.

If V-start (CV02) is accidentally programmed to a CV value greater than that programmed for V-mid (CV06), the decoder will force the output voltage for all steps below the V-mid value to be fixed at the V-mid value. This is done to prevent undesirable operational effects.

If a value of 00 or 01 is programmed into CV06 (V-mid), the decoder assumes a "straight-line" throttle response curve is desired. In this case, the decoder will run as though V-mid were set at a value of 50% of total motor voltage.

Note: Some Digitrax decoders are not able to set V-mid in 128 speed step mode. If you encounter this problem, status edit the decoder to run in 28 speed step mode and you will be able to set up v-mid.

V-mid is not available when loadable speed tables are in use.

6.8   Factory Reset CV: 08

CV08 is the factory reset CV for all FX^3 decoders and also the Manufacturer ID CV for all decoders.

To reset all CV values to their factory default, program CV08 to a value of 008/x08.

To reset all CV values except for 28 step speed tables to their factory values set CV08 to a value of 009/x09.

Note: Performing a factory reset will not affect the manufacturer ID and will reset the decoder's address to the factory default of 03, a 2 digit address.

6.9   Analog Functions Enable/Disable: CV13

In FX^3 decoders, CV13 is disabled.

In FX decoders, the analog functions enabled CV, CV13 lets you define which functions are active when the decoder is operating on DC track power. If you want function outputs F0 forward and reverse and F1 through F6 to be active when on DC (for example when using a short DC track as "brake section") program CV13 for a CV value of 255/xFF. The factory default value for CV13 is 00, which turns OFF all functions when on DC track. Note that if analog mode conversion is disabled in CV29, it will NOT affect how CV13 controls the functions. Even though the motor will stop on DC power, the functions will still operate if CV13 is programmed for them to do so. To find the best settings for you experiment with the values until you get the desired settings.

To determine the value to program in CV13 add all the values for the functions you want to have ON during DC operation and use **TABLE VI** to convert the decimal number you came up with to the hex value you will use for programming:

Function Output	Value if ON
F0 Forward White	064/x40
F0 Reverse Yellow	128/x80
F1 Green	001/x01
F2 Violet	002/x02
F3 Brown	004/x04
F4 White/Yellow	008/x08
F5 White/Green	016/x10
F6 White/Blue	032/x20

For example 64+128+1+2+4+8=207 decimal or xcF hex will operate F0 forward & reverse, F1, F2, F3 & F4 functions on DC. To operate F0 Reverse and F0 Forward add 1+2=003 decimal or x03 hex.

6.10   Digitrax Special Light Effects: CV49-CV63 & CV113-CV116

Decoders with FX^3 features have 8 user configurable, independent special effects generators. Decoders with FX features have 4. These are set up by programming CV values as described below.

Digitrax decoders offer five different types of function outputs:

There are five types of functions available on Digitrax decoders:

  Standard functions turn functions on and off. Digitrax decoders with standard functions offer head lights that can be set up to be either automatically reversing or individually controllable. If your decoder has CS, FX or FX^3 and you do not program the CVs to set up the features, your function outputs will run as standard on/off function outputs.

  Standard* functions turn functions on and off. These decoders offer automatically reversing head lights only.

  Configurable strobe (CS) functions can be programmed with a limited number of simulated lighting effects similar to FX but without as many options. Use CVs 49 & 50 to set up the effects you choose for each function output. Configurable strobes are offered in those few Digitrax decoders where there was not enough "code space" to provide full FX features.

  FX functions incorporate generators for prototypical lighting effects, like Mars lights, ditch lights, Gyralites, random flicker, single & double pulse strobes, etc. FX decoders offer up to 4 independent special effects generators.

FX^3 functions incorporate up to 8 independently controllable FX generators with additional dynamic and static qualifiers. FX^3 functions are fully remappable so they can be controlled by any function key on your system. A master light switch can be set up to turn off all lights on a locomotive. Functions associated with advanced consists can be controlled, too.

NOTE: If using DH142, DN142, DN141K2, DN149K2 series decoder, when F1 is set up for FX, F2 must also be set up as FX (It can't be used as standard on/off function.) If you want to use a combination of FX & standard on/off functions, please use F1 as the standard on/off function and F2 as the FX function.

6.10.1 Setting Up FX & FX^3 Effects On Function Outputs

1. Each function output has an FX or FX^3 control CV associated with it. Using **TABLE IVa** below, determine which CV you need to program to set up an FX or FX^3 feature for the function output you are working with. For example, if you want to set up an FX feature on your forward headlight, you will use CV49 to control the FX feature for the lamp attached to F0F.

   Some decoders do not have function output wires attached. See the specific decoder instructions to determine which "pad" on the decoder controls each function. Use thin wire or wire saved during previous decoder installations to solder function output wires to the pads associated with the function you want to use.

TABLE IVa: FX & FX^3 Generator CVs

FX CV #	FX^3 CV#	Function #	Output Color
CV49	CV49	F0/Light Forward (F0F)	White
CV50	CV50	F0/Light Reverse (F0R)	Yellow
CV51	CV51	F1 Function 1	Green
CV52	CV52	F2 Function 2	Violet
CV53	CV113	F3 Function 3	Brown
CV54	CV114	F4 Function 4	White/Yellow
NA	CV115	F5 Function 5	White/Green
NA	CV116	F6 Function 6	White/Blue

NOTE: CV53 & CV54 are not used for FX^3 control.

2. Each FX and FX^3 effect has a CV value that generates the effect you want and controls how the effect works with respect to locomotive

direction and the head light (F0) function.

The FX CV value is made up of 2 digits. The second digit determines which FX effect will be generated. The first digit determines how the effect will work with respect to the locomotive direction, the head light and other functions. Use **TABLE IVb** to determine the second digit and Table IVc to determine the first digit of the FX CV value to program into the CV selected in step 1.

TABLE IVb: The second digit of the FX/FX [3] CV value determines which FX effect will be generated.

FX CV value second digit (hex)	FX effect generated
x0	No effect, normal function control of lead
x1	Random flicker
x2	Mars light
x3	Flashing head light
x4	Single pulse strobe
x5	Double pulse strobe
x6	Rotary beacon simulation
x7	Gyralite
x8	Rule 17 dimmable headlight, dim when F4 is active or locomotive direction is opposite normal direction of travel (NDOT)
x9	FRED or "end of train" light
xA	Right ditch light on when loco is running forward and F0 is on. When F2 is on, the right ditch light flashes alternately with the left ditch light to simulate ditch light operation at a grade crossing.
xB	Left ditch light. on when loco is running forward and F0 is on. When F2 is on, the left ditch light flashes alternately with the right ditch light to simulate ditch light operation at a grade crossing.
xC-xF	Digitrax reserved for effects expansion.

TABLE IVc The first hex digit of the FX CV value determines how the effect generated will behave. For example, two strobe lights can be set up to flash alternately by setting one to phase A and the other to phase B. The strobes can also be set up to be on when the loco is moving forward and off when moving backward.

TABLE IVc: How FX & FX^3 effects generated will work

FX CV value first digit (hex)	How the FX effect generated will work
0x	Forward direction, ON with function ON, effect phase A
1x	Reverse direction, ON with function ON, effect phase B
2x*	Non directional effect, ON with function ON, effect phase A
3x*	Non directional effect , ON with function ON, effect phase B
4x*	Forward direction, ON with F0 ON **&** function ON, effect phase A (Master Light Switch F0)
5x*	Reverse direction, ON with F0 ON **&** function ON, effect phase B (Master Light Switch F0)
6x	Special Logic for Fwd Ditch Light or Rule 17 dimming (Master Light Switch F0) Standard Ditch Operation
7x	Special Logic for Rev Ditch Light or Rule 17 dimming (Master Light Switch F0) St andard Ditch Operation
FX^3 CV value first digit (hex)	**How the FX^3 effect generated will work**
Ax	Speed=0, non directional effect, phase A and function qualifier
Bx	Speed>0, non directional effect, phase B and function qualifier
Ex	Ditch off phase A (Mas ter Light Switch F0) Alternate Ditch Operation -Off when running flash on with F2
Fx	Ditch off phase B (Master Light Switch F0) Alternate Ditch Operation -Off when running flash on with F2

*For decoders with part numbers that end in 2 (DH142, DN142, DN149K2, etc.) these work with F0-Forward (White) & F0 Reverse (Yellow), only if CV61 is set to a value other than 00 to map the yellow lead to F4.

3. Program the FX CV value from step 2 to the FX CV identified in step 1. If you are using the PR1, an FX set up section is available where you can just "point and click" to set up the effects you want to use. The software lets you select which function output and which FX feature you want from a menu so you don' have to use the tables above to determine which CV or CV value to use.

Setting Up Ditch Lights
with **DiGiTraX** FX & FX³ Decoders

DC Motor (Brushes isolated)

Right Side (Engineer's) Power Pickup

Left Side (Fireman's) Power Pick-up

Gray — Motor -
Orange — Motor +
Red — Right Rail (Engineer's Side)
Black — Left Rail (Fireman's Side)
White — Forward light (F0 FWD)
Yellow — Reverse light (F0 REV)
Blue — Lamp Common
Green — Function 1 (F1)
Violet — Function 2 (F2)

Digitrax Decoder

Rear Light (12V bulb)

Head Light (12V Bulb)

Right Ditch Light (12V Bulb)

Left Ditch Light (12V Bulb)

CV Numbers and Values for Great Ditch Lights with FX/FX³

CV #	CV Value	Effect
49	x00 or 104/x68	00=no effect, 68=Rule 17 on head light & no ditch lights in reverse
50	x00 or 120/x78	00=no effect, 78=Rule 17 on rear light & no ditch lights in reverse
51	106/x6A	Right ditch light, directional F0 & F2 must be ON for this to operate
52	107/x6b	Left ditch light, directional F0 & F2 must be ON for this to operate
62	xc4/196	High keep-alive for lamps, rate 4 gives approx. 1 second FX effect rate
63	064/x40	5 second ditch light holdover after F2 is turned OFF

This will cause your ditch lights to be ON while moving along the track and flash when you press F2 at the crossing. If you have an FX³ decoder and you want the ditch lights to be OFF while moving & come ON & flash when you press F2, program CV51 to 234/xEA and CV52 to 235/xEb.

4. For FX decoders, you can repeat steps 1, 2 and 3 to set up a total of 4 FX effects on any 4 function outputs you choose. If your FX decoder has more than 4 function outputs, you can set up only 4 FX effects and the other function outputs will be simply on/off functions.

5. For FX^3 decoders, you can set up up to 8 function outputs. All FX^3 outputs can be set up with FX effects.

6. If you want any function output to remain a simple on/off output, leave it programmed to the factory default of CV value 00.

6.10.2 Customizing FX & FX^3 Effects CV62

CV62 lets you control the rate and keep-alive brightness for each FX effect you set up. The CV value for CV62 is made up of 2 digits, the first digit and the second digit.

The first digit controls the keep alive/baseline off voltage for incandescent lamps. This value should be between 0 and F. A value of 0 gives no keep alive and a value of F gives maximum keep alive. Values between the high and low allow you to vary whether the lamp actually goes off between light pulses or whether it stays on very dimly or more brightly. (If you are using LEDs, the first digit for CV62 should be 0.)

The second digit controls the rate of the FX effects programmed. This value should be between 0 and F. A value of 0 gives a fast rate and a value of F gives a slow rate of operation. We recommend you start with a 4 and adjust it up or down until you get the effect you are looking for.

6.10.3 Ditch Light Hold Over Time CV63

If you are using the ditch light effect in conjunction with F2, CV63 lets you set up a hold over time to control how long the ditch lights continue to blink after F2 turned off by releasing the key on the throttle. Remember that F2 is a momentary key on most Digitrax throttles that will keep function 2 on as long as you hold the key down and then turn function 2 off when you release the key. This allows the ditch lights to be on steady during regular operation and to begin alternate flashing when F2 (usually the horn) is activated and to continue flashing alternately for a predetermined length of time after F2 is released; just like the prototype. A value of 00 yields no hold over time, a value of 40 yields a realistic time of about 5 seconds. A value of 255/xFF yields about 20 seconds hold over time.

6.10.4 FX Examples

Any function output on the decoder can be set up for any FX effect by pro-
gramming its associated FX CV to the appropriate FX CV value. For example,
if CV52, the FX CV for F2, is programmed with an FX CV value of 002/x02,
the violet F2 function output will be a Mars light when F2 is turned on for this
decoder address and the decoder's direction is forward.

TABLE IVd: FX CV EXAMPLES

CVs that affect all FX function outputs

Meaning	Recommended CV# & CV Value dec/hex	Effect on Decoder
Analog Functions Enable/Disable (Not applicable for FX[3])	13: 207/xcF	All functions F0 though F4 are ON in analog (DC) mode
Configuration Register	29:006/x06	Advanced 28/128 speed step mode, analog mode conversion enabled
Keep Alive/Rate	62:196/xc4	High keep-alive for lamps, Rate 4 for approx. 1 sec FX effect rate
Ditch Light Hold Over Time	63:064/x40	5 Sec Ditch light holdover after F2 is turned OFF

CVs that affect specific FX outputs:

Function/ Color	CV #:CV Value dec/hex	FX Effect Generated
F0 Fwd White	49:104/x68	Rule 17 dimmable headlight, directional
F0 Rev Yellow	50:000/x00	Normal directional reverse headlight, NO effect used
F1 Green	51:106/x6A	Right Ditch light, directional. F0 & F2 must be ON for this to operate.
F2 Violet	52:107/x6b	Left Ditch Light, directional. F0 & F1 must be ON for this to operate.
F3 Brown	FX 53:034/x22 FX[3] 113:034/x22	MARS light, ON when F3 is ON (If we used {113 or 53:050/x32} we would get opposite phase MARS light)

To set up two alternating double pulse strobes on the green and violet function outputs controlled by turning on both F1and F2, program CV51 to a CV value of 037/x25 and program CV52 to a CV value of 053/x35. This is an example of using the alternate effects phases A & B.

For FX decoders, if you set up more than 4 effects to the function outputs, the effects selected after effect 4 will be the same as the 4th effect selected, assuming the first effect was set up on CV49, the second on CV50, the third on CV51 and the fourth on CV52. An FX CV Value of 000/x00 will set up the function output as a standard on/off function output with no FX effects generated.

For FX^3 decoders you have up to 8 FX^3 generators available to use with your function outputs. Limited by functions available on each decoder. For example 6 function FX^3 decoders support only 6 FX^3 generators.

6.10.5 Troubleshooting FX effects

Common problems with FX set up are:
   Trying to program a decoder for FX when the decoder does not support FX. Be sure the decoder you are installing has FX features. Digitrax introduced FX in the summer of 1995 so if your decoder was made before then it does not have FX capability. Since 1995 all Digitrax premium decoders have included FX. Digitrax standard and economy decoders do not have FX features.

   FX effects don't work as expected. Review the qualifiers you set up for the effect. For example, if the effect is set up to come on only when F1 and F0 are active and the loco is headed in the forward direction, be sure you have met those conditions.

   If using DH142, DN142, DN141K2, DN149K2 series decoder, when F1 is set up for FX, F2 must also be set up as FX (It can't be used as standard on/off function.) If you want to use a combination of FX & standard on/off functions, please use F1 as the standard on/off function and F2 as the FX function.

6.10.6 Setting Up A Master Light Switch with FX^3 Decoders
For FX^3 decoders F0 can be used as a master light switch to turn off all lights in the locomotive when F0 if OFF.

6.10.7 Setting Up Configurable Strobes CV49, CV50, & CV61
For decoders with configurable strobe capability, configurable strobes are set up using CVs 49, 50 and 61 as outlined below. Configurable strobe function

outputs can be programmed with a limited number of simulated lighting effects similar to FX effects but without as many options. Configurable strobes are offered in those few Digitrax decoders where there was not enough "code space" to provide full FX or FX^3 features.

CV49 controls F0 Forward, the white function output. CV50 controls F0 reverse, the yellow function output.

To set up configurable strobe lights, first program CV61 with the CV value 001/x01 to enable configurable strobe operation. Use the following table to look up the CV values to program for CV49 & CV50.

Configurable Strobe (CV49 & 50)	Light active when	Simulated Effect
017/x11	Reverse	Blink
018/x12	Reverse	Mars
019/x13	Reverse	Blinking Headlight
020/x14	Reverse	Single Pulse Strobe
021/x15	Reverse	Double Pulse Strobe
022/x16	Reverse	Rotary Beacon
033/x21	Non directional	Blink
034/x22	Non directional	Mars
035/x23	Non directional	Blinking Headlight
036/x24	Non directional	Single Pulse Strobe
037/x25	Non directional	Double Pulse Strobe
038/x26	Non directional	Rotary Beacon

For example if you program CV49 to a value of 038/x26 hex, the light on the white output will be on no matter which direction the loco is traveling and will be blinking with an effect similar to a rotary beacon. For FX^3 the white output must be made non-directional by programming CV34 to 001/x01. Experiment and ENJOY!

6.10.8 Lamp Selection For Prototypical Lighting Results
At the heart of realistic FX lighting effects is the selection of lamps that can give realistic looking results. Adjusting the brightness and locating the lamps in the model also have an effect on how realistic your installation will look.

We recommend using incandescent lamps to achieve the most realistic lighting effects. Miniatronics model #18-001-20 1.5 Volt/15 mA 1.2 mm diameter lamps work very well in most applications and have a good life expectancy when you use a proper current resistor and operating voltage.

For 1.5V lamps, a current setting resistor MUST be used in series with the + voltage supply to the lamp. This is usually installed in series with the "white or yellow" wire. For example operating on the DB150 "N scale" setting with 12V DCC signal on the track, we have found a resistor of about 500 ohms 1/4 watt gives the #18-001-20 1.2mm lamps a good brightness level without shortening their lives too much. With 1.5V lamps, the brightness level is very sensitive to the resistor value. As you change the value of the resistor you will see that the related change in lamp brightness is "non linear." Running a few volts higher will create too bright a light and degrade lamp life and lower voltages may result in very dim lights.

A 12 or 14 Volt lamp run directly without resistors will be less sensitive to voltage fluctuations. ***For regular 12 to 16 Volt lamps that draw more than 50 mA when lit, we recommend that you put a 22 to 33 ohm 1/4 watt resistor in series with the lamp leads. This will ensure that the lamp "start-up currents" (up to 10 times normal current draw) do not overload the outputs.***

To achieve the best results, select an appropriate incandescent lamp and experiment with different resistors and FX or CS settings to get just the right prototypical lighting effects for your model. To get the best looking "pulse" and "Mars" type light effects, place the lamp so that it is viewed directly. Lamp end lenses can intensify and focus the filament image when viewed end-on. Lenses can be used to create a more intense bright period without having excessive, voltages on the lamp which can reduce lamp life.

LEDs and incandescent bulbs have inherently different lighting characteristics. You may find that you prefer one or the other. Since plastic light pipes diffuse lamp outputs, installations with light pipes will look different from those where lamps that are directly viewed.

6.10.9 Setting Up Non-FX Functions with FX³

When an FX³ decoder output is set up for no FX effect, you can use static qualifiers to customize the operation of the on/off function of that output. In this case, the second digit of the FX control CV will always be 0 to set the decoder for no FX function operation. The first digit is determined by the following table.

Static CV value	How The Static Function Output Will Work
000/x00	On/Off Output controlled by function map
016/x10	On/Off Output controlled by function map
032/x20	Forward qualified On/Off Output
048/x30	Reverse qualified On/Off Output
064/x40	F0 qualified On/Off Output (Master Light Switch F0)
060/x50	F0 qualified On/Off Output (Master Light Switch F0)
096/x60	F0 On in Forward Direction qualified On/Off Output (Master Light Switch F0)
112/x70	F0 On in Reverse Direction qualified On/Off Output (Master Light Switch F0)
160/xA0	Speed=0, non directional qualified On/Off Output
176/xB0	Speed>0, non directional qualified On/Off Output

6.11   CV53 & CV54 Torque Compensation & Switching Speed

In FX decoders, the value in CV53 determines which FX effect is generated on F3, the brown function output. In FX decoders, the value in CV54 determines which FX effect is generated on F4, the white/yellow function output.

In FX[3] decoders, CV54 is used to control the decoder's torque compensation and switching speed features.

Torque Compensation improves loco performance by internally adjusting for the loss of torque caused by SuperSonic silent operation. This feature is turned on at the factory.

Switching speed gives you fast access to lower speeds used in switching operations. This feature effectively reduces the throttle's target speed by about 50% and reduces the effects of accel and decel programmed into the decoder by 1/4 when the user activates this mode by turning on F6.

FX[3] CV54 Values For Controlling
Torque Compensation and
Switching Speed Features

CV54 Values	Switching Speed	Torque Compensation
000/x00 (default)	**OFF**	**ON**
001/x01	ON	ON
016/x10	OFF	OFF
017/x11	ON	OFF

6.12 Function Remapping

Function remapping allows you to set up which function outputs are controlled by which function controls on your throttle. You can even control more than one function output with one control. Use the table below to determine the CV values to program to the function remapping CVs to make the function controls on your throttle work the way you want them to work.

Each row shows a function control key on your throttle and its associated control CV. The columns show the function outputs on your decoder that you can remap to be controlled by the function controls on your throttle. We show these as the wire colors related to each function output. In the case of decoders without function wires attached, check the wiring diagram to determine what color the wire would be if there were one attached to the decoder. On the following table, a ● in any column indicates the default throttle function control key that controls the decoder function output.

You can remap more than one function output to be controlled by a single throttle function control key. Not all remapping combinations are available, only the ones shown on the three tables below.

Throttle Function	Map CV	Decoder Output Colors								Default Value
		Wht	Yel	Grn	Vio	Brn	Wht Yel	Wht Grn	Wht Blu	
Add Value to Include		001 x01	002 x02	004 x04	008 x08	016 x10	032 x20	064 x40	128 x80	
F0F	CV33	●								001/x01
F0R	CV34		●							002/x02
F1	CV35			●						004/x04
F2	CV36				●					008/x08
F3	CV37					●				016/x10

Throttle Function	Map CV	Decoder Output Colors					Default Value
		Vio	Brn	Wht Yel	Wht Grn	Wht Blu	
Add Value to Include		001 x01	002 x02	004 x04	008 x08	016 x10	
F4	CV38			●			004/x04
F5	CV39				●		008/x08
F6	CV40					●	016/x10
F7	CV41						032/x20
F8	CV42						064/x40

		Dcdr Output Colors		
Throttle Function	Map CV	Wht Grn	Wht Blu	Default Value
Add Value to Include		001 x01	002 x02	
F9	CV43			016/x10
F10	CV44			032/x20
F11	CV45			064/x40
F12	CV46			128/x80

To remap functions, place ●s in the appropriate columns, add up the numbers and program the decoder with the hex values derived.

The following example shows how to remap as follows:

F0 non-directional controlling both White & Yellow Outputs
F1 controls Green
F2 and F8 control Violet. Turns Violet ON when either F2 or F8 is ON.
F3 controls Yellow
F5 controls White with Yellow Stripe and White with Green Stripe
F6 controls nothing
F7 controls Brown

Example of Function Remapping CV Value Computations

		Decoder Output Colors								
Throttle Function	Map CV	Wht	Yel	Grn	Vio	Brn	Wht Yel	Wht Grn	Wht Blu	Value to Prog
Add Value to Include		001 x01	002 x02	004 x04	008 x08	016 x10	032 x20	064 x40	128 x80	
F0F	CV33	●								001/x01
F0R	CV34	●								001/x01
F1	CV35			●						004/x04
F2	CV36				●					008/x08
F3	CV37		●							002/x02

		Decoder Output Colors					
Throttle Function	Map CV	Vio	Brn	Wht Yel	Wht Grn	Wht Blu	Value to Prog
Add Value to Include		001 x01	002 x02	004 x04	008 x08	016 x10	
F4	CV38			●			004/x04
F5	CV39				●	●	024/x18
F6	CV40						000/x00
F7	CV41		●				002/x02
F8	CV42	●					001/x01

		Dcdr Output Colors		
Throttle Function	Map CV	Wht Grn	Wht Blu	Value to Prog
Add Value to Include		001 x01	002 x02	
F9	CV43			016/x10
F10	CV44			032/x20
F11	CV45			064/x40
F12	CV46			128/x80

6.13 Throttle Response Curves & Loadable Speed Tables

THROTTLE RESPONSE CURVE
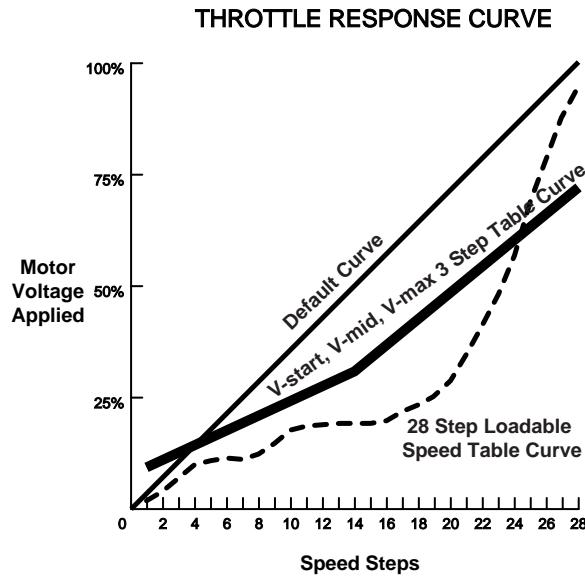
When you are using a throttle to control a locomotive, you will notice that as you increase and decrease the speed, the loco responds to the change in throttle settings according to the relationship between motor voltage applied and the throttle setting. This is called the throttle response curve. Decoders are shipped from the factory with a linear throttle response curve. This means that as you increase the throttle setting from 0 to full speed, the loco will look like the default curve in this diagram.

If you want to create a more realistic throttle response curve, you can set up a loadable speed table. Loadable speed tables define the percentage of motor voltage applied at each of 28 digital speed steps. By programming a value for each of the 28 steps, you can set up a customized throttle response curve for each individual decoder equipped locomotive. The shape of this curve defines the "feel" of the decoder's throttle response.

You can use the 3 step method for some locos and the 28 step method for other locos on your layout, you **do not** have to choose only one method or the other.

6.13.1 Simple 3 Step Speed Tables with V-max, V-mid & V-start

In most cases, a simple 3 step speed table will give you the throttle response curve you want. Try this simple method and if you still want more resolution in your throttle response curve, move on the the next section.

You can set up a simple 3 step throttle response curve by setting V-start (CV02), V-mid (CV06) and V-max (CV05). This method requires programming just 3 CVs. Once these three CVs are set, you are ready to run the loco, no programming of CV29 is needed for this type of speed table.
The following are examples of 3 step speed tables you might want to try. Keep in mind that these are average examples for average locos and you may need to adjust the values for your particular loco to achieve the results you desire.

Recommended for locos NOT using torque compensation or scaleable speed stabilization

Throttle Response Curve Type	V-start CV02	V-mid CV06	V-max CV05
Switcher Concentrated low speed control. Limited top speed.	026/x1A	038/x26	064/x40
Road Switcher Prototypical top speed with evenly distributed speed control over range of throttle operation.	026/x1A	048/x30	098/x62
Mainline Loco Quick increase to cruising speed then levels off to prototypical top speed.	026/x1A	128/x80	154/x9A

6.13.2 High Resolution 28 Step Speed Tables CV65-95

If you want more precision in setting up throttle response curves for some or all of your locos most Digitrax decoders also have available a 28 step speed table option. With this method, you must program values for up to 32 different CVs as detailed below. This can be time consuming but you only have to do it once, since the settings will be remembered by the decoder until you change them.

Most Digitrax decoders use the 28 steps programmed and interpolate them so that in operation, they look like 128 speed steps for even smoother operation!

28 Step Speed Table Programming Example
  1. Program CVs 65 through 95 and CV29 with CV values from
      TABLE V.

2. After programming the table values, program CV29 to the value of 16 to enable the loadable speed table. If you want to disable the loadable speed table later, just program CV29 to 06 and you will return to 128 speed step operation (the speed table is still remembered and can be re activated by programming CV29 to 16 again later). Setting CV29 to the value of 16 will enable the 28/128 step speed table, enable analog mode conversion, set the normal direction of travel of the loco and enable 2 digit addressing. This CV value is just one of many choices to enable the loadable speed table and control the other variables handled by CV29 at the same time. Consult Section 6.2 for complete information about what value to program into CV29 to get the features you want.

3. Once the speed table is programmed, you can scale the entire speed curve by using the forward trim value (CV66) and reverse trim value (CV95). These CVs act like a "volume control." When you use these trim values, you don't have to reload the entire 28 step table if you want to change, for example, the maximum forward speed from 45 scale mph to 80 scale mph. Changing the forward or reverse trim values will scale all the values used in the table, in the corresponding direction, by the value programmed into the CV. Using different forward and reverse trim values allows for many different combinations. The trim values can increase the table values from 100% up to 200% or decrease them from 100% down to 2%.

If you are using the PR1 programmer, programming a speed table is as simple as "drawing" the throttle response curve you want on the screen and pressing the "Send" or Program button.

When speed matching locos, get the first loco running the way you like and then match subsequent locos to it. We strongly recommend that you keep a running list of the CVs and CV values you have programmed for each decoder.

When CV29 is set to enable a loadable speed table, any V-max(CV05) or V-mid(CV06) values programmed are not used by the decoder when it determines how much motor voltage to apply. Non FX decoders don't use V-start (CV02) when a loadable speed table is enabled. Non-FX decoders don't run loadable speed tables in 128 speed step mode. To run non-FX decoders with a loadable speed table, you must run them in 14 or 28 speed step mode. Set their CV29 value to 016/x10, 017/x11, 020/x14, 021/x15, 048/x30, 049/x31, 052/x34 or 053/x35 and status edit these decoders to a value of 10, 20, 12, or 22. FX decoders have start voltage and 128 speed step table operation available. The following **TABLE V** is an example of a loadable speed table.

TABLE V: Example Loadable Speed Table

Used For	CV #	HEX CV Value	Lenz Register Value	DECIMAL CV Value
			Page 17=PL	
Kick Start	CV65	x01	1	001
Forward Trim	CV66	x80	2	128
Step 4 value	CV67	x0A	3	010
Step 5 value	CV68	x0E	4	014
			Page 18=PL6	
Step 6 value	CV69	x12	1	018
Step 7 value	CV70	x16	2	022
Step 8 value	CV71	x18	3	024
Step 9 value	CV72	x1c	4	028
			Page 19=PL6	
Step 10 value	CV73	x20	1	032
Step 11 value	CV74	x24	2	036
Step 12 value	CV75	x28	3	040
Step 13 value	CV76	x2c	4	044
			Page 20=PL6	
Step 14 value	CV77	x32	1	050
Step 15 value	CV78	x36	2	054
Step 16 value,	CV79	x3c	3	060
Step 17 value	CV80	x40	4	064
			Page 21=PL6	
Step 18 value	CV81	x46	1	070
Step 19 value	CV82	x4c	2	076
Step 20 value	CV83	x52	3	082
Step 21 value	CV84	x5A	4	090
			Page 22=PL6	
Step 22 value	CV85	x60	1	096
Step 23 value	CV86	x6A	2	106
Step 24 value	CV87	x72	3	114
Step 25 value	CV88	x7E	4	126
			Page 23=PL6	
Step 26 value	CV89	x88	1	136
Step 27 value	CV90	x94	2	148
Step 28 value	CV91	xA2	3	162
Step 29 value	CV92	xb2	4	178
			Page 24=PL6	
Step 30 value	CV93	xc6	1	198
Step 31 value,	CV94	xdA	2	218
Reverse Trim	CV95	x80	3	128
Configuration Register	CV29	x16	5	022
Page Register	None	None	PL6=Page register	001

Notes for **TABLE V:**

1. The Kick Start CV provides for a short voltage "kick" when you start the locomotive decoder from 0 speed. A value of 00 turns this option OFF.
2. If you program Forward Trim (CV66) & Reverse Trim (CV95) to CV values of 128/x80, 000/x00, or 001/x01 you will get no scaling effect. A trim value of 255/xFF will give 200% scaling of the table entry value.
3. A final scaled table value of 255/xFF represents 100% applied motor voltage or Full speed. A value of 128/x80 represents 50% applied motor voltage, i.e., the actual table step entry is multiplied by the appropriate Trim value to yield the final scaled table value that defines the voltage to apply to the motor.
4. The steps defined in the table are for the 28 speed step mode. Step 4 is the first motion step in the 28 speed step system. Step 31 is the "full throttle" speed step. When setting up the decoder to run 14 step mode, only every second entry in the table is used. When 14 speed steps are used by the command station, the decoder will automatically use the correct CVs and their CV values from the speed table.
5. The suggested CV values given in the example speed table will give a throttle response curve that most US users will find useful. Once you have loaded the example table, feel free to modify the CV values to suit your own preferences.

Please use 3 step speed tables for all DZ121 & DN121 Series Decoders, because of size constraints in their processors, they do not support 28 step speed tables.

6.14 CV61 Non-directional Headlights, Transponding™ & Split Phase Motor Drive

Fourth Generation Digitrax Decoders use CV61 (one of the manufacturer specific configuration variables) to give you the following options: Non-Directional Headlight Operation, Transponding™ Enabled or Disabled, & Split Phase Motor Drive for Marklin AC and Lionel Type motors.

CV61 Value	Non-directional headlights	Transponding	Split Field Motor/AC
00	No	No	No
01	Yes	No	No
02	No	Yes	No
03	Yes	Yes	No
04	No	No	Yes

6.14.1 Non-Directional Headlight Operation

Most Digitrax decoders support the independent control of the head light and tail light. In decoders with this capability, if you don't want automatic reversing headlight operation (the decoder's factory default setting), you can set up the white output for the headlight to operate on F0 (function 0) and the yellow output for the rear light to operate independently on F4 (function 4). This lets the engineer have complete manual control over when these lights are on.

Program CV61 to a value of 01 and the decoder will "map" the normal reverse light function output (yellow) to be controlled by the F4 function key. In addition the normal forward light function output (white) will become a non-directional light output that is controlled by the F0 (light function) button on the handheld. The FX operation of the white & yellow outputs are still controlled by CV49 & 50. The FX effects can be made directional if desired by following the FX programming instructions in this manual. CV50 will still control the FX effect you are using on the yellow output (F0 reverse headlight) only it will now be controlled by F4 rather than F0).
Program CV61 to a value of 00 and the decoder will return to automatic directional lighting with the white output being the headlight and the yellow output being the reverse light.

The non-directional headlight feature is not available on Digitrax DN121 series decoders.

To make FX[3] white & yellow outputs non-directional remap them to be controlled on two separate throttle function keys using CV33 & CV34.

6.14.2 Split Field/AC Motor Drive

When you program CV61 to 004/x04, Digitrax decoders with split field motor drive capabilities will convert their motor leads to drive a "split field " AC motor instead of the default DC motor. This lets you run Marklin 3-pole AC motors and similar motors in a number of locos built in Europe with Digitrax 1.5 amp decoders. For Hi-rail AC motors, you can use Digitrax decoders rated at 3 amps or more.

To use an AC motor, connect the common motor/brush to the blue (lamp common) lead on the decoder. Connect the forward field coil to the decoder's gray lead. Connect the reverse field coil to the decoder's orange lead. Be sure that any other mechanical or electrical reversing relay and/or track feeds are removed from the AC motor. The decoder's wires should be the only wires connected to the converted AC motor. Be sure all motor connections are isolated from the motor chassis.

Programming decoders set up for AC operation: Once you set up your decoder to run with an AC motor by programming CV61, you must have the motor or a lamp load connected from the blue lamp common wire to one of the motor leads to do any additional programming. You can also connect a 1 k ohm resistor to the blue and gray wires to simulate the AC load to allow additional programming.

6.14.3 Transponding Enabled/Disabled

Digitrax decoders with transponding are shipped with CV61 programmed to 00 for transponding disabled. Before implementing transponding, you must enable this feature in the decoders. Transponding enabled or disabled does not affect operation on non-transponding layouts. See Section 6.16 below for more information about installing transponding decoders.

6.15   Scaleable Speed Stabilization (Back EMF): CV55, 56 & 57

Some Digitrax decoders offer scaleable speed stabilization or back EMF control to help smooth out low speed operation. This feature is especially beneficial for switching. Speed stabilization is a decoder feature that can be used with any DCC system. Digitrax FX^3 decoders are shipped with CV57, the Scaleable Speed Stabilization CV set at a value of 006/x06 and CV55 & CV56 set at 000/x00. These values are beneficial to the operation of most locomotives. Other Digitrax decoders that support this feature are shipped with scaleable speed stabilization turned off so, to use it with those decoders, you will need to program the following CVs.

CV55 controls the STATIC compensation or how much the decoder considers the difference between the current motor and locomotive speed and the target speed set on the throttle when determining the next speed command to send to the motor. This is like the stiffness of a spring. The stiffer the spring, the more compensation you will get. CV values can range from 000/x00-255/xFF. Higher values give a more intense reaction and lower values give less intense reactions. The factory default setting for CV55 is 128/x80. It will have no effect on decoder operation until you program CV57 as described below.

CV56 controls the dynamic compensation or how much the decoder considers the historical difference between the current speed and the target speed when determining the next speed command to send to the motor. This setting is like a damper or shock absorber on the spring that helps to restore the spring to its new position. CV values can range from 000/x00 to 255/xFF. Higher values cause more rapid adaptation to the target speed and lower values cause slower adaptation to the target speed. The factory default setting for CV56 is 048/x30. It will have no effect on decoder operation until you program CV57 as described below. Excessively high CV values programmed to CV56 will tend to let the locomotive "hunt" around a new desired speed when a change of speed is commanded. We recommend that you use the lowest CV value in CV56 that gives the desired performance.

CV57 control the amount of intensity or speed loss as load is increased, by limiting the amount of change or compensation that the decoder is allowed to implement. CV57 controls the intensity separately for both regular addresses and consist addresses. The first hex digit controls the amount of intensity in effect when speed is controlled using the standard decoder 2 or 4 digit address. The second hex digit of the CV value controls the intensity in effect when the decoder is part of an advanced consist for speed and direction control. Values for each digit can range from 000/x00 to 015/x0F.

If either digit is 00, speed stabilization OFF. A value of 015/x0F is speed stabilization FULL ON. If the intensity CV value is too high, you may see locos jump from one speed to the next if they encounter an obstacle or problem with track work. If the value is too low, there will be very little speed stabilization effect at all. A higher digit makes the intensity or speed fall-off less. A typical value for most locomotives not part of an advanced consist is CV57=005/x05, but the actual value that is best for a locomotive and train size must be determined by observation and experimentation. Note that this

value of 005 for this example means that no speed compensation is used when this decoder is in an Advanced Consist.

CV55, CV56 and CV57 can be changed while the locomotive is moving using Ops Mode programming. With Ops Mode, you can change the operating characteristics of the decoder while it is running on the layout. When you are using Scaleable Speed Stabilization (Back EMF), you don't need to program a large CV value for V-start (CV02) to compensate for sluggish motors. This is because when scaleable speed stabilization is in effect, the decoder will automatically try to adjust the motor power up to at least the Vstart setting, to achieve the actual speed commanded. This means that low speeds like 3% or 4% of full speed will give best performance when CV02 is programmed to a CV value of 00.

How to set up a loco with Scaleable Speed Stabilization (Back EMF)

1. Install the decoder.
2. Program CV57 (Intensity) to a CV value of 005/x05. This will turn on speed stabilization.
3. Put the loco on level track and run it at about 20% of full speed. Beginning with the default value of 128/x80 in CV55 (Static), reprogram the CV value to increasingly higher values until you observe the loco jumping as speed steps increase when you run the locomotive. Finish this step by reprogramming CV55 to the CV value just before the jumping started. Ops Mode programming on the main line works very well here.
4. Follow the same procedure with CV56, beginning with the default value of 048/x30 and increasing it until you notice the loco oscillating, faster-slower, faster-slower, as speed is increased. Finish this step by programming CV56 to the CV value just before the oscillation started.
5. Follow the same procedure with CV57, beginning with the value 05 as programmed in step 1. Increase the CV value in this CV until the speed when going up hill is roughly equivalent to the speed on level track. This will yield a best intensity consistent with the locomotive characteristics.
6. Keep notes about the values you program for these 3 scaleable speed stabilization control CVs so that you can use them as a starting point for setting up scaleable speed stabilization in similar locomotives.

6.16 Digitrax Transponding™

Many premium Digitrax decoders incorporate Digitrax Transponding™. Digitrax transponding lets you know the transponding zone location of any specific locomotive or other rolling stock equipped with a transponder. Location and identification information are updated constantly on LocoNet and can be displayed on a track diagram, throttle, or computer. Transponding decoders and transponders work in conjunction with BDL16 & RX4s installed on the layout.

To set up your layout for transponding:

1. Install BDL16 occupancy detector(s).
2. Add transponder receivers (RX4) to the zones you want to use as transponding zones. (Not all detection sections will need to be set up for transponding. You can use a combination of transponding and occupancy detection to set up feedback on your layout at a reasonable cost.)
3. Enable Digitrax transponding decoders or transponding devices (TD1, TF2, TF4, or TL1) in the locos, cars, and/or cabooses you want to be able to track as they move around the layout. Transponding devices can be added to DCC equipped locos as well as non-DCC equipped locos and rolling stock. You can install transponding devices in locos with decoders made by other companies to get the benefits of transponding. If you are using "silent-running" decoders made by other DCC companies on your layout be sure that they are Digitrax transponding compatible. If they are not, simply disable this feature in those decoders to prevent interference with transponding.
4. When you install a wired transponder equipped decoder, you should also install a load resistor of between 270 ohms & 470 ohms between the blue and white decoder outputs. If you are using a board decoder, like Digitrax DN149K2, the resistor may already be installed on the decoder. Digitrax transponder current pulse generation uses the F0 decoder function output that is also used for the forward light function. Transponding will not affect the operation of the forward light but you may see a slight glow when the light is turned off because of the way transponding works. If you are running zones where the average current draw is more than 3 amps, you can connect an additional 100 ohm 1/8 watt resistor in series with a 0.1uF ceramic capacitor across the white and blue decoder outputs.

Note: If the resistor is not connected between the blue & white outputs, then the locomotive will transpond in only one orientation on the track.

Note: If you are using TD1, TF2, TF4, or TL1 to equip your loco or rolling stock for transponding, you won't need to install the resistor because it is included on the board.

5. All Digitrax transponding decoders are shipped with transponding
    enabled. If you find that transponding is not enabled simply program
    CV61 to a value of 02 to enable it.

6. Place the loco on the track set up for transponding, select it and run it
   back & forth. Verify that transponding is working in that orientation.
   If transponding is not working, be certain that the resistor described
   in step 4 above is installed properly between the white and blue out-
   puts of the decoder.

7. Pick up the loco and turn it around on the track, select it and run it
   back and forth again. Verify that transponding is working in that ori-
   entation. If transponding is not working, be certain that the resistor
   described in step 4 above is installed properly between the white and
   blue outputs of the decoder.

NOTE: Locos must be selected in the system for transponding to work.

6.17   Advanced Consisting Controls CV19, CV21 & CV22

CV19 is the advanced consist address. When this CV is active, the functions
within the advanced consist are individually controlled at their regular address-
es. CV21 & CV22 allow you to override this and place specific functions under
the control of the advanced consist address. To determine the hex value to pro-
gram into these CVs, add up the hex values of the functions you want to con-
trol in the advanced consist and program that value into the CVs. To make all
CVs be controlled by the advanced consist address, program a value of
255/xFF to both CV21 & CV22.

CV21 Values		CV22 Values	
F1	x01	F0	x01
F2	x02		
F3	x04		
F4	x08		
F5	x16	F9	x16
F6	x32	F10	x32
F7	x64	F11	x64
F8	x128	F12	x128

For example: If you want to have F0, F1 and F5 controlled by the advanced
consist address, program CV21 to a value of 023/x17 and CV22 to a value of
001/x01. All other functions will still be controlled by the decoder's regular
address.

7.0   Operation With Digitrax Compatible Command Stations

Digitrax decoders support paged programming. Digitrax decoders are designed to operate with command stations that are compatible with DCC industry standards. If your command station and/or programmer are designed to interoperate with other DCC products, you will be able to operate with few problems. If you experience problems when running Digitrax decoders with other manufacturers' command stations please refer to the command station manual first to determine if any special programming or set up is required to run Digitrax decoders with the system you are using. If there is still a problem, please contact us right away!

Digitrax Decoders are shipped from the factory with the default programming settings outlined in **TABLE II** and some values are loaded as "0s". This "0" value may not be read back correctly by some programmers although the decoder will operate properly. You can always program values that are within a particular system's operating range with that system's programmer, e.g., store a value of 1 instead of zero.

Programming differences: To harmonize with NMRA's "RP 9.2.3" programming RP, the DH140 and subsequent decoders do not implement the "legacy" {F9} decoder interrogate instruction. Note that this will not allow correct "address" read back on Marklin 6032 and older revision Lenz programmers that use this older {F9} instruction, and not physical register 1 read back. Note that even though the read back will fail with no confirmation, you will always be able to write a new value correctly.

8.0   Analog Operation of Digitrax Decoders

Analog operation occurs when Digitrax decoders are operated on DC or conventionally controlled layouts. Automatic analog mode conversion is a feature of most Digitrax decoders, which lets you run your decoder equipped loco on a DC layout without having to re-program the decoder. There are a few things you need to know about analog operation:

· Digitrax decoder equipped locomotives will not move until the voltage is above 5 to 6 Volts DC. When operating decoder equipped locos on DC power, increase the voltage quickly from zero to five volts for best operation.

· Some decoder equipped locos may not operate smoothly on conventional "pulse power." The decoders should be driven from a quality smooth DC power supply when on a conventional layout. Some DC

throttles/power supplies with proprietary control systems, such as "tracking control," exhibit pulse power characteristics and may give unpredictable operation.

· Decoders that use the Digitrax 9 Pin Decoder Interface can be easily removed from the loco and replaced with the DHDP Dummy Plug (available separately). This is very useful when you want to run your locomotives on conventional layouts without sacrificing low speed performance. It also allows you to run your engine on layouts that use pulse power. And, when you are ready to run DCC again, just remove the dummy plug & re-install the decoder and you're ready to go!

Appendix A: Programming with the PR1 & Your Computer

The PR1 is a low cost IBM PC-Windows based DCC decoder programmer that gives you a convenient way to program decoders using your PC.

· With the PR1 software's graphical capabilities you can "draw" loadable speed tables and send them directly to decoders via the PR1 and the programming track. You can also read back a decoder's speed table via the PR1 to the same graphical display.
· Save decoder information on your computer. This makes it simple to load the same speed table into several different decoders.
· Point and click programming for many advanced options. The software automatically loads the CV value based on your choices.
· Point and click programming for stationary decoders like the DS54, too!

Windows Compatibility Note: The PR1 works with Windows 98 and prior versions only. PR1 is not guaranteed to work with later versions of Windows.

Note: The latest programming drivers are available for download from the computer section of www.digitrax.com . We recommend that you upgrade your PR1 software frequently to take advantage of the latest new decoder features available.

PC Compatibility Note: Because of differences in hardware used for personal computers, PR1 is not guaranteed to work with all PCs. Within 60 days of purchase and after you contact our technical support department, if you find that the PR1 does not work with your computer, your purchase price will be cheerfully refunded.

What You Will Need

To program decoders using the Digitrax PR1 you will need:

* Digitrax PR1 programmer and software.
* Windows 98 (or earlier version) or DOS based computer with an available COM port
* 15-20 volt DC power supply or two 9 volt batteries connected in series to provide 12-18 Volts DC.
* Programming track wired to the PR1 with the cable provided.
* Be sure your computer's baud rate is 16,457 or 19,200. See "Exploring the PR1" for information on setting the PR1's serial parameters.

Connect the PR1 to your Computer

* Connect the PR1 to a known good COM port, with correct standard Interrupt settings.
* The PR1's COM port should NOT share interrupts with any other devices.
* The PR1 should be connected to the computer via the DB25 female connector. You can use a DB9 to DB25 adapter if using a 9 pin AT style COM port.

1. Connect the RED wire to the POSITIVE power supply output.
2. Connect the BLACK wire to the NEGATIVE output.
3. Connect the BLUE wire to one rail of the programming track.
4. Connect the WHITE wire to the other rail.
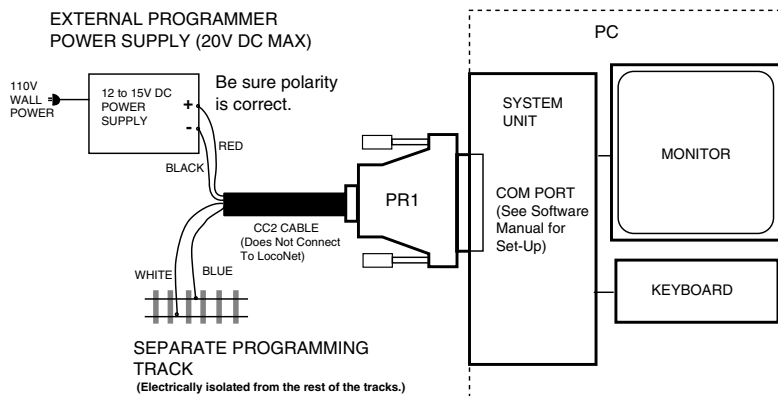
Set up the Programming Track

* When connecting the PR1 to the programming track, be sure to use ONLY the Digitrax provided CC2 cable. You can extend the cable

up to 20 feet but be sure to follow the color code exactly and use 24-26 AWG wire.

* Connect the Blue and White Leads on the CC2 Cable (which is included with your PR1) to an isolated piece of track with the loco-motive you want to program on that piece of track. This program-ming track must not be connected to any other tracks on the layout.
* Connect an appropriate DC power supply. Many users find two 9 volt batteries connected in series to be the best solution here. You can also use a low noise 15 to 20 Volt DC power supply with less than 0.1V of AC noise on the output. (Mouser part number 412-1104 is a good low cost choice for this power supply.)
* Connect the Black wire from the PR1's CC2 cable to the negative ter-minal of the power supply.
* Connect the Red wire from the CC2 cable to the positive (+) terminal of the power supply. Be sure to get the correct polarity or damage to the PR1 is likely.
* If you are using an unregulated supply it is a good idea to connect a 1,000uF 25V electrolytic capacitor (with correct polarity) across the CC2 Red and Black leads to ensure good filtering.
* If there is too much noise or insufficient input voltage, the PR1 may fail to correctly read back decoder information (although the CVs and their values can generally be programmed into the decoder).

Installing the Digitrax PR1 For Windows Software
· Open the README file on the disk that came with your PR1 and fol-low the installation instructions provided.
· Open the application according to your version of Windows

The first screen of the PR1 software will appear
This screen shows two small boxes in the upper left & right corners. The left box indicates the presence or absence of the PR1 plugged into the COM port of your computer. The right hand box indicates whether or not a digital locomo-tive is on the programming track. The red slash through the graphics indicates that there is no PR1 plugged in to the computer or there is no digital loco on the programming track. (Note that the presence of a locomotive without a decoder will not register on the programming track).

The connector icon indicates whether there is a PR1 module found on the selected COM port.

The locomotive icon indicates whether a decoder is present on the program-ming track.

The Red slash appears if the PR1 is not connected or a loco is not present and an "OK" appears if the opposite is true. These diagnostic icons appear on many

screens in the PR1 software. Both must show "OK" for you to be able to program or read back decoders.

NOTE: The PR1 is limited in the current it can provide to a decoder or locomotive on its Blue and White programming track leads. If the decoder is not connected properly, no damage is likely from trying to run it on the PR1 programming track. If you cannot read the locomotive address successfully, click on the "Abort" button to terminate the reading process and check that there is a correctly connected motor load on the decoder motor terminals. A mobile decoder does NOT have to be wired in a locomotive but can be simply connected to the PR1 programming track with temporary clip leads. If directly connected in this way you will need a resistor or 12V 5W lamp load on the decoder Orange and Gray Motor leads for correct read back. The decoder will still be programmed properly if you click on the "Send" button.

Note About Programming DS54 Stationary Decoders: For reading and writing the DS54 stationary decoder, remember that the Program Enable link must be in place on the DS54 to allow programming or reading to occur. For read back on the DS54 refer to the DS54 manual and be sure that a 12V 5W lamp load or a 10ohm resistor is connected from any Yellow lead in a DS54 output cable to either of the track feeds from the programming track. It is easiest to use temporary clip leads to make all the programming track connections.

Exploring the PR1
The first screen that you should see is the one with the picture of the PR1 as shown above. The tool bar has two main menu items: "PR1 for Windows" and "PR1." Let's look briefly at each one.

When you click on "PR1 for Windows" there are three choices:
       1. Help
       2. Exit
       3. About PR1 for Windows
The first two items are self-explanatory. (We will explore the Help file later.) The last item on this list tells you about the PR1 programmer software.

When you click on "PR1" you will see several choices including the following:
       1. Serial Interface
       2. Installed Programmer
       3. About PR1 for Windows

Serial Interface: Choose this option if you need to change the COM port, baud rate, or the transmit buffer length. We recommend an 800 byte buffer length and 16.457 or 19.2K Baud rates for faster operations.

Digitrax Programmer: This option allows you to program any Digitrax decoder, mobile or stationary. You can set up the decoder's speed curve, set FX settings, program the address and set other CVs. Performing any of these functions is literally as easy as filling in the blanks, or clicking a check box. The speed curve can be altered by simply dragging the curve to the position that you want. We'll go into more depth later with an actual example.

CV Programmer: This is the "Universal Programmer- NMRA" and it gives you the power to change the value of any Paged configuration variable. When the CV programmer is in the "read" mode, it can search the decoder and display the value for a particular CV in both decimal format (in the "%" box) and hexadecimal format (in the "$" box). This mode is compatible with any decoder that complies with the NMRA RP 9.2.3 Paged programming method.

Please note that some CVs may not be supported by the version of PR1 software you are running. These CVs can always be programmed using your built in programmer on your Digitrax command station.

DS54 Stationary Decoder: The DS 54 Stationary Decoder Programmer allows you to configure the settings on your DS54 using the PR1. Simply select this option under the drop menu and the DS54 screen appears. Consult your DS54 manual for complete DS54 programming information.

About PR1 for Windows: This shows the user information about the PR1 Software.

Note: The latest programming drivers are available for download from the computer section of www.digitrax.com . We recommend that you upgrade your PR1 software frequently to take advantage of the latest new decoder features available.

Programming a Digitrax Mobile Decoder with the PR1
Now that we have reviewed the PR1's options, let's go through the steps needed to program a Digitrax decoder and see how easy it can be!   From the opening PR1 screen, click on PR1 and follow the menus to the **Digitrax Programming** option. The programming screen will appear.

Notice that the screen is divided into several sections: **Configuration, CV Values, Characteristics, FX Setup, Programmer Task and a Tool Bar**. On this screen you will set up the various Configuration Variables (CVs) you want to program into the decoder by clicking on the "write" button, you can also read back the values in an existing decoder by clicking on the "read" button beside each item. Once you have made your read and write selections, you click "Search" to read back the decoder on the programming track or "Send" to program it. Note that only those items checked for read or write will be updat-

ed when you click on the "Search" or "Send" button on the Tool Bar. This allows you to change only the CVs you want to and leave others already programmed unchanged. For example, you can change a decoder's address without changing its loadable speed table.

Tool Bar and "Read" "Write" Buttons: The tool bar at the bottom left of the screen has 5 buttons.

 ·The "Search" button will cause the software to search the decoder
    attached to the programming track and read back the CV values you
    have checked for "read." Note that only those CVs checked for
    "Read" will be updated on the screen.
 ·The "Send" button will cause the programmer to "Write" the values you
    have entered for the CVs checked for write on the screen to the
    decoder on the programming track.
 ·Click the "OK" button to return to the previous screen.
 ·Click the "Help?" button for the on-line help file.
 ·Click the "Abort" button to terminate the "Search" or "Send" in
    progress.
 ·The programmer task section keeps you informed of the program's
    progress as it communicates with the decoder.

At the bottom right of the screen in the center are three buttons that let you save decoder set ups and load them into other decoders.
  *Clicking the "Load" button lets you choose previously saved decoder
    configurations to be loaded into a decoder.
  *Click the "Save" button to save the current decoder configuration.
  *Click the "Save As" button to save the current decoder configuration
    under another file name.

The **Configuration Register** section makes it easy to set up CV29. Here you tell the decoder whether to use analog mode conversion, to use a custom speed table, and whether to use Standard 14 speed step mode or Advanced 28/128 speed step mode.

The **CV Values** section lets you set and read back CVs related to the decoder's address, acceleration rate, deceleration rate, start voltage, mid point voltage and 2 private codes. Note: If you are using the loadable speed table, the values entered in V-Start , V-Mid & V-Max will not be used by the decoder but they will be "stored" in case you disable the speed table option.

The **Characteristics section** on the right side of the screen shows you the decoder's throttle response curve in graphic format. When you are not using a custom speed table then the only items that will be available for you to change on the curve are the start voltage, midpoint voltage and max voltage. You can manually enter values for these in the CV Values area or you can point and

click on the curve itself and drag it to the desired position. When you are using the loadable speed table you will be able to specify 28 discrete points on the curve. Note that the decoder's programming is not changed until you have placed a check mark in the "write" button and then click the "Send" button. Be sure that "use" speed tables is checked in the configuration register. See the speed table section in this manual for a complete explanation of how speed tables work.

When you click on the **"FX-Setup"** button a second menu screen appears which contains the special light effects for the FX decoder. If the decoder you are programming is not capable of FX effects, this section will not apply to your situation.

On this screen we have access to F0 Forward Light, F0 Reverse Light, F1, F2, F3 & F4. The programming directions and choices are the same for each function. The pull down field to the right of this shows you which effect is assigned to that particular function. Following is a list of choices:

·No effect, normal function control of output. This option leaves the output as normal ON/OFF operation.
·Random Flicker Effect
·Mars Light
·Flashing Headlight
·Single Pulse Strobe
·Double Pulse Strobe
·Flashing Beacon
·Gyralite
·Rule 17 Dimmable Headlight
·FRED
·Right Ditch Light
·Left Ditch Light

By choosing one of these effects, you are assigning it to a particular function on your hand held throttle.

The next column shows a red bi-directional arrow at the top and a check box below, these are the "direction" boxes or selectors. If you leave this box empty, you are telling the decoder that "forward" is the qualifying direction for the effect if you choose a Directionally qualified effect using the next menu selection to the right.

If you click this "direction" box to be marked with a small cross then this means you select "reverse" as the active direction, if this effect is directionally qualified.

The next column in the FX set up screen contains the pull down menus for qualifying the various effects. That simply means that you tell the decoder

when you want the special effect to be active. All the choices except "unqualified" are directional and use the direction set by the "direction box".

·**DIR=0=FWD** This means that the effect you have selected will be active only when the locomotive is running in the same direction as that selected by the "direction" box. For example, if the "direction" box has a small cross in it, the effect on this function output is "reverse" and will be forced OFF in the locomotive's Forward direction. The effect can only be active in the reverse direction. If the "direction " box is empty then the opposite is true and the function output and effect are considered "forward" qualified.

·**Unqualified** This option tells the effect to be "ON" when the function associated with it is "ON" regardless of direction.

·**DIR/F0=ON** This option tells the function F0 button to be an additional master function control button. Any effect qualified in this way will only be "ON" when the master function key F0 is "ON" and will operate when the loco is in the direction selected by the "direction " box. The advantage to this is that you can turn F0 "OFF" at the end of a session and all of the functions qualified this way will turn off at the same time, as opposed to turning each one off individually.

·**Special Effect** This option is used when you have ditch lights or rule 17 light effects. You will select this qualifier if you are setting up ditch lights or rule 17 dimming lights. This also is directional.

The last column is labeled DC. Check here to enable or disable functions when the decoder is operated in DC mode (no DCC signal present).

When all of your lighting effects are set, click on "OK" to return to the previous screen. When you have finished setting values click on the "Send" button and the PR1 will program the decoder.

Below the lighting effects section there is a field to enter a four digit address for the decoder and an option that allows you to set up the decoder for reverse as the normal direction of travel.

PR1 Programming Examples:

Setting up Ditch Lights
The following CV set up simulates prototypical ditch lights that are on steady when running and alternately flashing when the horn blows. The ditch lights will be on when the engine is running, when you simulate blowing the horn by going into function mode and pressing F2 the ditch lights will flash on alternate sides of the loco. Note, the F2 key on Digitrax throttles is set up as a non-latching function so that the function assigned to F2 will be "ON" as long as you

hold the F2 key down and will go "OFF" when it is released. Follow these simple steps with the PR1:

1. Go into the Digitrax Decoder Programmer
2. Click on FX Set up
3. Choose F1 and select "Right Ditch Light"
4. Select "Special Effect"
5. Choose F2 and select "Left Ditch Light"
6. Select "Special Effect"
7. Click OK
8. When you have returned to the regular programming screen click "send"

You can also set up options for Off Voltage (to determine whether the ditch light actually goes completely off), Effect Rate (to determine the rate at which the ditch lights flash), and F2 release delay time (to determine how long the ditch lights continue to flash after F2 is released).

Note that the ditch lights configured as above will be flashing when both F1 & F2 are "ON". When F2 goes OFF, the Ditch Light Hold time set by CV63 is in effect, and will keep the lights flashing until the programmed time finishes. The Ditch lights will then go steady ON. You can turn off both ditch lights by simply turning "OFF" F0, the Master Light control. In this example since the Right ditch light is on F1, F1 must be ON for this side to flash. The Special effect of Ditch Lights configures the F2 button for Flashing control , and the actual F2 function output simply follows the effect.

Setting Up a Mars Lights with the PR1
To program the decoder for Mars Light or other "single" output applications, follow these steps:

1. Go to the Digitrax Decoder Programmer
2. Select FX Set up
3. Choose the function that you want to be the Mars Light
4. Select "Mars Light"
5. Click "OK"
6. When you are back in the main screen click "Send"

Appendix B: Decimal & Hex Numbers

Over the years, different Digitrax throttles have used a combination of decimal, modified hexadecimal and hexadecimal numbers for entering CV#s and CV values. The following information is provided as a programming reference to show you how these different schemes work so that you will be able to use your throttle to program decoders.

UT1 & UT2 Utility throttles use decimal numbers exclusively for CV#s and CV values. Because these throttles use 2 selector switches that can access the numbers 0-9, you are limited to programming only CV#s and values 00 to 99.

DT100 Throttles use a modified hex numbering system for accessing CV#s and the CV value for the decoder address (CV01) as shown in **TABLE B1**. The DT100 is limited to programming CV#s 01-128. (See your DS54 Manual for special method of programming CVs related to stationary decoders that are above this range.) A 2 digit decoder address can be any decimal number from 01-128. When you use your DT100 throttle to access 2 digit addresses or CV#s, decimal numbers 00 to 99 appear in the display as 01-99 and decimal numbers 100-128 appear as listed below. For example, if want to select address 120 to run on your DT100, dial up C0.

TABLE B1

DT100 Throttle Display-CV# & 2 Digit Address
01-99 appears as 01-99 Addresses above 99 listed below:

DEC	HEX	DEC	HEX	DEC	HEX
100	A0	110	B0	120	C0
101	A1	111	B1	121	C1
102	A2	112	B2	122	C2
103	A3	113	B3	123	C3
104	A4	114	B4	124	C4
105	A5	115	B5	125	C5
106	A6	116	B6	126	C6
107	A7	117	B7	127	C7
108	A8	118	B8		
109	A9	119	B9		

DT100 Throttles use hexadecimal notation for all other CV Values entered. TABLE B2 is a conversion chart for decimal and hexadecimal numbers.

DT300 & DT400 Throttles use decimal numbers for entering CV#s and can use either decimal or hex for entering CV Values. You can change from decimal to hex and vice versa by clicking the R encoder knob when you are in programming mode. When a hex value is displayed, you will see an "x" in front of the number. When a decimal number is displayed you will see three numbers.

TABLE B2

<u>Decimal to Hexadecimal Conversion Chart</u>

DEC	HEX	DEC	HEX	DEC	HEX	DEC	HEX	DEC	HEX	DEC	HEX	DEC	HEX
000	x00	039	x27	078	x4E	117	x75	156	x9c	195	xc3	234	xEA
001	x01	040	x28	079	x4F	118	x76	157	x9d	196	xc4	235	xEb
002	x02	041	x29	080	x50	119	x77	158	x9E	197	xc5	236	xEc
003	x03	042	x2A	081	x51	120	x78	159	x9F	198	xc6	237	xEd
004	x04	043	x2b	082	x52	121	x79	160	xA0	199	xc7	238	xEE
005	x05	044	x2c	083	x53	122	x7A	161	xA1	200	xc8	239	xEF
006	x06	045	x2d	084	x54	123	x7b	162	xA2	201	xc9	240	xF0
007	x07	046	x2E	085	x55	124	x7c	163	xA3	202	xcA	241	xF1
008	x08	047	x2F	086	x56	125	x7d	164	xA4	203	xcb	242	xF2
009	x09	048	x30	087	x57	126	x7E	165	xA5	204	xcc	243	xF3
010	x0A	049	x31	088	x58	127	x7F	166	xA6	205	xcd	244	xF4
011	x0b	050	x32	089	x59	128	x80	167	xA7	206	xcE	245	xF5
012	x0c	051	x33	090	x5A	129	x81	168	xA8	207	xcF	246	xF6
013	x0d	052	x34	091	x5b	130	x82	169	xA9	208	xd0	247	xF7
014	x0E	053	x35	092	x5c	131	x83	170	xAA	209	xd1	248	xF8
015	x0F	054	x36	093	x5d	132	x84	171	xAb	210	xd2	249	xF9
016	x10	055	x37	094	x5E	133	x85	172	xAc	211	xd3	250	xFA
017	x11	056	x38	095	x5F	134	x86	173	xAd	212	xd4	251	xFb
018	x12	057	x39	096	x60	135	x87	174	xAE	213	xd5	252	xFc
019	x13	058	x3A	097	x61	136	x88	175	xAF	214	xd6	253	xFd
020	x14	059	x3b	098	x62	137	x89	176	xb0	215	xd7	254	xFE
021	x15	060	x3c	099	x63	138	x8A	177	xb1	216	xd8	255	xFF
022	x16	061	x3d	100	x64	139	x8b	178	xb2	217	xd9		
023	x17	062	x3E	101	x65	140	x8c	179	xb3	218	xdA		
024	x18	063	x3F	102	x66	141	x8d	180	xb4	219	xdb		
025	x19	064	x40	103	x67	142	x8E	181	xb5	220	xdc		
026	x1A	065	x41	104	x68	143	x8F	182	xb6	221	xdd		
027	x1b	066	x42	105	x69	144	x90	183	xb7	222	xdE		
028	x1c	067	x43	106	x6A	145	x91	184	xb8	223	xdF		
029	x1d	068	x44	107	x6b	146	x92	185	xb9	224	xE0		
030	x1E	069	x45	108	x6c	147	x93	186	xbA	225	xE1		
031	x1F	070	x46	109	x6d	148	x94	187	xbb	226	xE2		
032	x20	071	x47	110	x6E	149	x95	188	xbc	227	xE3		
033	x21	072	x48	111	x6F	150	x96	189	xbd	228	xE4		
034	x22	073	x49	112	x70	151	x97	190	xbE	229	xE5		
035	x23	074	x4A	113	x71	152	x98	191	xbF	230	xE6		
036	x24	075	x4b	114	x72	153	x99	192	xc0	231	xE7		
037	x25	076	x4c	115	x73	154	x9A	193	xc1	232	xE8		
038	x26	077	x4d	116	x74	155	x9b	194	xc2	233	xE9		

Notice that when using Hex numbers, the 6 and b look very similar in the throttle display so be careful that you are programming the value you want.

Ь = b   Ƃ = 6

Warranty & Repair Information

Digitrax fully tests every decoder we ship to be sure that you receive reliable products. Because we want you to be comfortable installing your own decoders, we recommend that you use a decoder tester to check each decoder prior to installation. This lets you be sure the decoder is working properly without worrying about decoder damage due to locomotive problems. If your decoder fails to pass the decoder test, we will replace it free of charge to you within 60 days of purchase. Because we can't control the actual decoder installation we can't cover your decoder once you have tested it and started the installation.

See www.digitrax.com for complete information about our warranty and repair policies and procedures.

In the event that you damage a decoder, we will repair or replace it for US$17.00 if you return the decoder to us. This includes shipping the decoder back to you at a continental U.S. address. For decoders that are shipped to addresses outside the continental US the charge is US$23. Note that in some cases with Digitrax lower cost decoders,, the cost to purchase a new decoder may be less than the repair charge.

Proof of date of purchase is required for all warranty repairs.

All warranties on Digitrax products are limited to refund of purchase price or repair or replacement of Digitrax products at the sole discretion of Digitrax. In the event that Digitrax products are not installed or used in accordance with the manufacturer's specifications, any and all warranties either expressed or implied are void. Except to the extent expressly stated in this section, there are no warranties, express or implied, including but not limited to any warranties of merchantability or fitness for a particular purpose.

Digitrax, Inc. reserves the right to make changes in design and specifications, and/or to make additions or improvements in its products without imposing any obligations upon itself to install these changes, additions or improvements on products previously manufactured.

FCC Information

Radio or TV Interference: (this information is MANDATED by the FCC)
This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference in a residential environment. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

-Reorient or relocate the receiving antenna.
-Increase the separation between the equipment and the receiver.
-Connect the equipment into an outlet on a circuit different form that to which the receiver is connected.
-Consult the dealer or an experienced radio/TV technician for help.

Note that any modifications to the equipment not expressly approved by Digitrax voids the users authority to operate under and be in compliance with CFR 47 rules, as administered by the Federal Communication Commission. Digitrax believes any conscientiously installed equipment following guidelines in this manual would be unlikely to experience RFI problems.
For Canadian Users:
"This digital apparatus does not exceed the Class B limits for Radio noise emission from digital apparatus set out in the Radio Interference Regulation of the Canadian Department of Communications."
Le present appariel numerique n emet pas de bruits radio-electriques depassant les limites applicables aux appareils numeriques de la classe B prescrites dans le Reglement sur le brouillage radioelectrique edicte par le ministere des Communications du Canada.

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