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DIGITAL COMMAND CONTROL | THE | OF | FUTURE |
| WAVE | THE |

DH82/DH82F
1 Amp Digital Command Control Decoder
Users Manual



DH82/DH82F USERS MANUAL

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1.0 Introduction:

Congratulations on your purchase of a Digitrax DH82 or DH82F Digital Command Control Decoder. It is engineered to give you exciting Advanced DCC control features at a reasonable price. It operates using the *proposed* NMRA DCC standard baseline packet format. Digitrax Decoders are American designed and manufactured to address the needs of the American Model Railroader.

Digitrax Inc., encourages and supports owner installation of decoders. We feel that most serious modelers have the common sense, judgment and skills needed to successfully install decoders. However, it is important that you follow the directions included in this manual and perform all tests and inspections carefully. To help make your first installation a pleasant experience, we recommend that you follow the Decoder Test Procedure. This simple test can be performed with a Digitrax Decoder Test Kit (included with Challenger systems or available from your dealer at a nominal charge or you can assemble your own kit from a few simple parts as outlined on page 4). The Test Procedure allows you, to check your new Digitrax decoder's functionality and familiarizes you with the decoder's features and hookup procedure. Please note that decoders that don't pass the Test Procedure should not be installed in your locomotive. See Section 9.0 Warranty & Repair on page 22 for details.

Please read this manual carefully before you install your DH82/DH82F. We have included lots of hints and operating ideas based on our experience with the Digitrax system. Your dealer can give you suggestions too. If you have questions not covered by this manual please let us know. Feel free to call, write or fax your inquiry.

If you choose not to convert your own locomotives, your dealer can handle the installation or refer you to someone who can perform the job for you.

2.0 DH82/F Features & Specifications:

- 1 amp (1.5 amps peak) Digital Command Control Decoder designed to fit easily in HO scale narrow-body Diesel prototypes, e.g., GP30 & GP35's
- Compatible with the proposed baseline NMRA Digital Command Control Standard
- An "open" mobile address range that allows you to program up to 236 loco addresses.
- Programmable decoder addresses, acceleration, deceleration, start voltage and mid-point voltage are easily reprogrammable from DCC compatible programmers without opening the locomotive
- Programmable Acceleration (simulation of train weight or inertia).
- Programmable Deceleration (simulation of braking action).
- Programmable Start Voltage (allows trim for locomotive motor efficiency).
- Smooth conversion to Analog operation for use with regular DC power packs.
- Programmable Mid-Point Voltage setting for adjusting the motor speed curve & performance.
- Directional lighting outputs for Forward and Reverse lights rated at 200ma.
- Smooth deceleration to stop before changing direction, when locomotive is reversed while moving forward. No sudden, non prototypical stops unless you send an Emergency Stop command.
- Complies with FCC Part 15, ClassB RFI requirements.
- Programmable Configuration Register allows full control of decoder personality.
- Selectable 28 Forward & 28 Reverse speed step operation or 14 Forward & 14 Reverse speed step operation.
- Decoders accept Advanced Direct speed control for 128 Forward & 128 Reverse speeds.
- Optional control of 2 additional 200ma function outputs on the DH2F model decoder.
- Automatic Thermal Overload shutdown protects components against temperature stresses. If the receiver gets overheated it shuts down and cools off before starting again.
- Bipolar DC motor drive of up to a *conservative* 1 amp rating, typically limited by heat buildup in locomotive body. (Transistors are actually rated for brief pulse of over 3 Amps.) This is more than adequate for most of HO scale motors on the market today.

3.0 DCC Communication Strategy:

The Digital Packet based DCC communication strategy offers a very robust and reliable method for a Command Station to convey commands to decoders.

Digitrax decoders:

- Verify all packets for valid SYNC, START, FRAME & STOP bits & reject incorrectly formatted packets.
- Perform Error Control Byte checking as part of the DCC protocol & reject packets with data errors.
- Only decode commands that are allowed in operating context, ignoring false actions.
- Will accept 3, 4 or 5 byte data packets and process those that it is programmed to execute.
- Utilize nominal 56 micro-second "1" bit 1/2 cell timing.
- Implement an additional "1/2 Cell Parity check" to help reject bad data bursts.
- Will accept Zero-bit (Analog mode) stretching in excess of 15 milliseconds/zero bit.
- Have sophisticated Digital filtering algorithms to ensure smooth mode conversion, including: "bounce-back" prevention when converting from Digital to Analog power mode or vice- versa.



DH82/F Decoder Wire Colors & Electrical Specifications

	DH82/F	Notes
Power Right rail	Orange	Engineer's side
Power Left rail	Red	Fireman's side
Motor +	Violet	1 amp rating, 1.5 amps peak
Motor -	Blue	1 amp rating, 1.5 amps peak
Forward Light	Yellow	200ma rating
Reverse Light	Brown	200ma rating
+RAW (Light Common)	Green	+ve full-wave supply, max 250ma
Function 1	Black	200ma rating
Function 2	White	200ma rating

Table 1

4.0 DECODER TEST PROCEDURE & KIT:

In order to provide maximum support to our customers, Digitrax has developed this quick and easy Decoder Test Procedure. We recommend that you test ALL decoders upon receipt to ensure that you are confident of their hookup, programming and function. The units leave the factory fully tested and ready to go, but it is always *comforting* to see correct operation before installing a decoder in your locomotive. This is especially true for anxious first time installers!

Digitrax will gladly exchange or refund payment for any decoder that you are not convinced works correctly after performing this test procedure. If there is a problem, please call for technical assistance. **Do not install any decoder that does not pass this test.** Do not shorten any decoder wires until the unit has passed this test.

4.10 Test Kit:

To perform the decoder test you need either a Digitrax Decoder Test Kit (provided with Challenger Systems or available from your dealer at a nominal charge) or you can assemble your own test kit from a few simple parts as outlined below.

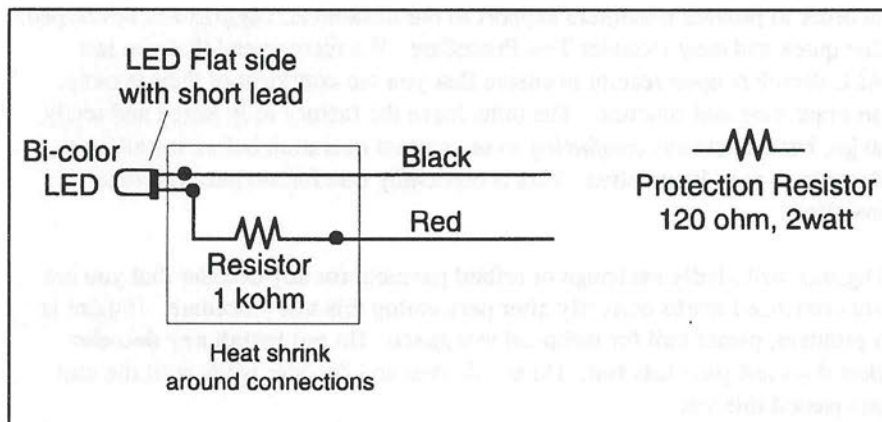
4.11 Build Your Own Test Kit:

Test Kit Parts List

#	Description	Radio Shack #
1	Resistor 120 ohm 2 watt (brown-red-brown bands) (Any resistor between 100 & 120ohms, minimum 2 watts, will do)	271-135
1	Resistor 1 kohm 1/4 watt (brown-black-red bands) (Any resistor between 750 & 1.5 kohms, minimum 1/4 watt, will do)	271-1321
1	Bi-Color LED ,e.g. Radio Shack 276-012	276-012
1	Black wire	
1	Red wire	
	Shrink tubing	

Note: Do not substitute an Incandescent (regular) or non-resistor LED lamp for the bi-color test LED.


Test Kit Diagram



4.2 Decoder Test Procedure:

This procedure is detailed for a **CHALLENGER™** Command Station but can be performed with other DCC compatible Command Stations. This test should be performed on a non-metallic surface. Please refer to Diagram 1 on page 6, along with the following instructions.

4.21 Test Power Connection:

Turn the **DB 100** command station  OFF. Connect one end of the 120ohm protection resistor from the Test Kit to the BLACK output terminal labeled TRACK A (RAIL A). This connection protects your Digitrax decoder from ANY subsequent wiring errors *as long as no other connection is made to the "TRACK A" (RAIL A) terminal*. Connect the free end of the protection resistor to the decoder's Right hand power input lead (ORANGE). Next, use a wire to connect the BLACK output terminal labeled TRACK B (RAIL B) on the command station to the decoder's Left hand power input lead (RED). This is the "protected" power input to the decoder. This arrangement limits the track power available which could cause damage to an incorrectly wired decoder.

4.22 Test "Motor" Connection:

Connect the RED lead of the Test Kit's bicolor LED to your decoder's Motor + lead (VIOLET). Connect the BLACK lead of the Test Kit LED to the decoder's Motor - lead (BLUE). Make sure none of the decoder leads is shorted to ANY other lead. (It may be easiest to temporarily tape the other leads out of the way to the non-metallic bench or table top).

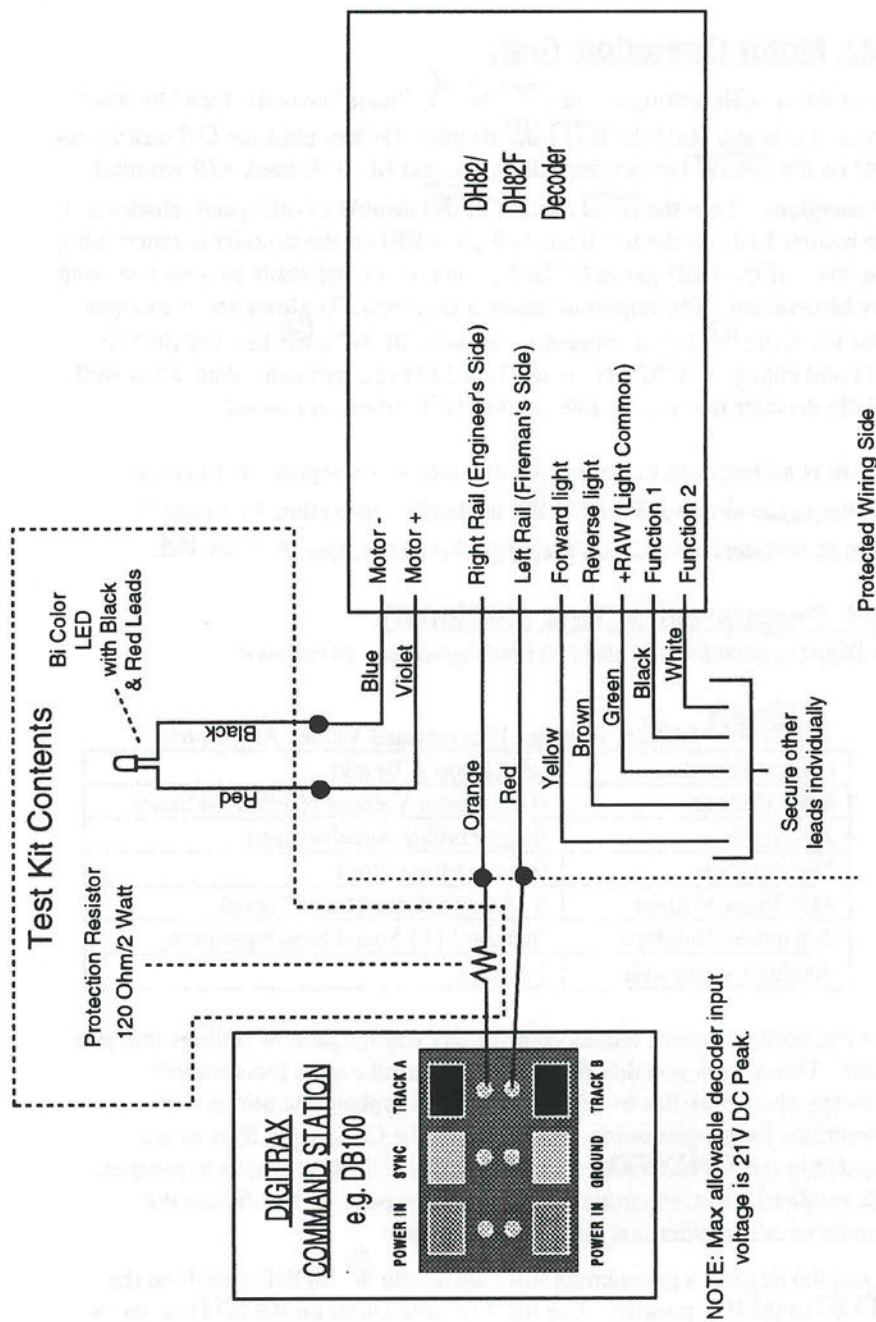










Diagram 1: DH82/F Decoder Test Procedure Wiring Diagram

4.23 Motor Operation Test:

Select the N-scale setting on the **[DB 100]**  "Scale" switch. Turn ON track power. Press and Hold the **[CT4]**  **[RUN/STOP]** key until the  Track Status LED on the **[DB 100]** glows, indicating that the BLACK track A/B terminals are energized. Turn the **[CT4]**'s BLACK  throttle to full speed (clockwise). The bicolor LED on the test leads will glow RED if the decoder is functioning properly. (If the LED glows GREEN, don't worry, the leads on your test lamp may be reversed. The important thing is that the LED glows and it changes color when the  key is pressed.) Press the BLACK  key and the test LED will change to GREEN. If the Test LED changes color then, all is well, and the decoder is correctly interpreting DCC command signals.

If there is no response to the throttle movement, try reprogramming the decoder to the Group A BLACK  as detailed in section 4.24 page 7. Digitrax decoders are shipped preprogrammed to Group A Black .

4.24 Programming Test (Optional):






All Digitrax decoders are shipped preprogrammed as follows:






DH82/F Decoder Programmed Values As Shipped

Loco Address	03 (Group A Black)
Start Voltage	0 (No Extra Voltage Needed To Start)
Acceleration	0 (Immediate Acceleration)
Deceleration	0 (Immediate Stop)
Mid-Point Voltage	0 (Straight Line Motor Curve)
Advanced/Standard	Standard (14 Speed Step Operation)
Analog Conversion	Enabled











You can easily program the decoder for any combination of settings that you prefer. This allows you the flexibility to determine each locomotive's operating characteristics to achieve truly prototypical operations. Full instructions for programming decoders with the Challenger System are included in the **CHALLENGER™** Operating Manual. If you wish to program with another DCC compatible programmer see page 15 and follow the manufacturer's instructions for that equipment.

To test the decoder's programmability, move the  MODE switch on the **[DB 100]** to the P/R position. Use the 4 throttle knobs on the **[CT4]** to set the decoder's  Acceleration,  Deceleration,  Start-voltage and  Mid-point motor curve adjustment to characteristics that you want. *The text under*

each knob indicates the type of adjustment that knob affects when programming is underway. Press one of the BLUE, GREEN or BLACK  keys to send the programming information to the decoder, this will set the decoder's address to that "color" locomotive channel. If all the throttle knobs are turned completely counter-clockwise when you press the selected color  key the nominal value of "0" will be loaded into the decoder's control registers. You can check that programming is occurring by watching the test LED when you press the  key. The Test LED will briefly pulse several times, indicating that good program commands were received and stored by the decoder. The unit will remember all programmed settings in Non-volatile memory even when the power is turned OFF. Experiment with the program settings to gain an understanding of their effects on your locomotives. Digitrax One-Step programming makes it easy to change loco settings as often as you wish.

Note: The Group A RED address is reserved as the "ANALOG" operation channel to allow operation of one conventional locomotive on your Digitrax layout. Therefore, the Group A RED throttle is not programmable for digital locomotives. Note the DB100 defaults to Group A at power on.

4.25 Directional Lighting Test:

Turn OFF the **DB 100** track power by pressing and holding down the **CT4**  RUN/STOP key until the unit beeps twice and the track status LED goes off. Disconnect the Test LED leads from the decoder. Attach the BLACK lead of the Test LED to the wire that is connected to the decoder Left power lead (RED). Connect the RED lead of the Test LED to the Forward light lead from the decoder (YELLOW). Be sure that the Motor and all leads *not being used* are secured and not touching each other. Press  to turn ON the track power. Press the  LIGHT key followed by pressing the colored  key corresponding to the decoder's programmed address. The Test LED will glow when the Light has been turned on by the command station. (More than one  command may be required because the DB100 simply sends a toggle command and if the decoder's Light function was OFF and the OFF command was sent then nothing will happen until the next  command which sends the ON command.) Once the Test LED lights up, press the  key several times to simulate changing direction. The light should toggle between on and off as you "change direction." Press and hold  to turn OFF track power (you'll hear 2 beeps). Change the Test LED RED lead to the Reverse Light function lead (BROWN) and repeat the test. This completes the Directional Lighting tests.

4.26 Function Output Test (Optional):

To test the extra function outputs you will need a command station that is able to access these outputs. The **CHALLENGER™** System does not access these functions but you can use Digitrax DCS200, DCS300 or DT200 command stations to do this. Some other DCC compatible Command Stations are also able to access these functions. The test setup is the same as for the lighting test but the RED Test LED lead is connected to the specific function to be tested. Verify that the Test LED glows for each function command given, i.e., F1, F2 extra functions.

At this point you can **confidently** install your decoder in a locomotive, knowing it is working properly, is correctly configured and that you understand the connections. For installation instructions refer to section 5 which follows.

5.0 Decoder Installation Instructions:

Please refer to the wiring Diagram 2 on pages 11 & 12, along with these instructions. Before beginning ANY conversion it pays to carefully plan the whole installation strategy and review the options available.

5.1 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. So, be sure to address any mechanical issues with your locomotive before you install the decoder.

Remove the shell and look inside. Is there a readily available space to put the decoder or will you need to "make room?" The answer to this question is as varied as the different locomotives available.

5.2 Decoder Placement:

The mechanical placement of the decoder is important, and may involve sculpting plastic and or metal parts to allow enough room for installation. Try to locate the decoder in the coolest part of the body. Digitrax decoders have built in thermal overload protection to protect them from long term overloads and high ambient temperatures. We recommend an operating temperature of between 20 and 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. Try to put them where they can shed as much heat as possible. If your decoder becomes overheated, it will briefly shut down until it cools down.

5.3 Choosing the Right Decoder For Your Locomotive:

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 the DH82/F Decoder. Some older motor designs (older Athearn open frame motors, Pittman motors, etc.) may exceed these limits and you may need to use a higher current decoder such as the DH83F in these applications.

To determine whether a particular motor is suitable to run with the DH82/F decoder, check the stalled motor current at 12V. To test the motor put the loco without shell on regular DC powered track at 12V for HO & N Scales (16V for G Scale). Attach a DC current meter (ammeter) in series with one of the track feeds. Apply DC power to the track. 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. If the stall current exceeds 1.25 amps, you should use a Decoder with a higher current rating.

TECHNICAL NOTES:

For use with motors other than normal 3 or 5 pole axial DC motors (Open-frame or sealed cans) you should test the motor's suitability to run with the DH82/F Decoder at different voltages and loads, and be sure the motor's thermal ratings won't be exceeded in operation.

Examples of these may be very low inductance and low inertia ironless rotor type designs and other new technologies as they are introduced to the scale model locomotive market.

5.4 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 exclusively by the decoder circuitry*. *Failure to do this could damage your decoder. Damage caused by failure to isolate the motor is specifically excluded from our warranty. If you do damage your decoder, all is not lost, just call Digitrax and return the decoder to us along with the replacement fee and we will either repair the decoder or replace it.*

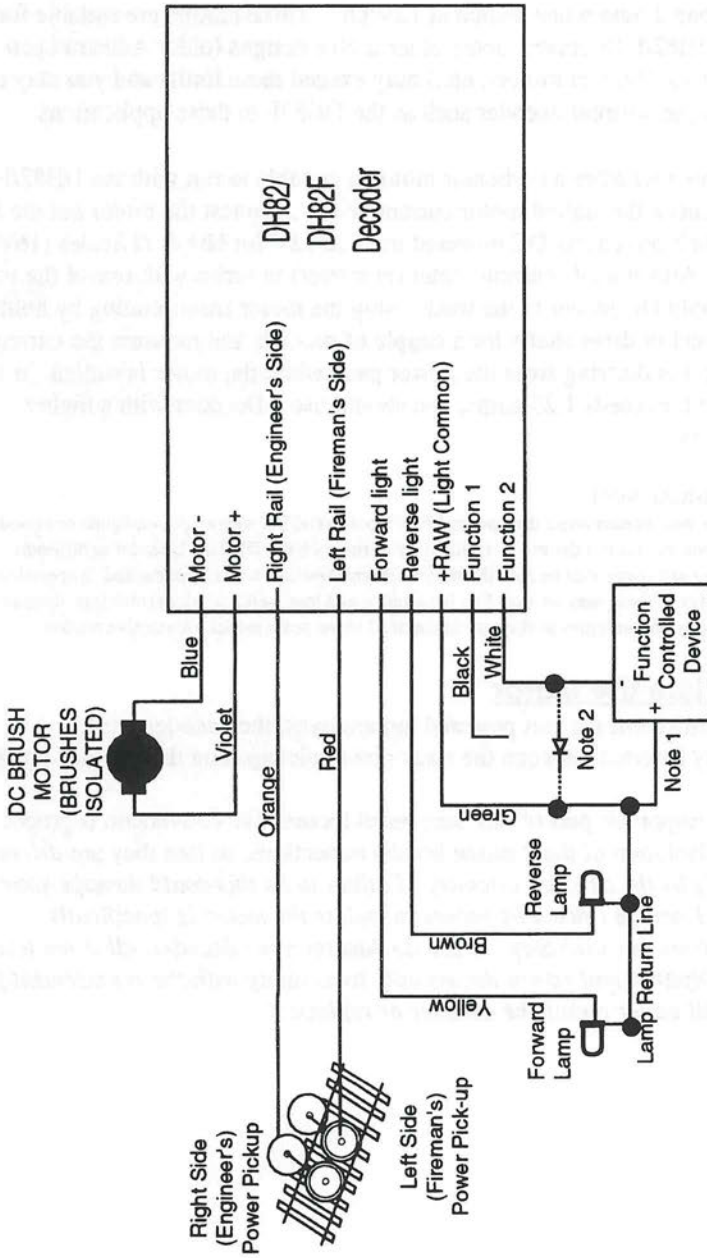


Diagram 2: DH 82/F Decoder Installation Wiring Diagram

Diagram 2 Notes:

- 1) If +RAW is available, e.g., on the DH82/F, this is the positive lead for "full wave" function power operation. Do not exceed the 200 ma rating of the function outputs. If +RAW is not used, connect function power to either track power pick-up for "half wave" operation. The directional light function "Lamp Return Line" can be hooked to +RAW as shown or to either track pick-up.
- 2) If you use an inductive (coil) type load, you should place an inductive kick-back suppression diode across the coil with the cathode (banded) end connected to the function power side, Not the function output connection. A small signal diode such as IN4148 or rectifier such as IN4001 should be satisfactory. An incorrectly connected diode may damage the function output, so be careful.
- 3) See Diagram 3: Directional Lighting Wiring Specifics on page 13 for details of wiring 12-16V lamps, 1.5V lamps and LED's for full and half wave operation.

Once you think the motor is isolated, visually inspect the brushes one more time to be sure. Then measure the resistance of both brushes to the power pickup and frame, with a reliable continuity checker. There must be an OPEN circuit (very high resistance) from both brushes to any other part of the locomotive chassis or power pickups and wheels. If this is not the case, determine what is causing the low resistance path. Some motor brush power connections may be tricky, such as a spring to or interference fit with part of the chassis. Some locos pick up brush power from the chassis through a spring. After removing the spring connection to the brush, wire the corresponding decoder power input to the chassis.

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

5.5 Motor & Power Connections:

Connect the wire that was previously connected to the motor from the Right power pickup to the decoder's Right power input (ORANGE). Connect the Motor + lead (VIOLET) from the decoder directly to this motor brush. Remove the wire from the Left power pickup and connect it to the decoder's Left power input (RED). Hook the MOTOR - (BLUE) to the brush that was connected to the Left power pickup.

5.6 Directional Lighting & Function Outputs:

See Diagram 3 on page 14. Connect the Forward light function (YELLOW) to the forward lamp or cathode lead of a resistor LED. Make sure that this lead does not connect directly to either track power feed via a lamp socket, other wire, etc. Hook up the Reverse light function (BROWN) in the same manner. Hook both directional light outputs together if the locomotive has only one lamp. In this case the light will be on if the light function is turned ON. Hook up extra function outputs (BLACK & WHITE) the same way as directional lighting. Be sure not to exceed the 200 milliamp output current rating. Make sure all joints are heat shrink sleeved or reliably insulated.

Again make sure that BOTH motor brushes are completely isolated from any connection other than the decoder and that there are no short-circuits. Unfortunately, with a real motor load it is impossible to use a protection resistor to prevent decoder damage. So, be very careful and visually inspect the installation for any possible interferences or mechanical hazards that may cause problems. Examples of this may be wire routings that can touch moving surfaces and be chafed, or wires that could be pinched when the locomotive boogies, etc., articulate on the track.

Diagram 3: Directional Lighting Wiring Specifics

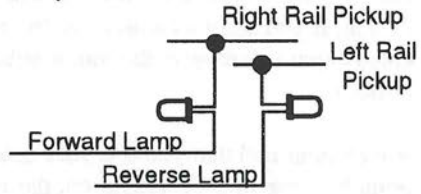
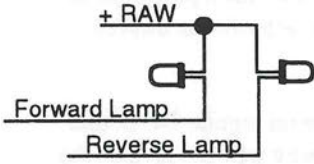
Full Wave Operation

Lamp brightness will not be affected by analog stretching 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 this way.

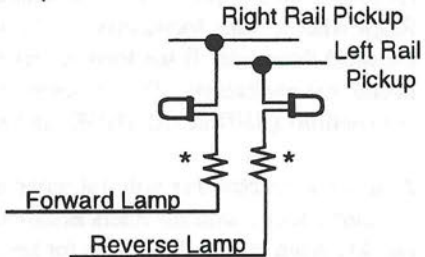
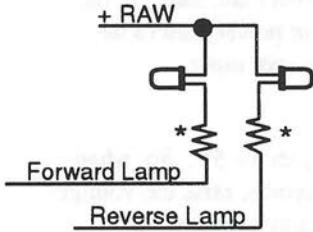
Half Wave Operation

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 the two modes of operation.

12-16V Lamps

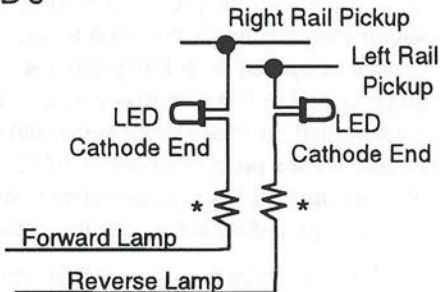
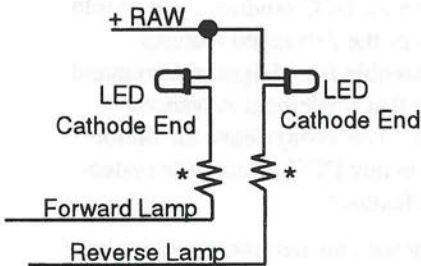


1.5V Lamps



*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.

LED's



* Note: LED's are sensitive to polarity when hooked up. Typical resistor 680 ohm 1/4 watt.

5.7 Final Test:

Finally, you are ready for the test track. If you followed the conversion steps carefully and correctly, you will be able to drive the locomotive and turn the lights and functions ON and OFF. Most problems are the result of some small detail in the conversion process.

If the unit does not travel in the proper direction you have reversed the polarity of the motor brush connection. (The DB100 powers up with all locomotives in the Forward direction.) Power down, swap the motor leads and retest. (Of course, if you want a locomotive to seem to "run in reverse" for a prototypical consist you can reverse the motor polarity on purpose to achieve the desired effect.)

We recommend that you test your converted locomotive on regular DC at this point because in DCC operation, the wrong pickup polarity will not reverse the motor direction. If the pickup polarity is reversed, it must be fixed for proper Analog operations. Test your locomotive for proper analog operations, by running it on a regular DC track with the positive polarity connected to the Right wheels. The locomotive will convert to Analog power and move in the Forward direction. If the loco moves in reverse, the input power feed to the decoder is backwards. Power down, swap the decoder power input connections (RED & ORANGE) and retest.

Note: The locomotive will not move until the voltage is above 5V. So, when operating locos with decoders installed on regular DC layouts, raise the voltage quickly from zero to five volts for best operation. You may switch polarity instantly without a problem.

6.0 Operation With Other DCC Compatible Command Stations:

Digitrax decoders are designed to operate with Command Stations that are compatible with the proposed NMRA DCC standard. If your command station and/or Programmer is designed to interoperate with DCC products, you should be able to operate with few problems. Several of the Advanced features incorporated in Digitrax decoders are only accessible from Digitrax Command Stations and more advanced command stations that implement Advanced features of the proposed NMRA DCC standard. You **always** have the option of programming Digitrax decoders to operate on any DCC compatible system even though it does not access these advanced features.

Digitrax Decoders are shipped from the factory with the default programming settings outlined on page 7 and some values are loaded as "0"s. Also, the

Challenger System loads "0" values in some registers when the knobs are turned completely counterclockwise during programming. *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.

The Decoder Test Procedure can be performed with any DCC compatible command station as long as the Protection resistor is correctly wired into the Track output, and you substitute the appropriate commands to select Locomotive addresses, directional light functions and extra Functions. Be sure the output peak voltage from the command station is appropriate for the decoder you are testing. The manufacturer of your command station should be able to easily assist you with these details.

7.0 Troubleshooting:

If the decoder has intermittent problems on the track, check the following possibilities:

- 7.1 Is the Decoder is Overheating? See Sections 5.2 & 5.3 on pages 9&10.
- 7.2 Is the track clean, and are the power feeds reliable?
- 7.3 Are the locomotive wheel pickups and internal electrical connections reliable?
- 7.4 Strange Lights? Does the programmed operating mode of the decoder match the mode used by the command station? 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 receiver or by changing the command station's operating mode.
- 7.5 Does the locomotive have any mechanical binding problems, etc., are any wires shorting, etc., or touching moving parts?
- 7.6 Locomotive "buzzes" after decoder installation? Try lubricating the loco's brushes.

8.0 Technical Reference for Programming & Configuration:

The Locomotive address, start voltage, acceleration, deceleration, mid-point voltage value and configuration register are all "One Step" programmable using the "Challenger"™ Command Station. This allows the user to **avoid the confusion** inherent in the "nuts and bolts" details.

Other DCC compatible programmers are able to access and program Digitrax decoders as well. The following details are provided for the technically minded user who wants to decipher the appropriate programming sequences detailed in the technical support documentation provided with his or her programmer. Digitrax *intentionally* designed its advanced configurations, expanded features and future product enhancements to be generally usable from earlier

generation programmer devices, and to allow upgrading to more powerful programming techniques planned in the proposed NMRA advanced packet formats.

Note that numbers following are decimal values (binary or hexadecimal representations will be noted if referred to).

Digitrax decoders are programmed using reserved "Service Mode" addresses that are not normally used for operating locomotives. To allow access to more configuration variables and proposed future NMRA features, one of the direct service mode addresses is always a "PAGE" address register. This register is write data address at 125 and performs a "read compare" match response at address 117. The value in this register is the page number for a "page" of four values written at 120 to 123 and "read compared" at 112 to 115. These four "offsets" are tabulated in Table 2 for the currently defined Digitrax usage. This is compatible with the baseline usage of these addresses by other programmers that use the four baseline values (LOCO ADR through DECEL).

Note that the V-MID value is stored in page 2 at offset 2, or service mode address of 121/113. The Digitrax configuration register has been fixed at service mode address 124 for writing and 116 for read comparison.

The "read comparison" of the service mode is the way a programmer can determine what data a decoder has stored in its many registers. A packet sent to one of the 8 reserved read addresses causes the decoder to generate a motor current pulse response when the data in the packet matches the data in the register being interrogated. This is why locomotives "chirp" during programming and when they are read on a programming track.

Digitrax Configuration Register:

This is a full 8 bit flag register with 2 defined and 6 reserved flag bits. These are defined by data bit position and function. This section assumes that the reader is familiar with data formats and "bit positions."

Digitrax Flag Map:

Flag Data Bit	Decimal Equivalent	Flag Function
0(lsb)	1	Reserved
1	2	If Set, use Advanced 28 Speed Steps
2	4	If Set, allow ANALOG mode conversion
3-7	x	Reserved, all reserved bits programmed 0 (or cleared by) Digitrax Command Stations

To decode the register setting, add up the decimal equivalents for any flags that are SET. This is the decimal data to write to the register. Factory settings for Digitrax decoders are: analog conversion SET and advanced speed steps NOT set (since Digitrax Command Station owners can so easily configure decoders) the data value is 4 in this register when shipped. This allows Digitrax decoders to operate properly on a system that does not support advanced modes. Decoder users using Digitrax Command Stations generally reconfigure new Digitrax decoders during the initial Decoder Test Procedure.

Locomotive Address:

The locomotive address has a valid decimal value between 1 and 253, excluding the numbers 112 to 127, which are service mode programming access addresses. Note that Digitrax

decoders *do not limit* mobile decoder addresses to addresses below 99. If a user experiences conflicts with stationary decoder addresses in the range 128 to 253, as are used in some existing systems, it is a simple matter of reprogramming the locomotive to a different address outside the stationary address range used. This gives Digitrax customers maximum flexibility and the greatest available address range, since it is unlikely that the whole 128 to 253 address range will be used by stationary decoders.

Start Voltage:

The start voltage, V-START, is added to the motor drive voltage at the first code step (NMRA code 02 speed code). The value is defined as valid between 0 and 255. Each value increment represents an increase of approximately 0.25% of the motor drive voltage, when using a "straight-line" motor speed curve. The value of 255 represents 100% motor voltage. Note that this V-START value is interpolated from the first code step, 02, to the mid code step, code 15 in the advanced 28 speed steps mode, which itself has a motor voltage of V-MID, see following section. If the V-START value loaded in the decoder is *greater* than the V-MID value, the decoder will clamp the motor voltage output for code values from code 02 to the mid-code 15 (28 step system) to the V-MID value. This avoids undesirable throttle effects.

Acceleration:

This register sets the rate at which the decoder can increase code steps in response to a new speed value. The valid range of values is 0 to 31. A value of zero sets an *immediate* response to any new speed. The rate of speed step change is approximately 0.1 second per increment in acceleration value. For example a value of 1 in this register sets the decoder to change at 0.1 second per code step (using the 28 speed step range), such that it takes 2.8 seconds to slew from stopped (code 0) 28 steps to full speed (code 31), assuming a full speed code is received when the locomotive is stopped. If the user is using the older 14 speed step command stations the decoder will process this data so that the acceleration rate appears the same in either mode.

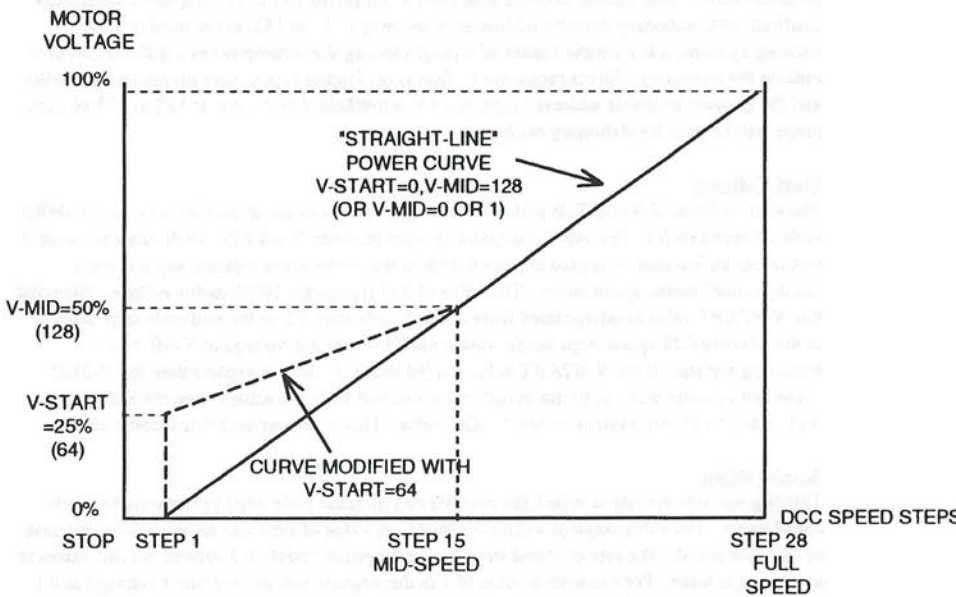
Deceleration:

This register sets the rate at which the decoder decreases code steps in response to a new speed value. The valid range of values is 0 to 31. A value of zero sets an *immediate* response to a new speed. The rate of speed step change is approximately 0.1 second per increment in Deceleration value. For example a value of 1 in this register sets the decoder to change at 0.1 second per code step (using the 28 speed step range), such that it takes 2.8 seconds to slew from full speed (code 31) 28 steps to stopped speed (code 0), assuming a Stop code is received when the locomotive is at full speed. If the user is using the older 14 speed step command stations the decoder will process this data so the deceleration rate appears the same in either mode.

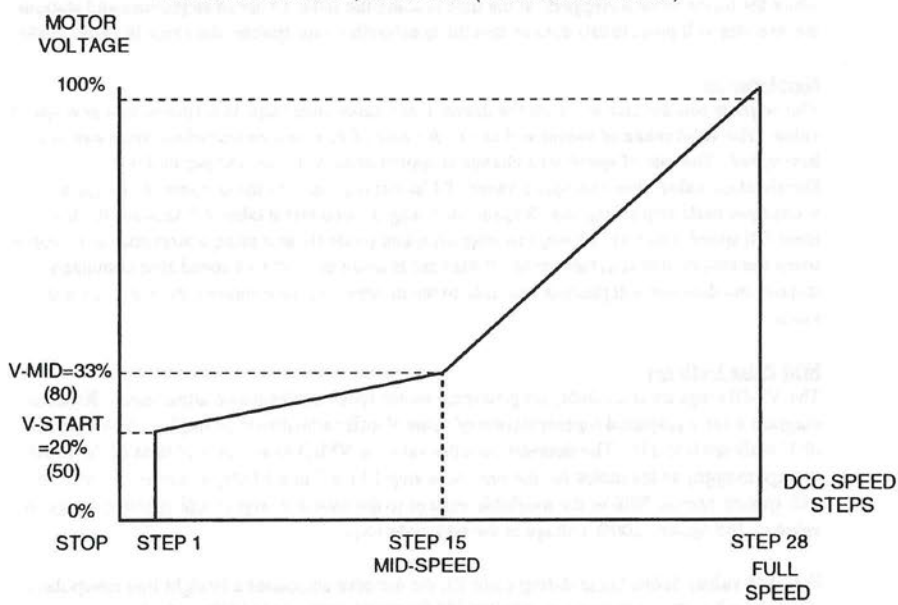
Mid-Point Voltage:

The V-MID register is a subtle, yet powerful, motor speed performance adjustment. Refer to diagram 4 for a graphical representation of some V-MID adjustment examples. Valid values of V-MID are 0 to 255. The decoder uses the value of VMID as a representation of the exact voltage to apply to the motor for the mid-code step 15 (or 7 in a 14 step system). A value of 128 applies exactly 50% of the available voltage to the motor at step 15 (28 speed system). A value of 255 applies 100% voltage at the mid-code step.

For code values *below* the mid-step code 15, the decoder calculates a straight line interpolation proportional to the code step value and the V-START initial and V-MID endpoint values, respectively. In a similar manner, for the code value *above* mid-step code 15, the decoder calculates a straight line interpolation proportional to the code value and the V-MID initial and maximum voltage (100%) endpoint values, respectively. The code for the mid-point code for the 14 step system is 7, and the adjustment is transparent and appears to have the same result

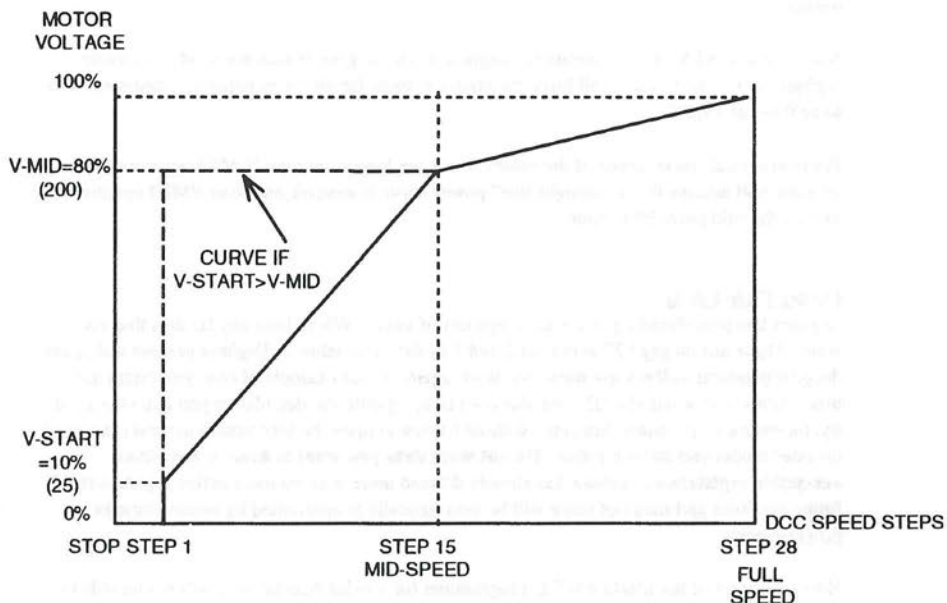


(A) NOMINAL "STRAIGHT-LINE" SPEED/VOLTAGE CURVE
V-MID=128 OR 0 OR 1, V-START=0 (FACTORY SETTINGS)



(B) SPEED/VOLTAGE CURVE COMPRESSED IN LOWER RANGE
V-MID=80, V-START=50

DIAGRAM 4: Digitrax Decoder V-MID Control Examples



(C) SPEED/VOLTAGE CURVE EXPANDED IN LOWER RANGE
 V-MID=200, V-START=25

NOTES:

1)"STOP" is code 0, step1 is code 2, step 15 is code 15 and step 28 is code 31 in the proposed NMRA data format for advanced 28 speed packets.

2)For CT4 programming, if either the RED(V-Start) or the BLACK(V-Mid) throttles are at STOP position, the Challenger Command Station will load a zero data value to the corresponding setting. A 1/2 throttle value will load approximately 128, the mid-span value, and full throttle will load the 255 maximum value.

Experimentation with several throttle settings will help you find the motor settings you prefer for any locomotive.

DIAGRAM 4: Digitrax Decoder V-MID Control Examples (continued)

whether the decoder is configured for Advanced or Standard mode in the Configuration register.

Note that if V-START is accidentally programmed to be greater than the V-MID numeric register value, the decoder will force the output voltage for all codes below the mid-step value to be fixed at V-MID.

For operational convenience, if the values 0 or 1 are loaded into the V-MID register the decoder will assume that a "straight-line" power curve is desired, and load VMID operationally as 128, the mid point 50% value.

Owner Code 1 & 2:

Digitrax has predefined 2 private data registers of your OWN to load any ID data that you want. These are on page 27 at offsets 2 and 3 as shown in table 2. Digitrax present and future decoder products *will not use these two data registers*. An example of how you might use these codes is as a decoder ID code that is fixed to a particular decoder so you can identify it by, for example, purchase date, etc., without having to open the locomotive to verify the exact decoder model and serial number. **Do not store data you want to keep in any other accessible registers** as Digitrax has already defined more than 90 more active registers for future products and many of these will be automatically programmed by future Digitrax programmers.

Note that users of the Marklin 6032 programmer (or similar Arnold unit) will not be able to read the offset 1 (corresponding to loco address in page 1) data back properly in any page except Page 1, since this programmer will interpret the offset address 1 (a single LED bar in the 6032 display) as an address interrogation command, and it executes this in a different manner than a normal DCC compatible service mode read comparison at address 112. However write data to offset 1 will program properly as a DCC compatible write to address 120, only limited by the data range of 1 through 99 of the 6032.

Table 2: Program Data Map of Digitrax DH82/F (Release B December 1993)

Usage	Address (Write)	Address (Read)	Valid Range	Factory Setting	6032 "Bars"
Configuration Register	124	116	See flag map	4	5
Page Register	125	117	1 to 30	1	6
Page 1:					
Loco Address	120	112	1 to 253	3	1
Start Voltage (V-START)	121	113	0 to 255	0	2
Acceleration (ACCEL)	122	114	0 to 31	0	3
Deceleration (DECEL)	123	115	0 to 31	0	4
Page 2					
Mid-Point Voltage (V-MID)	121	113	0 to 255	0	2
Page 27					
Owner Code 1		113	0 to 255	x	2
Owner Code 2	122	114	0 to 255	x	3

Notes & Observations:

- 1) "x" denotes that the value is not defined.
- 2) The 6032 "Bars" refer to the number of horizontal LED segments the Arnold/Marklin 6032 style programmers use to indicate which data value they are referencing, e.g., 2 bars lit

corresponds to the service mode address of 121 to write and 113 for read compare, which for example, programs the start voltage in a Marklin 6082 2-Rail DC decoder.

3) For the 6032 programmer, "5 code bars" will always read the Digitrax configuration register irrespective of page number, which itself is always in the "6 code bar" register location.

4) The data in all the programming registers is non-volatile and will be remembered during any time the power is off. Thus, the page number will always be left at the last page address loaded.

5) 6032 style programmers read back data for the "1 code bar" in a different fashion from the DCC service mode protocol, since they consider this a locomotive address interrogation and not generic service mode data read comparison. This interrogation will also suppress proposed advanced flying programming data address 25 that is at present unused.

Operational Considerations:

Initially, you should keep deceleration numeric values as small as practical. This allows you to adapt to the delays in deceleration you have programmed without crashing your valuable locomotives!

If you are uncertain about these programming effects, load either zero or one into all the page 1 values except Locomotive address. The V-MID on page 2 should also be loaded with zero or 1. Digitrax factory presets are shown in table 2.

Use of +Raw (Light Common)

For decoders with no +RAW output, the directional light and function outputs will always have the "other" supply lead of the device being controlled connected to *either* of the track power pickups via the chassis or a wire. This results in "1/2 wave" drive, or put more simply, the light will see only about half the track voltage when the function is activated. If "analog zero-stretching" is used this can result in variations in the brightness of the lamp. Connection of the supply leads of the device to the +RAW line will result in full voltage drive for the function whenever it is active. Be sure +RAW is not shorted to either track pickup!

On the DE8x series of decoders, the MOTOR leads are configured for the "split phase" universal type motor found on some Lionel, Marklin, etc., locomotives. In this case the +RAW line is hooked to the common return line of the motor and the MOTOR + and - leads are hooked to the directional field windings of the motor. To test in this case, connect the Test LED RED lead to the decoder +RAW and connect the Test LED BLACK lead to Motor + and Motor - in turn to prove functionality. In this case the LED will only glow RED when the decoder turns on the motor in the direction being tested.

9.0 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 outline a Decoder Test Procedure for performing an assurance test on your decoder so that you can be sure your decoder works before you begin installing in your locomotive. If, within 60 days of purchase, your decoder fails to pass the Decoder Test Procedure outlined on pages 4-9, we will replace it free of charge to you. Because we can't control the actual decoder installation we can't cover your decoder once you have tested it and started the installation. In the event that you somehow manage to "blow-up" one of these little guys, we will repair or replace it for a nominal fee (call for the current amount) if you return the decoder to us.

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.





10.0 Appendix: Other Digitrax Decoders & NMRA Addresses:

Decoder Wire Colors For Selected Models

	DN82/F	DH82/F	DH83/F	DG82/F	DE82/F
Power Right	Red	Orange	Red	Red	Orange
Power Left	Black	Red	Black	Black	Red
Motor +	Orange	Violet	Orange	Orange	Violet
Motor -	Gray	Blue	Gray	Gray	Blue
Forward Light	White	Yellow	White	White	Yellow
Reverse Light	Yellow	Brown	Yellow	Yellow	Brown
+RAW (Light Common)		Green	Blue	Blue	Green
Function 1	Green*	Black	Green	Green	Black
Function 2		White	Violet	Violet	White
Function 3			Brown	Brown	

*Blue on all A&B Series DN82F's

NMRA ADDRESSES AS THEY CORRESPOND TO CHALLENGER COLOR CODES

	RED 	GREEN 	BLUE 	BLACK 
GRP A	CONV	01	02	03
GRP B	04	05	06	07
GRP C	08	09	10	11
GRP D	12	13	14	15



TECHNICAL NOTES-Decoder Installation:

December 21, 1993

1) **Motor Isolation:** On the basis of our installation experience and that of some customers, we have come across several locomotives in which the entire motor frame connected to one wheel pickup and the corresponding motor brush. One example of this arrangement is the SW1 HO switcher made for Walthers by ROCO of Austria. Note that in this locomotive the lower brush (brass hex-head cup) screws up to and connects to the motor frame. The easiest way to isolate the motor is to add a fiber-washer under the lower brush (similar to that used on the upper brush) to isolate the motor brush lead. Then you just solder the brush connection to the isolated brass brush-holder. Several customers have reported similar issues with Atlas locomotives made in Austria (by Roco?).

2) **High Current Lamps:** The Decoder manuals illustrate how to connect common 12 Volt to 16 Volt lamps for directional lighting. Some older & less efficient lamps draw significantly more current than the more modern lamps described. Compounding this problem is the fact that incandescent lamps briefly draw up to *nearly ten times their normal load current* when they are first switched on from "cold" or room temperature. Decoders typically have a 200 milliamp continuous current rating and a brief surge rating of 600 milliamps. To avoid over stressing the directional lighting outputs when using lamps with current draws over 80 milliamps (running), we suggest you place an 18 to 22 ohm 1/4 watt resistor in series with the lead from the directional light function to the lamp. This will limit the initial surge current to levels that will not cause excess stress on the decoder. When the lamp is steadily lit, this resistor will have little impact on the lamp's brightness. This issue will not be a problem with most modern HO Atlas, Kato, LifeLike locomotives, etc. since they typically use 30 to 50 milliamp lamps. Most N scale locomotives we have seen either use low-current incandescent lamps or low-current LED's (that do not have switch-on surges)

