

The DIGITAL plus locomotive decoder LE104XF is suitable for all DC motors in HO scale locomotives with continuous current draw of 1.0 Amp or less. The characteristics of the decoder are:

- \* Selectable for operation with 14/27, 28/55, 128 direct drive or 128 speed table mode with precision glide motor control.
- \* Two on/off function outputs with a current rating of 200 mA that can be configured for either directional lighting, full Rule 17 lighting, or lights and F1
- \* Headlights can also be dimmed using an extra function.
- \* Support for Advanced Consist Control and Extended Addressing
- \* Operation on conventional DC layouts is possible. This feature may be disabled.
- \* NMRA RP-9.1.1 medium plug
- \* Full Support for operations mode programming (long and short) and full support for all forms of programming as described in NMRA RP-9.2.3
- \* Rich set of properties which the user can set to customize the decoder to a particular locomotive.
- \* Size: L 1.52" x W .67" x H .13"    L 40.5 x W 17 x H 3.3 mm

# LE104XF

## Universal DCC Decoder

Art. No. 10116

Revised 2/99

*Digital*  

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*plus*  
by Lenz <sup>TM</sup>

NMRA Warrant 98-82



## ***The LE104XF Universal Decoder***

The LE104XF represents a whole new concept to the evolution of DCC. Not only is the LE104XF designed to use with our own DIGITAL plus system, it is also designed to be at home on all the other popular NMRA DCC systems. To accomplish this we first designed a decoder to be in full conformance to the NMRA Standards and RPs and then augmented the decoder to work well with all other major systems on the market.

Although the LE104XF has a low price, it is packed with all the features you expect in an advanced decoder. Independent or directional lighting (that can be dimmed using a function), advanced consist control, extended addressing, operations mode programming and full support for all the various speed step modes including 128 step motor control, are but a few examples of the advanced features found in the LE104XF.



The NMRA awards its prestigious C&I label to products it has tested and found to be in full compliance with all NMRA DCC Standards, Recommended Practices and industry norms. The LE104XF decoder was tested by the NMRA's C&I committee and has been awarded NMRA Warrant 98-82.

Many characteristics of the LE104XF decoder can be programmed to customize the decoder to its locomotive. Please read "The Configuration Variables and Their Meanings" section later in this booklet for details on the configuration variables supported by the LE104XF. The LE104XF supports all forms of programming described in NMRA Recommended Practice 9.2.3 including the user friendly direct CV programming mode and the operations mode programming so that you can adjust values while the locomotive is in use. For example, you can operate the decoder with the factory pre-set speed table or generate your own. You can set which end of the locomotive is the forward end. You can even decide whether or not you want to be able to operate on conventional DC layouts.

First, we will describe how to install the decoder in your locomotive.

## Preparing to Install the LE104XF

The locomotive must be tested for excellent operation on normal DC power before installing the decoder. Replace worn out motor brushes and burned out light bulbs. Clean any dirt or oxidation from the wheels and pickups, and make sure that electrical contact is smooth. Now is also a good time to lubricate your locomotive. Only a locomotive with impeccable mechanical performance will perform well with the decoder.

Take note which motor brush is connected to the right rail and which to the left rail. This information allows you to connect the decoder to the motor with the correct polarity.

The LE104XF is quite small and will fit into most HO locomotives even those with narrow hoods.

### ***Some advice on the current draw of the decoder output:***

The current for all the decoder outputs is supplied by an internal rectifier with a maximum current rating of 1.2 Amps. The sum of all currents to the motor and the function outputs cannot exceed this limit. Each individual output can only draw up to it's limit.

Summing up the individual current limits leads to a number larger than 1.2 Amps, but they still are not permitted to draw more than this limit.

#### **Example:**

Suppose the motor may require as much as 1.0 A continuously. Then the function outputs combined must not exceed 0.2 A. If the directional headlights require 50 mA each, then the load on function 1 and 2 must not exceed 150 mA.

### ***Some advice on installing the decoder:***

The LE104XF has few internal safeguards to prevent damage so you must not allow any metal part of the locomotive to touch the surface components of the decoder. This could cause a direct internal short circuit and the decoder will be destroyed.

#### ***DO NOT WRAP decoder with electrical tape or shrink wrap!***

Doing so will impede air circulation and degrade the performance of the decoder. Instead, put electrician tape over any part of the locomotive frame or body that might touch the decoder. This way, you will prevent short circuits without 'suffocating' the decoder.

The existing shrink wrap over a part of the locomotive decoder protects static sensitive parts and must not be removed. Install the decoder using the provided double sided tape.

After disconnecting the wiring from the motor brushes, the brushes **MUST** be isolated from the rail pickup. Achieving isolation may require some different approaches on different locomotives, perhaps unsoldering wires, placing a thin piece of insulating plastic between brush terminal and contact spring. In other words, after isolation there must be **NO** electrical contact between the motor and the rail pickup. If you have a VOM, check for infinite resistance between the motor and all the wheels. Take special note that metal contact might occur only when the loco body is reinstalled.

The LE104XF can not be set up for simultaneous use for 2-rail pickup and overhead cantenary or trolley operation. If the locomotive is turned the wrong way, the decoder could get twice the track voltage which would destroy it!

### ***Wiring Options***

The LE104XF comes with an NMRA RP-9.1.1 medium plug. This plug includes the wiring for the track, motor, headlights and one extra function. To install it simply remove the dummy socket in your locomotive and install the LE104XF plug. To ensure the headlights work properly you must align the plug

properly. Pin 1 of the plug (see Figure 1) connects to the orange wire. Ensure this is aligned to pin one of the locomotive. If the plug is installed backwards the lights will not work.

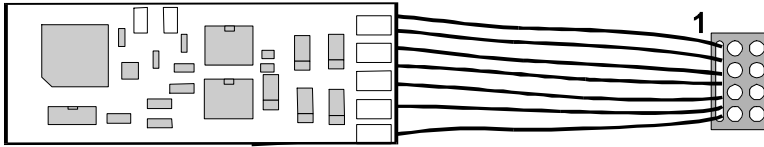


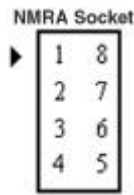
Figure 1: Wiring the LE104XF Decoder

### Wiring Color Code

There are 7 wires on the plug.

Two pins connect to the track pickups:

- Red wire to right rail pickup (Pin #8).
- Black wire to the left rail pickup (Pin #4).



Two pins connect to the motor terminals:

- Orange wire to the motor terminal, which was previously connected to the right rail (Pin #1).
- Gray wire to the motor terminal, which was previously connected to the left rail (Pin #5).

Three pins are for the headlights:

- White wire to the forward headlight (Pin #6).
- Yellow wire to the rear headlight (Pin #2).
- blue wire to the headlight positive common (Pin #7).

Normally the headlight common within the locomotive is connected to the blue wire, which is on Pin #7. You may optionally connect the headlight common to the left-hand rail instead of to the blue wire (but not both connections as connecting the blue wire to the left hand rail will destroy the decoder). More current will be available to the headlights if its common is connected to the blue wire. Do not exceed the current rating of 200 ma for the headlights.

If your locomotive implements an extra function that is connected to Pin #3, you can connect one of the headlight wires

to Pin #3 as well as to the headlight function so long as both the extra function and the headlight do not draw more than 200 ma in total. If only one headlight wire is used the extra function will be directional. See CV51 if you want the functions to be independent.

Placing two diodes (one for each headlight wire) between Pin #3 and the headlight wires (white and yellow) will allow the extra function to be on whenever the headlight is on regardless of the direction whenever either headlight is on.

Connecting the white and yellow wires together will result in both headlights being on at the same time independent of direction.

Once you have installed your decoder in your locomotive, place the locomotive (without the body) on the programming track and read back the locomotive address from the decoder. If the decoder is properly installed, you will be able to read back the factory pre-set address 03. Remove the locomotive from the track, and if necessary correct any wiring errors.

## ***Programming the locomotive decoder LE104XF***

Many features such as the locomotive's address, acceleration and configuration can be customized to the individual locomotive that the decoder is installed in. The properties will be saved in non-volatile memory locations on the locomotive decoder so they retain their value even after the power has been removed for years. The values are set electronically which means that the locomotive does not need to be opened after initial installation of the decoder to read or later modify any CV value. These memory locations are called "Configuration Variables, or CVs" by the NMRA. The LE104XF has a total of 128 CVs. Not all of them are used at this time as many are reserved for future use.

Any NMRA DCC Command Station, such as the DIGITAL plus LZ100 and a Hand Held LH100 or an Interface LI100, can be used to program the locomotive decoder LE104XF. With several

entry level systems such as the ROCO 'DIGITAL is cool' command station, only CV #1 (locomotive address) can be set unless you use a separate programmer. More advanced DCC systems support the ability to set many more CVs. The LE104XF supports all modes and can be programmed by all NMRA DCC programmers. Specific details for reading and writing the decoder's configuration variables can be found in the manuals of the appropriate equipment.

### ***The configuration variables and their meaning***

The new line of Lenz advanced XF decoders, (version 4.4), support a full range of features which are set up using a variety of configuration variables. All the configuration variables are numbered. These numbers are used during programming and are identical for all decoders that conform to the NMRA standards independent of the manufacturer. The following table lists the various CVs supported in the LE104XF decoder. Both the New CV numbers and the older Register numbers are provided for cross reference.

*Please note: Some CVs (such as CV29) have specific meanings for each bit. The bit assignments in this table use a bit numbering scheme of 0-7 to correspond the NMRA convention for universal bit numbering. DIGITAL plus LH100 handhelds version 2.3 and older use a scheme of 1-8 to refer to the individual bits rather than 0-7. (Bit 0 in this table is displayed as a "1" on LH100 handheld, Bit 1 is identified as "2"...)*The bit numbers in ( ) within these tables contain the LH100 bit numbers.

**Table 1: LE104XF Configuration Variables**

CV	Register	Description	Range	Factory setting
1	1	<b>Locomotive address:</b> This is the number with which you select a locomotive in the DIGITAL plus system.	1-127	3

\*\*Note: in the factory setting field the numbers in the ( ) are decimal.

CV	R	Description	Range	Setting
2	2	<b>Start voltage:</b> This is the voltage applied to the motor in speed step 1. Set this value so that the locomotive just starts moving in speed step 1.	1-15	4
3	3	<b>Acceleration Momentum:</b> Determines the rate of change of speed upon acceleration. A higher value leads to a slower acceleration.	1-31	1
4	4	<b>Brake Momentum:</b> Determines the rate of change of speed upon braking. A higher value leads to longer brake distance.	1-31	1
-	5	<b>Contains CV29 (see CV29 below)</b>	0-55	6
-	6	<b>Page Register:</b> Normally this CV is not modified directly by a user. For correct operation, this CV should be set to have a value of 1 after any use.	0-127	1
7	7	<b>Version Number:</b> This location stores the version number of the decoder. This location is read only.	-	44
8	8	<b>Manufacturers Identification:</b> This value is the manufacturer ID of the decoder, (Lenz =99). This location is read only.	-	99
17	-	<b>Extended Address High Byte</b>	192-231	0
18	-	<b>Extended Address Low Byte</b> The two byte address if used is contained in CV17+18	0-255	0
19	-	<b>Consist Address</b> The advanced consist address if used is stored in CV19	0-255	0
23	-	<b>Acceleration Trim</b> This Configuration Variable contains additional acceleration rate information that is to be added to or subtracted from the base value contained in CV3	0-255	0
24	-	<b>Deceleration Trim</b> This Configuration Variable contains additional braking rate information that is to be added to or subtracted from the base value contained in CV4	0-255	0
29		<b>Decoder Configuration, Byte 1:</b> Several decoder properties are set with this byte. Changes are easiest if done in binary mode, but can also be done by adding the decimal ( ) for all the features desired together and writing the total into CV29. The detailed properties are:	0-55	6



CV	Description	Range	Setting
	bit 0 (1)	<b>locomotive direction:</b> Locomotive's relative direction: This bit sets the direction the locomotive will move when told to move forward in digital mode. 0 = locomotive's direction is normal 1 = locomotive's direction is inverted	0,1  0 (1)
	bit 1 (2)	<b>Headlight mode:</b> 0 = Operation with 14 or 27 speed step systems. This setting is selected when the locomotive decoder is used with any Digital system that does not support 28 speed step mode. If the headlights turn on and off as the speed is increased, the command station is configured for 28 speed step mode, and the decoder is in 14 speed step mode. 1 = Operation with 28, 55 or 128 speed steps. If you use this setting, the Command Station must also be configured to use 28 speed step mode or 128 speed step mode for the decoder's address, otherwise the headlights can not be controlled.	0,1  1 (2)
	bit 2 (3)	<b>Usage on conventional DC layouts:</b> 0 = locomotive operates in digital mode only 1 = locomotive can operate on either conventional DC and on DCC	0,1  1 (4)
	bit 3	always 0	0 0
	bit 4 (5)	<b>speed curve:</b> 0 = factory pre-set speed curve is used 1 = user defined speed curve is used. Please enter the appropriate values into CV 67 to 80 before setting this bit.	0,1  0 (16)
	bit 5 (6)	<b>Extended Addressing</b> 0= Normal addressing 1=Two Byte extended addressing	0-1  0 (32)
	bit 6 bit 7	always 0	0 0
<b>50</b>	<b>Decoder Configuration, byte 2:</b> Similar to CV 29, but used to set other properties		0
	bit 0	not used	
	bit 1 [2]	0 = CV23 and CV24 are not active 1 = CV23/CV24 are active and contain the acceleration and deceleration trim values that are added to CV3 or CV4.	0,1  0 (2)

CV	Description	Range	Setting
	bit 2 [3] <b>Brake momentum on DC operation.</b> Used to achieve prototypical braking at red signal indications if conventional DC control CV29.2 is disabled. (CV 29 bit 2 = 0) 0 = locomotive proceeds with track voltage dependent speed inside the conventional DC section. 1 = locomotive brakes in the conventional DC section with pre set brake momentum.	0,1	0  (4)
	bits 3-7 not used		
<b>51</b>	<b>Lighting Special Effects</b>		0
	bit 0 (1) 0 = the headlights are directional. 1 = the lights are independent per Rule 17. F0 controls the front headlight and F1 the rear headlight or a separate function.	0,1	0  (1)
	bit 1 (2) 0 = function dimming disabled 1 = the value in CV52 is used for headlight/function dimming. If CV51.0 = 0 then F1 dims the headlight if on.	0,1	0 (2)
	bit 2 (3) 1= if CV51.0 and CV51.2 both =1 (dimming and Rule17 are both active), F4 dims F0	0,1	0 (4)
	bit 3 (4) 1= if CV51.0 and CV51.2 both =1 (dimming and Rule 17 are both active), F4 dims F1	0,1	0 (8)
	bits 4-7 Not used		
<b>52</b>	<b>Dimming CV</b> - contains the value used for dimming. 0 is dark 255 is max brightness	0-255	0
<b>67 to 94</b>	<b>Values for user defined speed curve:</b> These registers are used for a user defined speed curve. The factory setting for these registers is 0. If you are trying to use this speed curve unmodified, your locomotive will not move! The value in each register determines the velocity of the locomotive for each assigned speed step: For the 14 speed step mode the odd CVs are used If you are using 128 speed step mode and you have activated the user defined speed table, the intermediate speed steps are calculated by the decoder.	0-255	0
<b>105</b>	<b>User Identification #1</b>	0-255	255
<b>106</b>	<b>User Identification #2</b>	0-255	255
<b>128</b>	<b>Decoder Software Version</b> – read only		01

## ***Creating a Speed Curve***

One common feature is to set a specific operating speed curve for your locomotives. This is usually done to have dissimilar locomotives have the same performance characteristics or to have the locomotives perform more prototypically. Start by writing down how you want to assign the internal speed settings to the speed steps, for example by making up a table as shown below.

In the following description, we will assume the decoder is properly installed and tested. We also assume you are familiar with the general process of programming for your system.

Speed step in 14/27 mode	Speed step in 28 mode	Internal speed setting	CV / register
1	1	1	67
	2	6	68
2	3	12	69
	4	16	70
3	5	20	71
	6	24	72
4	7	28	73
	8	32	74
5	9	36	75
	10	42	76
6	11	48	77
	12	54	78
7	13	60	79
	14	69	80
8	15	78	81
	16	85	82
9	17	92	83
	18	105	84
10	19	118	85
	20	127	86
11	21	136	87
	22	152	88
12	23	168	89
	24	188	90
13	25	208	91
	26	219	92
14	27	240	93
	-	255	94

In 128 speed step mode the decoder internally averages the speed table to obtain the correct speed step value.

## Warranty

Lenz GmbH does everything it can do to ensure that its products are free from defects and will operate for the life of your model railroad equipment. From time to time even the best-engineered products fail either due to a faulty part or from accidental mistakes in installation. To protect your investment in Digital Plus products Lenz GmbH offers a very aggressive 10 year Limited Warranty.

This warranty is not valid if the user has altered, intentionally misused the Digital Plus product, or removed the product's protection, for example the heat shrink from decoders and other devices. In this case a service charge will be applied for all repairs or replacements. Should the user desire to alter a Digital Plus Product, they should contact Lenz GmbH for prior authorization.

**Year One:** A full repair or replacement will be provided to the original purchaser for any item that that has failed due to manufacturer defects or failures caused by accidental user installation problems. Should the item no longer be produced and the item is not repairable, a similar item will be substituted at the manufacturer's discretion. The user must pay for shipping to an authorized Lenz GmbH warranty center.

**Year 2 and 3:** A full replacement for any item will be provided that has failed due to manufacturer defects. If the failure was caused by accidental user installation or use, a minimal service charge may be imposed. Should the item no longer be produced and the item is not repairable, a similar item will be substituted at the manufacturers discretion. The user must pay shipping to and from the authorized Lenz GmbH warranty center during this portion of the warranty period.

**Year 4-10:** A minimal service charge will be placed on each item that has failed due to manufacturer defects and/or accidental user installation problems. Should the item no longer be produced and the item is not repairable, a similar item will be substituted at the manufacturers discretion. The user must pay shipping to and from the authorized Lenz GmbH warranty center during this portion of the warranty period.

Please contact your dealer or authorized Lenz GmbH warranty center for specific instructions and current service charges prior to returning any equipment for repair.

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This equipment complies with Part 15 of FCC Rules. Operation is subject to the following two conditions: (1) this device may not cause harmful interference, and (2) this device must accept any interference received, including interference that may cause undesired operation.

**CE** Please save this manual for future reference!

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