The industry's first truly universal N Scale decoder that is at home on all NMRA DCC systems. The characteristics of the decoder are:

* Precision back EMF motor control for exceptional performance.
* Selectable for operation with 14/27, 28/55, 128 direct drive or 128 speed table mode with precision glide motor control.
* Directional Headlights can also be dimmed using an extra function.
* Support for Advanced Consist Control and Extended Addressing
* Operation is possible on conventional DC layouts with a peak output of 14 volts DC. This feature may be disabled.
* 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.
* Provides 0.5A continuous motor current.
* Size L 0.51" x W 0.36" x H 0.14"
  L 13.0mm x W 9.1mm x H 3.6mm

LE010XF
Micro Back EMF DCC Decoder

Art. No. 10010
Version 5.2
Revised 2/01

Digital plus by Lenz™

The LE010XF Micro Decoder

The LE010XF represents a whole new concept to the evolution of DCC. Not only is the LE010XF 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 LE010XF has a low price, it is packed with all the features you expect in a high end 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 LE010XF.

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 LE077XF decoder has been awarded an NMRA C&I Warrant.

Many characteristics of the LE010XF 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 LE010XF. The LE010XF 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.

Back EMF Control

The LE010 uses a form of motor control called "back emf" control. All DC motors produce a small amount of current when they are rotating. The amount of current produced is a function of the load that the motor is controlling. The LE010 measures this current and is able to adjust the current to the motor based upon the motor load. The result is exceptionally fine motor control that is extremely smooth and quiet.

Preparing to Install the LE010XF

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. A locomotive that runs well under DC will run exceptionally well under DCC.

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 LE010XF is quite small and will fit into most N and Z 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 0.5 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.

Example:

Suppose the motor may require as much as 0.45 A continuously. Then the function output must not exceed 0.05 A.

Some advice on installing the decoder:

Although the LE010XF has many internal safeguards to prevent damage, 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 and use double sided foam mounting tape to mount the decoder. This 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. 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 LE010XF 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

There are two wiring options for installing the LE010XF, depending on how the locomotive is constructed. The two functions could be connected with their common to the track voltage as shown in Figure 1, or, use the decoders floating common as shown in Figure 2. A mixture of both options is also possible. Note that only traditional reversing headlights are supported.

If the bulbs for the headlights are floating (isolated against wheel pick up and chassis) and connected according to Figure 2, they will shine brighter compared to the option shown to Figure 1. Furthermore, the directional headlights will function while operating on conventional DC layouts.

Step by Step Installation

Two wires connect the decoder to the motor. Make sure that the motor is electrically isolated from both track pickups:

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

Two wires connect the decoder to the track electrical pickups:

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

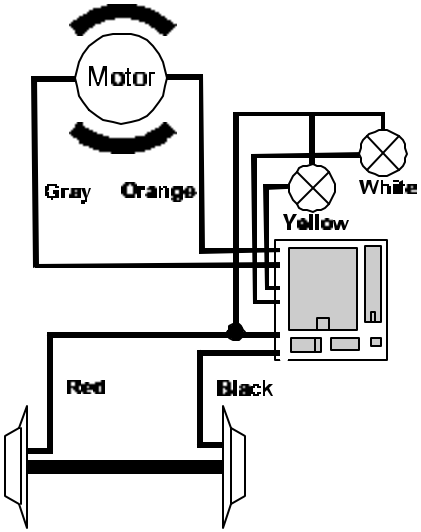

Figure 1: Wiring the LE010XF using track voltage common

Three wires connect the headlights and functions to the decoder:

- White wire (Pin #6) to the forward headlight with a max load of 100ma. If the bulb is isolated, connect the blue wire (Pin #7) to the other terminal.
- Yellow wire (Pin #2) to the rear headlight with a max load of 100ma. If the bulb or function is isolated, then connect the blue wire (Pin #7) to the other terminal.

Place the locomotive (without the body) on the programming track and read back the locomotive's 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.

If the bulbs are isolated, connect the blue wire to their common point as shown in Figure 2. Now you are ready to program the locomotive address and begin test running.

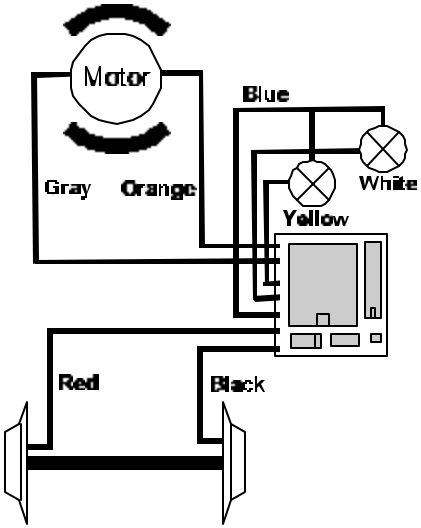

Figure 2: Wiring the LE010XF using a floating common.

Programming the locomotive decoder LE010XF

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 LE010XF 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 with a Hand Held LH100, LH200 or an Interface LI100, can be used to program the locomotive decoder LE010XF. The LE010XF supports all modes and can be programmed by all NMRA DCC systems. If your command station supports it, each of the CVs can be read on the programming track. The CVs can be changed on the programming track or on the layout using operations mode programming. 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 following table lists the various CVs supported in the LE010XF 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 and LH200 handhelds 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 and LH200 bit numbers.*

Table 1: LE010XF Configuration Variables

CV	Reg	Description	Range	Factory setting
1	**1**	**Locomotive address:** This is the number with which you select a locomotive in the DIGITAL plus system. Setting the address from #1 to #3 using register mode will reset the decoder to utilize 14 speed step operation.	1-127	3
2	**2**	**Start voltage:** 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.	0-31	0

**Note: in the factory setting field the numbers in the [ ] are decimal.

CV	R	Description	Range	Setting
3	**3**	**Acceleration Momentum:** Determines the rate of change of speed upon acceleration. A higher value leads to a slower acceleration.	1-31	1
4	**4**	**Brake Momentum:** Determines the rate of change of speed upon braking. A higher value leads to longer brake distance.	1-31	1
5	-	**Maximum speed** Determines the maximum speed that the locomotive will move. This allows you to operate your locomotives in a prototypical speed range.	1-10	10
-	**5**	**Contains CV29 (see CV29 below)**	0-55	6
-	**6**	**Page Register:** 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**	**Version Number:** This location stores the version number of the decoder. This location is read only.	-	52
8	**8**	**Manufacturers Identification / Factory reset** This value is the manufacturer ID of the decoder, (Lenz =99). Writing a value of 33 using Register mode resets all CVs to their factory condition	-	99
17	-	**Extended Address High Byte**	192-231	0
18	-	**Extended Address Low Byte** The two byte address if used is contained in CV17+18	0-255	0
19	**Consist Address** The advanced consist address if used is stored in CV19		0-255	0
29	**Decoder Configuration, Byte 1:** 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
29	bit 0 (1)	**locomotive direction:** 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)	**Headlight mode:** 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)	**Usage on conventional DC layouts:** 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)	**Speed Curve Selection:** 0 = factory pre-set speed curve is used 1 = user defined speed curve is used. Please enter the appropriate values into CV 67 to 94 before setting this bit.	0,1	0 [16]
	bit 5 (6)	**Extended Addressing:** 0= Normal addressing 1=Two Byte extended addressing	0-1	0 [32]
	bit 6 bit 7	always 0	0	0
50	**Decoder Configuration, byte 2:** Similar to CV 29, but used to set other properties			1
	bit 0 (1)	**Back EMF Control** If set back emf control is active	0,1	1
	bits 2-7	not used		

CV	Description		Range	Setting
51	**Lighting Special Effects for Outputs A and B**			0
	bit 0 (1)	0 = the headlights are directional. 1 = not used	0,1	0 [1]
	bit 1 (2)	0 = function dimming disabled 1 = the value in CV52 is used for headlight/function dimming.	0,1	0 [2]
	bit 2 (3)	If CV51.0 = 0 and CV51.1 =1 (directional dimming) then F1 dims the forward headlight if on.	0,1	0 [4]
	bit 3 (4)	If CV51.0 = 0 and CV51.1 =1 (directional dimming) then F1 dims the rear headlight if on.	0,1	0 [8]
	bits 4-7	Not used		
52	**Dimming CV** - contains the value used for dimming. 0 is dark 255 is max brightness		0-255	64

CV	Description	Range	Setting
67 to 94`	**Values for user defined speed curve:** These registers are used for a user defined speed curve. The factory setting for these registers is shown in the following speed curve table. The value in each CV 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	Factory Default Speed Curve
105	**User Identification #1**	0-255	255
106	**User Identification #2**	0-255	255
128	**Decoder Software Version** – read only		02

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.

Note: CV2 (Start Voltage) is still used as part of the calculation even when the decoder is in User Defined Speed Curve mode.

Speed step in 14/27 mode	Speed step in 28 mode	Default speed setting	CV / register
1	1	4	67
	2	8	68
2	3	12	69
	4	16	70
3	5	20	71
	6	24	72
4	7	28	73
	8	33	74
5	9	38	75
	10	43	76
6	11	48	77
	12	53	78
7	13	60	79
	14	67	80
8	15	74	81
	16	82	82
9	17	90	83
	18	98	84
10	19	106	85
	20	115	86
11	21	125	87
	22	137	88
12	23	152	89
	24	178	90
13	25	194	91
	26	212	92
14	27	232	93
-	28	255	94

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

North American 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 manufacturers 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!