The DIGITAL plus locomotive decoder LE030 is suitable for all DC motors in HO scale locomotives with continuous current draw of .7 Amp. or less. The characteristics of the decoder are:

∗   Control of the motor's rotational speed (load compensation). Regardless of the load, the motor's rotation speed is kept nearly constant. During extremely slow movement (for instance through sharp curves and over a series of turnouts), LE030 always provides the motor with enough voltage. This creates the impression that there is actually 100 tons moving.
∗   Selectable for operation with 14/27, or 28/55 speed steps.
∗   Operation on conventional DC layouts is possible. This feature may be disabled.
∗   Provides .7A continuous motor current.
∗   Two on/off function outputs with a current rating of 100 mA each dedicated for the directional headlights.
∗   Support for Advanced Consist Control and Extended Addressing
∗   Support for short form programming on the main for acceleration and deceleration trim
∗   Support for all form of programming as described in NMRA RP-9.2.3
∗   Programmable locomotive address, acceleration and brake momentum, speed curve and much more.
∗   Size: L 1.4" x W 0.45" x H 0.13"
       L 35.5 x W 11.5 x H 3.3 mm

Information
LE030

Art. No. 10030

DIGITAL
plus

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The features of the LE030 Decoder

The LE030 has been revised and is packed with features you expect in a high end decoder. Advanced consist control, extended addressing, outstanding 28 step motor control, and two directional headlight function outputs are but a few examples. The LE030 supports all forms of programming described in NMRA Recommended Practice 9.2.3, including the user friendly direct CV programming mode. Also, standard is a built in self-test procedure. The advantages of this standardization are obvious: Every locomotive decoder responds in the same way to changes in their properties. All new DIGITAL plus locomotive decoders are produced according to these NMRA DCC standards. This standardization will greatly improve interoperability of locomotive decoders for all manufacturers.

DIGITAL plus decoders built to the NMRA standards and recommended practices are labeled:

This prestigious label means that the NMRA has tested this product and found that it fully complies with all NMRA DCC Standards, Recommended Practices and industry norms.

Many characteristics of the LE030 decoder can be programmed to customize the decoder to its locomotive. 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.

Please read "The Configuration Variables and Their Meanings" section later in this booklet for details on the configuration variables supported by the LE030. There you will find much more information regarding the features and their respective settings.

The LE030 Locomotive decoder is small and very thin. It is designed to fit into small HO locomotives (such as switchers) and wide hood N-Scale locomotives. This decoder is designed to only be used with:

1. Lenz DIGITAL plus or another commonly available digital command control system with NMRA-DCC conformance warrant and a DCC voltage of less than 16 volts. (HO or N scale settings) If in doubt, check with the system supplier.

2. Commonly available model railroad controllers with a maximum output voltage of 14V peak.

The LE030 employs the finest motor control possible. It is suitable for all forms of motors including coreless motors.

Back EMF Control

The LE030 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 LE030 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 LE030

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.

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 .7 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 .7 Amps., but they still are not permitted to draw more than this limit.

> Take note of the maximum current load capacity of motor output and light outputs. You must ensure that this maximum current load is not exceeded. In case of an overload, the decoder will be destroyed!

Example:

Suppose the motor may require as much as .6 A continuously. Then the directional headlights must not exceed .1 A. Note that since only one headlight is on at a time, the headlight outputs are not additive in this equation.

Some advice on installing the decoder:

Although the LE030 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 electricians 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 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 LE030 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 LE030, depending on how the locomotive is constructed. The directional headlight functions could be connected using the decoders floating common as shown in Figure 1, or, using the track voltage as a common as shown in Figure 2. A mixture of both options is also possible.

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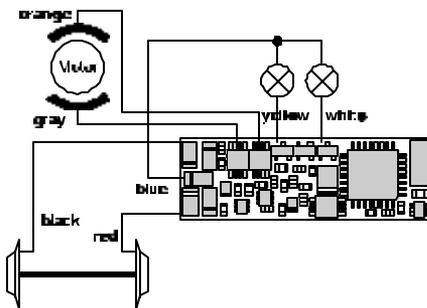

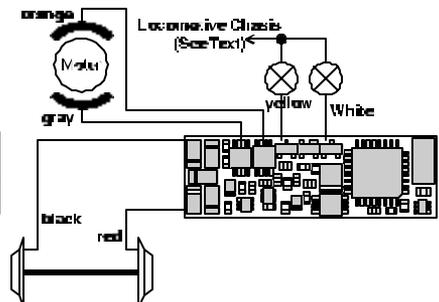**Figure 1: Wiring the LE030 using floating common**

Figure 2: Wiring the LE030 using a track voltage common.

Step by Step Installation

Connect the decoder to the track voltage pickups:

- Red wire to right rail pickup

- Black wire to the left rail pickup

Connect the decoder to the motor terminals:

- Orange wire to the terminal which originally to the right rail

- Gray wire to the terminal which was originally to the left rail

Now connect the headlights:

- White wire to the forward headlight. If the bulb is isolated, connect the blue wire to the other bulb terminal.
- Yellow wire to the rear headlight. If the bulb is isolated, then connect the blue wire similarly.

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. Now you are ready to program the locomotive address and begin test running.

Programming the locomotive decoder LE030

Locomotive address, acceleration and brake momentum and all other properties of the decoder can be changed as often as desired. This process is called *programming*.

The properties will be saved in non-volatile memory locations on the locomotive decoder. The values will be permanently saved, even after disconnecting the operating voltage. These memory locations are called "Configuration Variables, or CVs" by the NMRA. The LE030 has a total of 128 CVs. Not all of them are used at this time as many are reserved for future use.

The reading and writing of these values is done electronically, the locomotive does not need to be opened after initial installation of the decoder to read of later modify any CV value.

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 LE030. With older command stations (including Arnold or Märklin) the decoder supports index mode, a special form of register mode which allows you to easily address all the CVs. Using the Arnold Commander 6, or the ROCO 'DIGITAL is cool' command station, only register 1 (locomotive address) can be set. Many other DCC command stations support paged programming. The LE030 supports this mode as well. 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 decoders, version 5.1, 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 LE030 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 1-8 to correspond to the 1-8 display on DIGITAL plus systems. Many other systems use a scheme of 0-7 to refer to the individual bits. If you are using such a system you should subtract one from all bit numbers described in these CVs.

Table 1: LE030 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.	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.	1-15	1
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	**CV29 when the page/pointer register has a value of 1 or value of CV pointed to by Register 6 when register 6 is being used as a pointer register**	0-55	4
-	6	**Page/Pointer Register:** Used during programming for paging or indexing	0-127	1
7	7	**Version Number:** This location stores the version number of the decoder. This location is read only.	-	51
8	8	**Manufacturers Identification:** This value is the manufacturer ID of the decoder, (Lenz =99). This location is read only.	-	99
9	-	**EMF Frequency** Allows you to adjust the pulse rate frequency for finer motor control	0-15	4
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

CV	R	Description		Range	Setting
29	***5**	**Decoder Configuration, Byte 1:** Several decoder properties are set with this byte. Changes are best done in binary mode (see the information for the Hand Held LH100). The detailed properties are:		0-55	4
		bit 1	**locomotive direction:** 0 = normal: locomotive moves forward when the arrow on the Hand Held points up. 1 = inverted: locomotive moves forward when the arrow on the Hand Held points down.	0,1	0
		bit 2	**speed step mode:** 0 = Operation with 14 or 27 speed steps. This setting is selected when the locomotive decoder is used with a software below version 2.0, ROCO-Digital, LGB-Digital, Arnold Digital and with all other Digital systems that do not support the 28 speed step mode. 1 = Operation with 28 speed steps. This setting is selected when the locomotive decoder is used with a Command Station with software version 2.0 or higher. The Command Station has to be set to 28 speed step mode for the decoder address, if you are using this setting! Other Digital systems supporting the 28 speed step mode can use the decoder in this setting.	0,1	0
		bit 3	**Usage on conventional DC layouts:** 0 locomotive operates in digital mode only 1 locomotive can operate in both conventional DC and digital mode.	0,1	1
		bit 4	always 0	0	0
		bit 5	**speed curve:** 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
		bit 6	**Extended Addressing** 0= Normal addressing 1=Two Byte extended addressing	0-1	0
		bit 7 bit 8	always 0	0	0

CV	R	Description		Range	Setting
30	-	**Decoder Error Information**			
		bit 1	**Motor Short**	0,1	0
			If set short between motor and track		
		bit 2	**Front Headlight Short**	0,1	0
			If set the front headlight is shorted		
		bit 3	**Rear Headlight Short**	0,1	0
			If set the rear headlight is shorted		
60	-	**Decoder Configuration, byte 2:**			
		Similar to CV 29, but other properties are set with this byte:			
		bit 1	**Back EMF Control**	0,1	1
			If set back emf control is active		
		bit 2	**Decoder Control Active**	0,1	1
			If set CV30 contains decoder error		
		bit 3	**Brake momentum on DC operation.**	0,1	0
			This setting is only active with conventional DC operation disabled. (CV 29, bit 3 = 0) This setting can be used to achieve prototypical braking at red signal indications.		
			0 locomotive proceeds with track voltage dependent speed inside the conventional section.		
			1 locomotive brakes in the conventional section with pre set brake momentum.		
		bits 4-8	not used		
67 to 81	-	**Values for user defined speed curve:**		0-63	0
		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, speed step 1 is using the value in CV 67, speed step 2 the value in CV 68, speed step 3 the value in CV 69, etc.			
		For the 28 speed step mode, speed step 1 is using the value in CV67, speed step 3 the value in CV 68, speed step 5 the value in CV 69, etc. The intermediate speed steps are calculated by the decoder.			

Creating a Speed Curve

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. The table shown is just an example and gives the factory pre-set speed curve for a starting speed of 1.

In the following description, we will assume that the decoder is properly installed and tested, and the locomotive is on the programming track with the power on. We assume you are familiar with the general process of programming using your command station.

Speed step in 14/27 mode	Speed step in 28 mode	Internal speed setting	CV / register
1	1	1	67
2	3	3	68
3	5	5	69
4	7	7	70
5	9	9	71
6	11	12	72
7	13	15	73
8	15	19	74
9	17	23	75
10	19	28	76
11	21	34	77
12	23	42	78
13	25	52	79
14	27	60	80
--	28	63	81

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.