

Designed for use on all XpressNET systems



LH200 Knob based Engineer's Throttle

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Version 3.0



Submitted to the NMRA for
Conformance and Inspection testing

Welcome!

Thank you for purchasing our LH200 Knob based Engineer's Throttle. We would like to congratulate you on your acquisition of this **Digital plus by Lenz**[®] product and we hope you will enjoy working with this model-railway control system.

The purpose of this operating manual is to explain the use of the LH200 to you. In order to proceed as quickly as possible to the pleasure of operating your model railway with DCC. Begin by reading the section "First Steps". After you have operated your first train you will be better able to follow the step by step description of LH200's entire range of functions. It is not necessary to understand or use all the handheld's features. Select the set of features you are comfortable with and enjoy your model railroad.

The LH200 is designed to function properly on any manufacturer's **XpressNET** based NMRA DCC system. One note, the LH200 has a rich set of features. Not all features of the LH200 are supported by all **XpressNET** systems. If a feature is not supported the menu may not be displayed or the feature may have no effect. If in doubt please check your command station manual.

If you still have questions, for which you can not find the answers even after reading this operating manual, please contact us. We will be happy to help you. There are four different ways of contacting Lenz Elektronik GmbH:

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2 Quick Start Users Guide

In this section you will learn about:

- the few steps that you need to know to operate your LH200
- how to start your first test run

In the later sections, the whole range of functions of the LH200 will be explained in detail.

2.1 Connection and initial operation

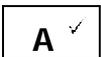
1. Turn on your NMRA DCC system
2. Plug the end of the coil cable with the phone plug into the socket of the LH200, and the other end of the coil cable with the DIN plug into an XpressNET socket on your command station or on your layout.
3. Put the locomotive which is equipped with the locomotive decoder onto the track. (refer to the instructions that came with the decoder for installation instructions)
4. Turn the rotary control-knob as far to the left as possible and then flick the direction switch into the horizontal / centre position (90° to face of box). This is the stop position.



You can now start operating trains! (Yes, already!)

2.2 Your first operation of a DCC train

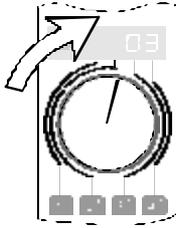
Let us assume that the decoder which is in the locomotive on the track is set to have address (number) 3. As shipped you can immediately control locomotives with the addresses (numbers) 0 to 5. Address 0 is intended for a conventional locomotive, i.e. a locomotive without an installed decoder.



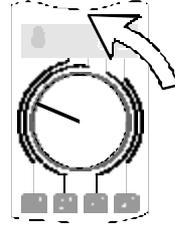
Press the key "A" key repeatedly until 3 is shown in the display.

Flick the direction switch into the upward position (forward is up)





Turn the rotary control-knob to the right. The locomotive moves forward, and the more you turn the knob to the right, the faster the locomotive will move (Throttle positions increase in size).



Turn the rotary control-knob back to the left. The locomotive slows down, the further you turn the knob to the left the more it will slow down (Throttle positions decrease in size).

Turn the knob as far to the left as possible: the locomotive stops.



Flick the direction-switch downwards through the centre position. This will change the direction of motion of the locomotive from forwards to backwards.

You can now move the locomotive in the opposite direction by using the rotary control-knob as described above.



If you flick the direction-switch switch to the centre position **while the locomotive is in operation**, the locomotive will stop with the amount

of delay in braking which is set in the locomotive decoder. If you then flick the switch in a different direction –without altering the position of the rotary control-knob-, the locomotive will speed up again, also with the amount of delay that is set in the decoder.



In order to switch on the light function of the locomotive decoder, press the key "0^M". Press the key once and you will turn on the light, press it again and you will turn it off. With LH200 you can control up to 9 functions in locomotive decoders.

You have just learned the most important things that you need to know for the general operation of your digital controlled model railway. In the next section you will learn about further functions that your LH200 has to offer.

3 LH200 Capabilities Overview

In this section you will learn :

- the range of functions of LH200
- the possibilities which this range of LH200 functions opens up to you in controlling your model railway

The use of the LH200 functions is explained in detail at the end of this section.

3.1 Range of possible addresses for your locomotives

With your LH200 you may control any 4 digit locomotive address. This means that a locomotive address can have any value from 1 to 9999.

Note: The LH200 can not provide more features than is supported by your NMRA DCC Command Station. For example, if your command station only supports 2 digit addresses than your LH200 can only control locomotives 0-99. If your command station does not support a specific menu selection, you will not see that menu on the LH200 display or you will the message "ERR 98" will be displayed.

Address 0 is special. With address 0 you control a non-decoder equipped conventional locomotive on your DCC layout. Using a conventional locomotive (a locomotive without decoder) and a digital locomotive (with the decoder included with this SET) you are immediately in the position to starting digital operation with two locomotives!

You will find more information about selecting the locomotive you wish to control from the LH200 in the section which starts on page 12.

3.2 Locomotive functions that can be controlled

You can address up to 9 functions in locomotive decoders (termed F0-F8). You will learn how to switch these functions on and off in the section "Switching locomotive-decoder functions on and off " which starts on page 17.

3.3 Throttle Notch choices

Within DCC operations there is a concept of speed steps. Speed steps refer to the number of throttle notches a locomotive decoder can apply to the motor. LH200 supports the choice of 14, 28 and

128 throttle positions. The default for all locomotives on the system is 28 throttle positions. For information on how to select the various modes and how to adapt them to your locomotive decoder, please see the section "Matching the LH200s Throttle Notches to the Decoders Speed Steps" which starts on page 18.

3.4 Multi unit (MU) consisting

Using Multi Unit control (in Europe called Multi Traction), you can simultaneously control multiple locomotives via a common address, the **multi unit address (MU-address)**. You will feel as if you are only controlling a single locomotive, but all locomotives in the MU react simultaneously. Locomotives can be set up head to head or head to tail and they still work properly together in this mode.

You will find detailed information on the assembly and controlling of an MU in the section "Multiple Unit (MU) Consisting" which starts on page 27.

3.5 Configuring decoder features

Decoders can be configured by the user to customize the behaviour of a particular locomotive. The address of a locomotive decoder is an example of a decoder feature that the user must set for each decoder used. The variable starting voltage, acceleration rate and braking rate are among the optional features of a locomotive decoder, that can be customized. Decoder features can be altered through a process called programming. LH200 has made programming as transparent to the user as possible. Two different modes are supported.

Programming on the programming track

A programming track is an section of track that is completely electrically isolated from the remainder of your layout. One decoder at a time can be placed on this isolated track for setting the various decoder configurations. For advanced decoders, only the locomotive address needs to be set using this programming mode. You will find information on this procedure in the section "Programming on the programming track" which starts on page 34.

Programming while your locomotive is on your layout

For advanced decoders that support this feature, you can program all the optional features of a locomotive decoder (except its address) while the locomotive is on your DCC layout. For example,

move your locomotive to the front of a heavy freight-train and then adjust the acceleration and breaking rate to suit the train! You will find more detailed information in the section "Programming on the main – POM" which starts on page 20.

4 Overview of the LH200 Operational Controls

In this section you will learn about:

- the information that is displayed in the LH200 LED display
- how to use the LH200 knob based Engineer's Throttle
- how to use the direction switch
- what the LH200 keys are used for

4.1 The LED display

LH200 has a luminescent, 4-digit LED-display. Each digit is able to display the numbers 0 to 9.

In this operating manual the display is presented as follows:



In normal operation the address of the locomotive which you are presently controlling is constantly shown.



Points below left, in the centre and below right are helpful for adjusting the rotary control-knob and the direction switch when you take control of a different locomotive. Diverging positions of rotary control-knob and direction switch are indicated by flashing lights. You will find more detailed information in later sections.

4.2 The rotary control-knob

The black line on the rotary control-knob shows the actual speed.

Turn it to the right and you increase the throttle position (locomotive speeds up), turn it to the left and you decrease the throttle position (locomotive slows down).

Since the rotary control-knob has a stop-limit to the right and to the left, you will know when you have reached the maximum speed or come to a complete stand-still without having to look at your handheld.

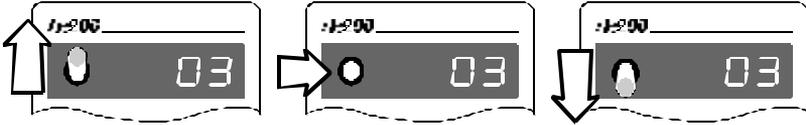
4.3 The direction switch

The direction switch has 3 positions:

Switch up: locomotive moves forward

Switch to center: locomotive stops. Turning the rotary control-knob does not influence the locomotive's speed.

Switch down: locomotive moves backwards



4.4 The keys

Only a few well arranged keys are necessary for the controlling of your locomotives:

	<p>With this key you scroll through the addresses which are saved in the "stack". When using the menu this key becomes the "ok" or check key.</p>	
	<p>"Shift" key: after you have pressed this key, the smaller printed numbers and symbols on the other keys become active. This key is comparable to the "Shift" key on a typewriter or computer.</p>	
	<p>Function 0 on / off. Function 0 is used by most decoders for the locomotive's headlights. After the "shift" key has been pressed, this key is used to scroll through the menu.</p>	
	<p>These 4 keys are used to switch between functions of the locomotive decoder or, within a menu, to choose the number of the 4-digit display that you wish to alter. The allocation is shown on the LH200: with key 4 you choose the first digit on the right, with key 3 the second digit from the right up to key 1 which will then choose the fourth digit from the right. To use function numbers 5-8 first press the "Shift" and then the number.</p>	
	<p>Emergency stop. This key has a variety of uses and effects. For example, switching off the voltage on the track, stopping all locomotives, stopping the locomotive indicated, or entering programming track mode. This will be described below.</p>	

5 Emergency Stop



If you want to immediately stop operation press the  key.

The voltage on the track will be switched off, and all locomotives stop immediately. During an emergency stop, the LED of the power station LV101 flashes, and in the LH200 display flashes.



To resume operation, press the key again.

If you are within a menu when the key is pressed, the menu will close down. If you desire, you can alter the function of this key.

You can choose whether you want to switch off the voltage on the track by pressing this key or whether only the locomotive, whose address you presently see on the display, is to be stopped. You will learn how you set this function from the section "Configuring your LH200" which starts on page 32

6 The LH200 menus

In this section you will learn:

- the range of functions that can be accessed with the aid of the LH200 menus
- how to select the desired menu
- how the menus are displayed on the LH200 display

All the LH200 menus are selected in the same way:



First press the "shift" key. On the display a dot will appear on the upper right hand side.



Next you press the menu key. You can now scroll through all the menus using this key.

Key

Display

Description



Enter a new locomotive address in the LH200 stack in order to control a new locomotive.



Display /change the speed-step mode the LH200 will use to control the locomotive whose address was on the display when you entered the menu.



Programming on the main (operations mode programming): allows changing of the features of the locomotive decoder while on the operational layout.



Multi unit operation. With this menu you can add remove or display locomotives that are within multi unit consists.



System configuration settings



Programming on the programming track. Allows reading or changing of the features of the locomotive decoder while on a isolated programming track.



After scrolling through all the menus, the LH200 returns the display to the last locomotive controlled.

Use the  key to confirm selection of any menu.

6.1 Entering numeric values within a menu

To enter numeric values within a menu, always follow the same procedure: Choose the relevant digit with the appropriate key and alter the value by turning the knob. This procedure is described in more detail in the following section.

7 Selecting the Locomotive you wish to Control

In this section you will learn about:

- how to scroll through the stack to select a new locomotive address
- how to enter a new locomotive address into the LH200

Before controlling a locomotive, its address must first be selected. There are two ways of selecting a locomotive address other than the one that is currently displayed. Either you scroll through the stack until the desired address is displayed or, if the address is not yet present in the stack, enter a different address in the stack replacing the one that is currently displayed.

7.1 Scrolling through the stack

The stack facilitates quick access to up to 6 locomotive addresses. Each entry in the stack can contain any locomotive address between 0 and 9999. This will ensure you have fast and reliable access to the locomotives, which are most important for the current operating session at the touch of a few buttons. When shipped, the locomotive addresses 0 through 5 are the default values in the stack.



When pressed this key switches over to the next locomotive address in the stack, and the address is shown in the display. Having reached the top of the list, the following key stroke will again display the digit address at the bottom of the list.

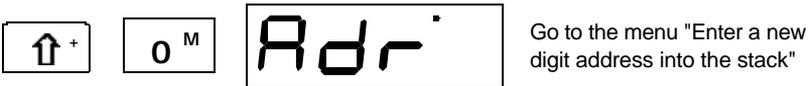
7.2 Entering a new locomotive address into the LH200 stack

From the factory the locomotive addresses 0 through 5 are stored in the stack. If you want to enter a different address in one of the 6 entries of the stack lists, scroll through the stack until an address is displayed that you want to overwrite. In DCC there is a concept of a short (2 digit) address and a long(4digit) address. The LH200 makes this transparent to the user. Simply enter the address you desire and the LH200 does all the work for you.

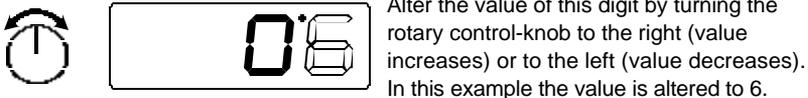
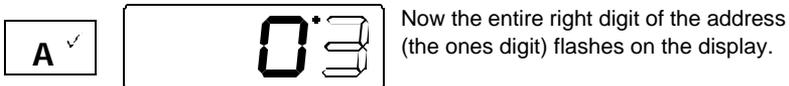
Example 1: entering a 2-digit digit address

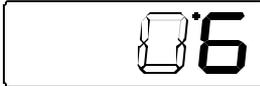
In the following example the current address "03" in the stack is changed to "46". The locomotive with the address 3 will remain running on the layout with the LH200 knob position that was present before the menu option was selected. In the following the user action is on the left and the display results are on the right.

First you select the address menu:

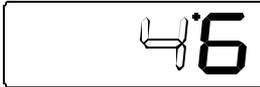


Now confirm the address menu selection with the "A" key:





Now select the 10s digit. The value 6 is now valid as the ones digit and the 10s digit begins to flash.



Turn the rotary control-knob until the desired value is shown and conclude the input with key "A " key.

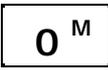
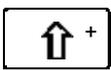


The new selected locomotive can now be controlled by the LH200. You can now adjust the positioning of the rotary control-knob and the direction switch as described above.

Example 2: entering a 4-digit address

In this example the address 46 in the stack is replaced by the address 1234.

First we enter the address menu:



Go to menu " Enter a new locomotive address into the stack"

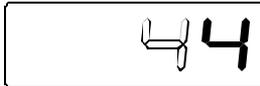
Now confirm the address menu selection with the "A " key:



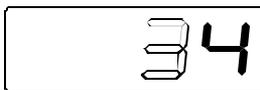
The furthest right digit of the address display now flashes.



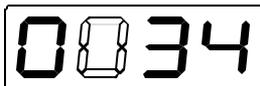
Alter the value of this digit by turning the rotary control-knob to the right (value increases) or to the left (value decreases). In this example the value is altered to 4.



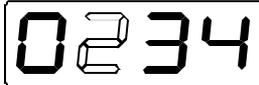
Now select the next digit you desire to alter. The value 4 is now valid as the ones digit and the 10s begins to flash.



Turn the rotary control-knob until the desired value is shown.



If a 4-digit number locomotive is desired, pressing either the "1" or "2" key extends the display 2 more digits. If the "2" key is pressed, the third digit flashes.



Turn the rotary control-knob until the desired value for the second digit from the left is shown, here 2.



Pressing the "1" key causes the left hand digit to flash indicating that this is the digit you desire to change.



Again the value is altered, in this example it is altered to 1. End with "A" key to complete the final take over of the address.



Now adjust the position of the rotary control-knob and the direction switch as described above.

Until you press the check key (the "A" key), which indicates that your selection is complete, you can switch back and fourth between the individual digits as often as you like by pressing keys 1 through 4 until the desired address is correctly displayed on the LH200 display.

Advice:

All 4 digits of the display do not have to be altered. If certain digits already have the correct value, you can leave them as they are and go to the next digit.

Example:

You want to alter address 1234 to 1334. Here you only have to select the second digit from the left with key '2' and then alter its value. When finished simply confirm the selection with "A" key

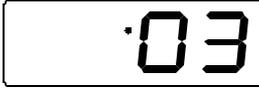
8 Operating a Locomotive with your LH200

In this section you will learn about:

- how the rotary control-knob and the direction switch are used to match the speed of an operating locomotive
- how to control the locomotives functions

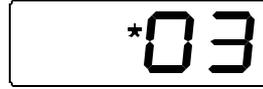
Once you have selected desired locomotive address and this address is in the LH200 display, it is possible to control the locomotive.

If the direction switch is correct, you can immediately take over the displayed locomotive address by moving the rotary control-knob. If the direction switch is in the wrong position you must first move the direction switch to the correct position. You will know that this is the case when one of the dots in the centre stops flashing.



Dot is not flashing:

direction switch is in correct position.
Take over the locomotive by turning the rotary control-knob.



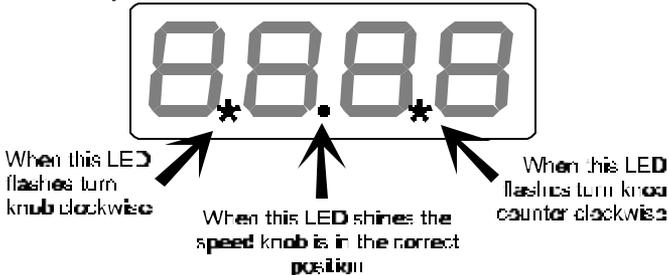
Dot is flashing:

direction switch is in wrong position. In order to take locomotive over, simply change the direction-switch.

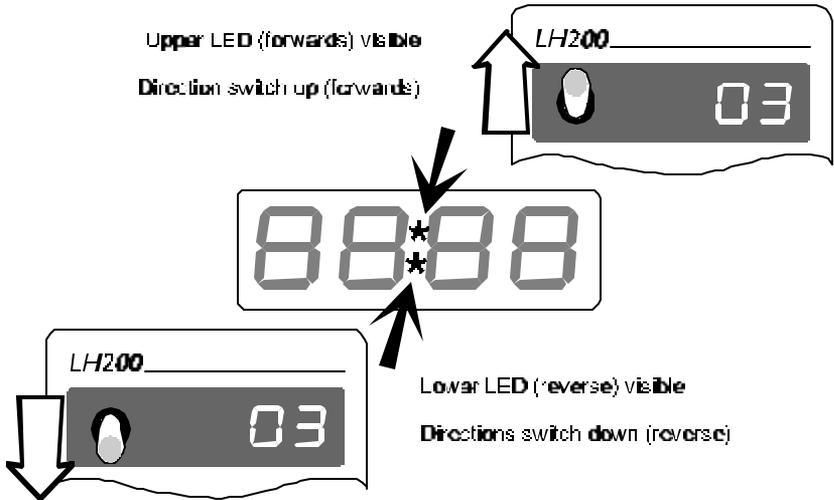
Such actions might result in a change the speed of the locomotive. It is better to adjust the position of the rotary control-knob in the manner described in the following section.

8.1 Adjusting the rotary control-knob position to the speed of the selected locomotive

After you have selected the desired address, and in order to adjust the rotary control-knob to the current speed, move the direction switch to the centre position. This is only necessary if a difference between the LH200 knob speed and the current locomotive speed are different. The display will indicate in which direction you need to move the rotary control-knob to correct for this difference:



Now place the direction switch in the correct position, up (forwards) or down (backwards). If the upper dot appears in the middle of the display, then you must move the switch up (the forwards position). If the lower dot appears in the middle of the display you must move the switch down switch it down (the backwards position backwards).



8.2 Switching the locomotive decoder functions on and off

The LH200 can control up to 9 locomotive decoder functions. To control these functions the locomotive must first be wired so that the desired function works. Activating a function which is not supported by the locomotive decoder will have no effect.

The functions 0 through 4 can be switched on and off by pressing the function key once.

0^M

switches function 0 on or off (normally the direction-dependent front lighting).

1⁵

switches function 1 on or off

2⁶

switches function 2 on or off

3⁷

switches function 3 on or off

4⁸

switches function 4 on or off

For functions 5 through 8 you need 2 keystrokes.

↑⁺

1⁵

switches function 5 on or off

↑⁺

2⁶

switches function 6 on or off

↑⁺

3⁷

switches function 7 on or off

↑⁺

4⁸

switches function 8 on or off

Of course these functions can only be used, if the decoder installed in the locomotive has the corresponding function outputs and if these outputs are connected to a locomotive function (lighting, smoke generator, coupling and so on).

9 Matching the LH200's Throttle Notches to the Decoder's Speed Steps

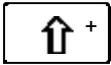
In this section you will learn:

- what throttle notches and speed steps are
- which throttle notch modes you can select
- how you can use the LH200 to match the number of throttle notches to a specific locomotive address

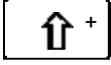
The range from a stop to the maximum speed of a locomotive is divided into throttle notches. In the prototype locomotive there is only a need for a very limited number of throttle notches. For our models we often want much smoother operation than offered in the prototype. The more precisely the speed can be controlled, (that is the more steps up or down in speed that the whole range can be divided into) the greater the number of throttle notches that are needed. The LH200 rotary control knob has 256 different throttle positions to provide the maximum smoothness in operation.

DCC decoders support a variety of speed step modes. The most common are 14, 28, and 128. Speed step modes reflect the number of throttle notches that the decoder will support. LH200 supports all three of these speed step modes. Since different commands are sent to the decoder in all three modes it is necessary to match the number of LH200 throttle notches to the decoder's speed step mode. The LH200 default is 28 throttle notches which in combination with the smoothness of the LH200 rotary control knob provides the smoothness that most modelers desire.

To change the number of throttle notches for a specific locomotive address the LH200 provides a special menu that lets you easily select a different option. To make this change first scroll through the stack until you reach the address whose throttle notches you want to display or alter. Turn the rotary control-knob as far to the left as possible (throttle position 0). Then go to the menu "Display/ alter throttle notches". In the following example the throttle notches mode is altered from 14 to 128.

   Change the menu and scroll with key "0^M".

  Now the present throttle notch mode for the previously selected address is displayed.

  Now you can scroll through the various throttle notch modes.

  When the mode you desire is displayed, confirm your choice with key "A".

  Now the locomotive address whose throttle notch mode you altered is displayed again.

Important note:

If the throttle position of the locomotive is not 0 (rotary control-knob not at the left limit stop), you can display the throttle notch mode currently set, but you can not alter it.

Before changing a locomotives throttle-notch mode you should first ensure that the locomotive decoder both "understands" and is configured to operate in the new throttle position mode. The correlation for Digital plus decoders is the following:

Type of locomotive decoder	Throttle-notch modes supported
XF and XS-series decoders which fully conform to the NMRA standards	14, 28, 128
Other DIGITAL plus decoders which fully conform to the NMRA standards	14, 28
All others legacy DIGITAL plus decoders	14

If you are not sure, please check the operating manual of the relevant decoders. Decoders built to be compatible with the NMRA standards will display one of the following symbols on the front page of the operating manual:



Decoders that have the NMRA Conformance and Inspection seal have been independently tested to fully conform to both the standards and the recommended practices.

10 Programming on the Main – PoM (operations mode programming)

In this section you will learn about:

- what "programming" actually means for *Digital plus by Lenz*® devices
- which features can be altered through POM programming
- step by step example for POM programming

10.1 What does programming mean and what is its use?

As explained in the section "Configuring decoder features", programming is a term used for the process for customizing the configuration of a decoder. Programming on the main is useful for locomotive decoders, because PoM takes place during operation, on a normal "running" track. This removes the need for a programming track once the decoder's address is set.

Within a decoder there is a storage location for each feature. A value is stored in each storage location. These storage locations are comparable to the cards of a card index box. In each decoder you find such a "card index box". On each "card" a feature of the locomotive decoder is written down, for example on "card" number 1 the locomotive address, on "card" number 3 the acceleration rate. That means one card for each feature. Depending on the number of features available in this decoder, the size of the "index card box" varies. On each "card" you will find a numerical value, the general range of values of such a card is 0 to 255.

Since you can alter these numerical values on the index cards (in these storage locations) at any time, they are often called variables. These variables are used to determine features, you use them to **configure**, and that is how the term "**Configuration Variable**", abbreviated to **CV**, developed (in the US). From now on we will no longer talk about index card, but instead we shall use the correct term CV. The concept of the CV will be used to explain the features or operations of the decoder.

Which CV contains which feature is standardized. CV1, for example, is always the address of the locomotive, CV3 is always the acceleration rate and CV4 the braking or deceleration rate. Information on which CVs are supported by a decoder and which features can be set with them, can be found in the decoder's manual which is available from your model railroad dealer. You can also get these documents by sending LSSAE / pre-paid envelope to Lenz Elektronik GmbH or from our WWW site.

Whether all possible figures from the range of values 0 to 255 are available for use, depends on the feature. For the feature "Basic address", CV1, only the range of values from 1 to 99 is available. For CV53 (dimming of function outputs), however, the whole range of values from 0 to 255 is permitted.

In addition to this, there are "cards" on which the entered numerical value is written differently in order to make it easier to deal with. This other presentation of the number we call **binary presentation**. Here the numerical value is not presented using the figures 0,1,2,3,4,5,6,7,8,9, but using only the figures 0 and 1.

It is easier to picture 8 switches in the relevant CVs that can be switched on and off. These switches we call "bits". If the switch is switched on, we say "the bit is set" or "the bit is 1", if the switch is switched off, we say "the bit is deleted" or "the bit is 0".

Example: binary presentation of CV29

Different settings are saved in this CV. Whether a certain setting is switched on or off, is determined by one of the 8 switches (bits):

switch no.	switched on (=bit set "1")	switched off (=bit deleted "0")
1	locomotive runs forward if direction switch points 'up'	locomotive runs backwards if direction switch points 'up'
2	locomotive runs in 28-Throttle positions mode	locomotive runs in 14-Throttle positions mode
3	locomotive can run analogue too	locomotive cannot run analogue
4	is not used	is not used
5	decoder uses user defined speed tables	decoder uses factory default speed tables
6	locomotive controlled via basic address from CV1	locomotive controlled via extended address from CV17 and CV18
7	is not used	is not used
8	is not used	is not used

To alter features of a particular locomotive by means of PoM, the address of this locomotive must be known, all menu commands take the current locomotive address as their basis. The command station sends a command such as: "Locomotive number 132 save a acceleration rate of 10!" This order will only be executed by the locomotive with address 132 and by no other. If the address is unknown or if you want to alter the address of a locomotive, use the procedure described in the section "Programming on the programming track" which starts on page 34.

10.2 Which features can be altered with the help of PoM?

All of a locomotive decoder's CVs can be altered using PoM except for the basic address in CV1. DIGITAL plus decoders also prevent the programming of the extended address in CV17 and CV18 using this mode. You should proceed with great care, because if you program the wrong CVs by mistake the locomotive might not work as expected afterwards! Once you have customized the decoder to a locomotive, you will probably use this mode to most often alter the CVs responsible for acceleration and deceleration rates.

10.3 Which locomotive decoders can have their features altered with the help of PoM?

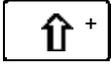
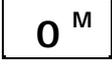
All Lenz Digital plus locomotive decoders ending with the XF- and XS-series are PoM capable. If you employ locomotive decoders from different producers, please check in the documentation whether these decoders are also PoM capable.

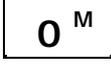
Locomotive decoders which are not PoM capable must be programmed on a special programming track. For further information on this please read the section "Programming on the programming track" which starts on page 34.

Programming of a numerical value in a CV – step by step

In the following example, using PoM, we will alter the acceleration rate of the locomotive with the address 3.

	(possibly more than once)		Scroll through the stack until the address 03 is displayed.
---	---------------------------	---	---

			Change the menu.
---	---	---	------------------

	2x		Scroll through the menu until PoM is displayed.
---	----	---	---

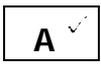
Now confirm the address menu selection with the "A " key:

	
--	--

On the very left of the display the letter "C" is displayed. This is to indicate to you that you now have to enter the number of the CV that you want to alter. The entire right-hand digit of the address display now flashes.

	
---	---

Alter the value of this digit by turning the rotary control-knob to the right (value increases) or to the left (value decreases). In this example the value is 3, because the acceleration rate CV is CV3.

	
---	---

Pressing the confirmation keys now brings up the value display. You have identified the CV that you want to alter and now you are asked to enter the desired value. The right-hand digit flashes.

In the following example value 10 shall be set for the acceleration rate.



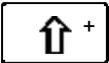
Select the next digit, When you do this the value 0 is taken over for the fourth digit from the left. Now the second digit from the right flashes.



Turn the rotary control-knob until the desired value (here 1) is shown.



Press the "A" key to execute the programming. The selected CV is shown again.



While you are in the CV selecting menu you can move to the next CV at any time by using the "Shift" key.

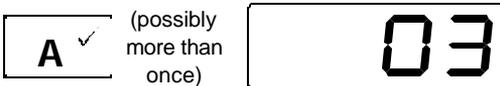
This "counting through" the CVs is especially useful if you want to alter more than one CV in succession, e.g. while programming a characteristic speed mark.



If you don't want to alter further CVs, press the "0^M" key repeatedly until the locomotive address is displayed again. This will end your programming sequence.

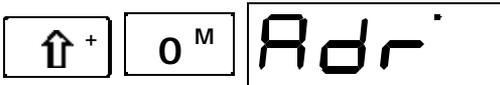
10.4 Setting and deleting bits via PoM – step by step

In the following example, using PoM, we will alter bit 2 of CV29 (the decoder configuration controlling the number of speed steps to be supported) for the locomotive with address 3.



(possibly more than once)

Scroll through the stack until the address 03 is displayed.



Change the menu.



Scroll through the menu until PoM is displayed.

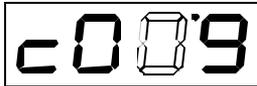
Confirm your selection with A key.



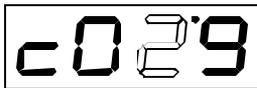
On the very left a "C" is displayed. Now enter the number of the CV that you want to alter. The entire right-hand digit of the address display now flashes.



Alter the value of this digit by turning the rotary control-knob to the right (value increases) or to the left (value decreases). In this example the value is being altered to 9.



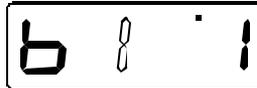
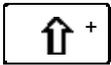
Select the second digit from the right.



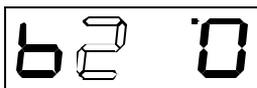
Alter the value of this digit by turning the rotary control-knob to the right or to the left. In this example the value is being altered to 2. (You now are ready to alter CV29.)



You have identified the CV that you want to alter and now you are asked to enter the desired value, the right-hand digit flashes.



The flashing '0' indicates that you have to select the bit you want to alter.



Turn the rotary control-knob until the number 2 is shown.



With key 4 you can now switch back and forth between "Bit is deleted" (display on the very right shows '0') ...



...or "Bit is set" (display on the very right is '1').

Set the desired condition.



By striking "A " key the programming is executed. In this example bit 2 of CV29 was set to have a value of '1'. The selected CV is again shown on the display.



If you don't want to alter further CVs, press the "0^M" key repeatedly until the locomotive address is displayed again. This will end your programming sequence.

You can now proceed as in the previous example above which explains how you program a numerical value.

Important note:

When using PoM, values can only be set, they cannot be read out. You can check whether the programming was successful or not by testing the actual alteration of the feature in operation.

10.5 Error message when using PoM programming

Er 10: you have gone outside the permitted range of values.

Example: You have tried to select CV1. The basic decoder address (CV1) may not be altered by means of PoM.

11 Multi unit (MU) Consisting

In this section you will learn about:

- what a multiple traction/ multi unit consist actually is
- how it is assembled and later disassembled
- how to activate the functions of the locomotive which is currently a member of a multiple traction/ multi unit

11.1 What is a Multi unit (MU) consist?

A Multi Unit (MU) Consist (in Europe called Multi-Traction) is a group of locomotives that you want to operate as a unit. Consider a train that has several locomotives pulling it. As a model railroad operator you have several choices, operate each locomotive separately (as was done in the steam era) or operate all the locomotives as a group (which we call a multi unit (MU) consist). The advantage of running the locomotives in a single consist is that it allows the engineer to control the speed of all the locomotives in the consist at the same time. To do this we need an address that we can use to refer to this group of locomotives that we wish to operate as a unit. This address is called the **Multi Unit (MU) or consist address**.

Whenever a locomotive is added to a consist the locomotive is instructed to use the consist address as its address for future speed and direction information. This information is saved by the locomotive decoder in addition to its individual address. Never fear though: the locomotive decoders do not forget their own addresses, these are still saved and when the locomotive is removed from the consist, the locomotive decoder reverts to its saved locomotive address.

All locomotives with the same Multi Unit (MU) address respond to the speed and direction information sent to the MU address. Most decoders do not respond to functions sent to the MU address. To access the functions that are controlled by a decoder that is in a consist, simply use its original locomotive address. With the LH200 it is very simple to switch between all locomotives with the same MU address, This will be discussed later.

When you remove a locomotive from a consist, the multiple multi unit address in the locomotive decoder is deleted and the locomotive again listens to its own address.

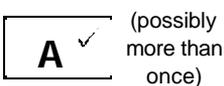
11.2 Head to head, head to tail, and tail to tail operation

On the prototype, locomotives can be oriented in any direction while in a multi unit consist. The LH200 allows you to do the same thing. When you add a locomotive to a consist you simply make sure that the direction switch is properly oriented. If the direction switch is up (forward), the locomotive will be added to the consist so that when the consist is told to go forward the locomotive will go forward. If the direction switch is down (backwards), the locomotive will be added to the consist so that when the consist is told to go forward the locomotive will go backwards. Always make sure you check the direction switch before adding the locomotive to the consist, to ensure that the locomotives all move in the proper direction together.

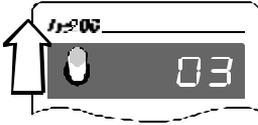
11.3 Constructing your first Multi unit (MU) consist

In this example we will use two locomotives: one with address "3" and one with address "4". We will create a consist with address 55 and add the two locomotives to this consist in what we refer to as a tail to tail consist. This means that the back ends of the two locomotives will be coupled together.

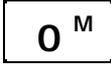
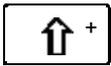
First move locomotive number "3" and locomotive number "4" to the location on your layout, where you want assemble the MU and couple the back ends of the two locomotives together.



Scroll through the stack until the first locomotive (#3) that you want to tie into the MU is shown. At this point make sure the speed is set to stop (knob turned full counter clockwise).



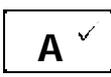
Set the direction switch so that the locomotive will operate in the proper direction when added to the consist. In this example #3 will operate in the same direction as the consist.



Enter the LH200 menu.



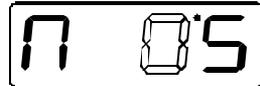
Scroll through the menu until the MU is shown and confirm the selection with "A " key.



The multiple traction/ multi unit address must be between 1 and 99. At this point enter the desired multi unit address.



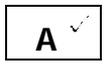
Alter the value of this digit by turning the rotary control-knob to the right (value increases) or to the left (value decreases). In this example the value is being altered to 5.



Select the next digit by pressing key 3. The value of the 10s digit is now confirmed as 0. The 10s digit now flashes.



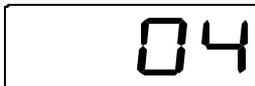
Again, alter the value of this digit with the rotary control-knob.



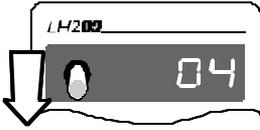
With the correct MU address in the display confirm the selection by pressing the "A " key. The locomotive with address 3 has now been added to the multi unit consist with MU address 55.



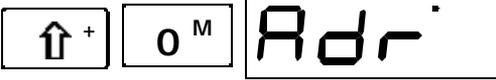
(possibly more than once)



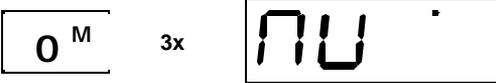
Scroll further through the stack until you reach the next locomotive that you want to tie into the MU or enter the new locomotive address. In this example it is locomotive #4. As before set the speed to stop (knob turned full counter clockwise).



Set the direction switch so that the locomotive will operate in the proper direction when added to the consist. In this example #4 will operate in the reverse direction as the consist.



Enter the LH200 menu.



Scroll through the menu until the MU is shown and confirm the selection with the "A " key.



This time MU address 55 is shown in the display since this is the last consist you were working with. You could change the address as above but in this example we want to add the locomotive to this consist address so confirm the selection with the "A " key



The locomotive with address 4 has now been added to the multi unit consist with MU address 55.

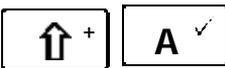
Now whenever you move the rotary control-knob when address 55 is in the display both locomotives #3 and #4 will move together.

You can repeat the steps above to add up to 24 locomotives to the consist. Locomotives can be added or removed at any time you desire.

When adding a locomotive to a consist just make sure that the LH200 direction set is set appropriately. If the locomotive is oriented so its front is the same as the consist, set the direction forward. If the locomotive is oriented so its rear is in the same direction as the consist, set the direction reverse.

11.4 Displaying the locomotive address within an MU

Scroll through the stack until the MU is displayed or enter the address in the stack.



Whenever you see the address of the MU on the display, you can scroll through the locomotives in the MU using this key sequence.

After the last locomotive address in the MU has been displayed, the multi unit address will again be displayed when you press the same key sequence again.

11.5 Controlling the speed and direction of a locomotive within a MU

The speed and direction of all locomotives in a MU can be controlled whenever either the MU address or any locomotive within the MU is on the LH200 display.

11.6 Controlling functions of a locomotive within a MU

You can control the functions of any locomotives in a MU whenever the desired locomotive address within the MU is on the LH200 display. If you want to control a function of a locomotive in a MU, and the MU address is on the LH200 display you can easily display the locomotive address by sequencing through the MU address queue. This is done by the following key sequence.



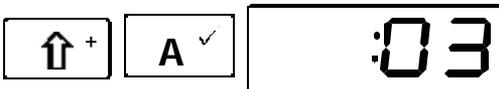
Use this key sequence to scroll through the locomotives in the MU, until the address of the locomotive whose function you want to change is displayed. Now you can set the functions of this locomotive (as described in the section "Switching the locomotive decoder functions").

11.7 Removing a locomotive from a MU

In this example we will delete Locomotive 3 from Consist 55



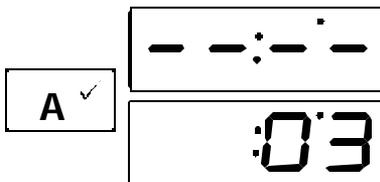
Scroll through the stack until the MU is displayed or enter the address of the MU in the LH200 display



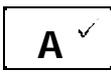
Scroll through the locomotive addresses within the MU until you reach the address of the locomotive that you want to delete from the MU.



Go to the MU menu, the deletion of this locomotive from the MU is offered to you.



In the display the relevant digit address alternates with 4 horizontal bars. At this stage it is still possible to stop the deletion. To do so press the "0"key.



To delete the locomotive from the MU irreversibly, press the "A" key a second time.

Now the multiple multi unit address is displayed again. When you have deleted the last locomotive address from the MU, the MU itself is deleted and the next locomotive address in the queue will be displayed on the LH200 display.

11.8 Preconditions for multi unit operation

LH200 Multi units operation utilizes a decoder feature called advanced consisting. For a locomotive to be able to be placed in a LH200 MU the decoder must have this feature. All DIGITAL plus locomotive decoders, that were built to conform to the NMRA standards have this feature. Many other decoders from other manufacturers also have advanced consisting. If in doubt check your decoder instructions.

One legacy decoder, that does not support advanced consisting, can be added to a multi unit. To do this simply assign the MU address to be the same as the locomotive address of the legacy decoder.

Multi unit operation only operates in 28 address speed mode. **Locomotive decoders have to be set to operation with 28 Throttle positions** before being added to a consist.

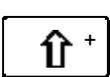
12 Configuring your LH200

In this section you will learn about:

- configuring your LH200

The LH200 can be configured by setting values in the system menu. LH200 system settings are items that affect not only individual locomotives, but the entire system. For example, the size of the stack is such a system feature, as is the display of the software version.

The setting of system features is always affected in the same way:



Select the LH200 menu.



4x



Scroll through the menu, until "SYS" is displayed.

Confirm your selection with "A" key.

From here onwards the numerical values are altered in the same way as for other menus. Which system feature you choose is now only dependent on the figure which has been set:

SYS	causes the setting
1	Stack size is set for 1 locomotive
2	Stack size is set for 2 locomotives
3	Stack size is set for 3 locomotives
4	Stack size is set for 4 locomotives
5	Stack size is set for 5 locomotives
6	Stack size is set for 6 locomotives
7	Striking the emergency stop key causes the voltage on the track to be switched off.
8	Striking the emergency stop key causes only the locomotive with the address shown on the display to be stopped.
9	Striking the emergency stop key causes all locomotives to be stopped, but the voltage on the track remains switched on (only available when the LH200 functions as XpressNET-device and is not functioning as the command station)
10	Set the LH200 XpressNET address. The default address is "02".
11	Version number of LH200 is displayed
99	The factory set configuration of LH200 is reset: <ul style="list-style-type: none"> - in the stack addresses 0 to 5 are entered - 28 Throttle positions are allocated to the locomotive addresses in the stack - all multi-traction / multi units are deleted from the LH200 memory

13 Programming on the Programming Track

In this section you will learn:

- what a programming track is
- the difference between "Programming in operational mode (POM)" and "Programming on the programming track"
- when it is necessary to use this programming method
- how to install a programming track
- detailed example on how to proceed step by step

Customizing the decoder's features is accomplished through a technique we refer to as programming.

13.1 What is a programming track?

A programming track is an isolated section of track that is used exclusively for checking for the correct installation of a decoder, setting a decoder's address, and configuring a decoders CVs. **To make sure that only a specific decoder receives a particular programming instruction, only the locomotive whose decoder features you want to alter should be placed on this track.** This is easy to achieve if you use a part of the layout which is electronically separated from the rest of the track system.

13.2 Difference between "programming using POM" and "programming on the programming track"

During "Programming on the main" the locomotive with the decoder can be located anywhere on the layout. To address this locomotive precisely and to distinguish it from the others, it is necessary to know the address of the locomotive. During programming in operational mode (PoM) a specific locomotive receives an order that can be described as follows:

"Locomotive number 1234, enter value 15 in CV4!"

Only the locomotive with address 1234 will execute this order.

During programming on the programming track it is **not** necessary to know the address of the decoder:

The other major difference is that on a programming track it is possible to read the value of the CV that is contained within the decoder. The ability to read the value of a CV is not available on all XpressNET based command stations

Caution: During Programming, every decoder which receives programming track commands will change their CVs. This means that if you do not use a programming track that is totally isolated from your layout, all your locomotives on the layout will at the same time change their CVs at to the value you program. For example, if you program the locomotive address to have the value of "1" than all locomotives on your layout will now respond to the address "1".

13.3 When is it necessary to program on the programming track?

You should always check out the proper installation of a decoder on a programming track before trying to operate the locomotive by attempting to set its address. Once you set the decoders address you can use PoM for setting all other CVs. However, not all *NMRA DCC* decoders have operations mode programming (POM) capabilities. For all these decoders it is necessary to set their CVs through use of "Programming on the programming track".

13.4 Where is the programming track connected?

Each NMRA DCC system has a different method for connecting a programming track. Some systems use a separate set of connections while others use the master handheld for all programming functions. Consult your NMRA DCC Command Station manual for more details.

13.5 Programming on the programming track" – step by step instructions

First place the decoder you wish to program on the programming track.

↑ +	0 ^M	Adr	Enter the LH200 menu.
0 ^M	5x	Pr c	Scroll through the menu until the MU is shown and confirm the selection with "A " key.
A ✓	Ad	First, it is suggested that you program the address (CV1) of a locomotive. If you wish to do this, confirm with "A ".key.If you press the Shift key at this point you can select any CV to program.	



You are now asked to enter the value that you want to program or simply press the "A " key a second time at this point displays the decoders current value for this CV



The alteration of the value is executed in the manner familiar to you from other menus. If you want to program a 4-digit address, the small "u" will disappear from the display if you press key "1".



When the desired value is set, begin the programming with key "A " key.

IMPORTANT NOTE

If the decoder is properly installed, the locomotive will have a slight jerk indicating successful programming, if instead you hear a audible buzz for the locomotive, there is a short in the locomotive and this should be corrected before you subject the decoder to full DCC track power.



Press key "A " key once more and you will see "Ad" again.

Programming a DCC locomotive's address with LH200 is different than from other DCC command stations. With LH200 you simply set the desired new locomotive address. The LH200 automatically decides which CVs to program on your behalf. To accomplish this LH200 uses a feature called "Direct CV Mode" if you wish to program an address greater than 99 using this easy method you need to ensure that your decoder supports "Direct CV Mode" and also supports 4 digit or extended addressing. All *Digital plus* by Lenz ® XF and XS series decoders and decoders with version 4.1 or 5.1 support these features. If you are using a different manufacturer's decoder, check with its operating manual to see if you can use this shortcut mode. If not you will have to manually program the decoder's CVs using register mode described on page 39.

Note: If you program the locomotive to have an address greater than the maximum number that your command station can control you will not be able to operate the locomotive

If you want to program a different feature of the locomotive decoder other than the address, press key "Shift" when "Ad" is shown on the display and choose a different feature (a different CV). The rest of the procedure including the ability to alter individual bits is identical with the procedure of PoM.

If your decoders do not support the programming mode "CV", you can program these decoders using a technique called "register mode". You will find Information on this in the section "Programming using Register Mode" which starts on page 39.

0^M

You can stop the programming mode at any time by using the menu key (it may be necessary to press twice). After doing so you will once again see a locomotive address on your display.

13.6 Error Messages

Er 01

The locomotive on the programming track either has a short or is drawing too much power to be programmed.

Er 02

The decoder on the programming track did not respond when the LH200 tried to read the value of the CV.

Pr

Only one handheld can perform programming on the programming track at one time. All other handhelds display this message

14 Technical Appendix

In this section you will find:

- information on the stack
- valuable information on the LH200's, LV101 power station
- information on the wiring of your model railway
- information on wiring the XpressNET network
- further help on terminology and procedures

14.1 The LH200 stack

The *stack* provides for fast selection of up to six locomotives.

The stack can be compared to a small index-card box: this box contains 6 index cards. Each one of these index-cards has a digit address stored upon it, as well as information on speed and direction and the status of functions. This means that as well as the locomotive addresses, information allocated to the addresses such as throttle position, direction of motion and functions is also stored. We call this information "locomotive data".

To scroll through the stack, use the  key.

You can configure the number of cards you desire to scroll through. It is possible to set LH200 so that you only switch back and forth between the first and second index cards. Or you may wish to see only the first 4 cards. You will learn how to configure this in the section "Configuring your LH200" on page 32. From the factory the LH200 is configured so that it is possible to scroll through all 6 locomotives in the stack. the addresses 0 to 5 are entered in the stack. Address 0 is the address with which you can control a conventional (analogue) locomotive.

The data relating to all other active locomotive address, which are accessed by means of on an additionally connected LH100 or LH200 handheld, are stored in additional memory in LH200. This memory is preserved by the LH200 across operating sessions.

14.2 Messages on the LH200 display

The LH200 shows a message if you have done something which is not permissible at the time. In such circumstances you will have to go back a step. To go back a step back simply press



The following is a list of possible messages:



You have exceeded the range of values permitted in this situation.



The MU-storage is full: you have assembled too many multiple traction/ multi units or else the maximum number of locomotive addresses in the MUs has been exceeded.



Either one of the XpressNET wires is broken or the command station is in programming mode

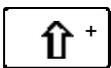


The feature being attempted on the LH200 is not supported by the command station

14.3 Programming using "Register-mode"

Older **Digital plus by Lenz**® decoders (produced before 1996) and some decoders from other manufacturers do not support programming using direct CV mode. These decoders can be programmed using "Register Mode" programming. For backwards compatibility, LH200 supports Register Mode programming.

First, proceed as described in the section "Programming on the programming track" starting on page 34 and place the desired locomotive on the isolated programming track.



Enter the LH200 menu.



5x



Scroll through the menu until the MU is shown. At this point press the "2" key



Confirm the selection of register mode programming with "A " key.



First, it is suggested that you program the address (CV1) of a locomotive. If you wish to do this, confirm with "A ".key.If you press the Shift key at this point you can select any CV to program.



First you are offered the opportunity to program the address (register 1).

By pressing the "A " key again, you reach the menu for the entering of the value. The procedure for the displaying a current value or entering a new value is identical with the procedure described in the section "Programming on the programming track".

The range of values which may be used is from 1 to 99.

If you do not want to program register 1, but a different one, press



Now you can scroll using the "Shift" key or determine the number using the rotary control-knob. Confirm your selection again with key "A " key and now you can enter the value.



You can stop the programming mode at any time by using the menu key (it may be necessary to press twice). After doing so you will once again see a locomotive address on your display.

14.4 Bits and bytes – conversion help

Setting and deleting of bits in a CV for decoders that do not support bit mode operations.

In many decoder CVs, individual bits are used for calculations rather than numerical values. If you wish to program a decoder which does not work with bits in altering CVs, you will have to program the appropriate decimal value for whichever bits are to be set or deleted in the CV. Therefore, ask yourself

Which decimal numbers do I have to enter in order to set or delete which bits?

Each bit set represents a number, a numerical value. Simply write the value of all bits which are to be entered into a CV one below the other and add up these values. The following table shows what is meant:

NMRA Bit	LH200 Bit	Value
0	1	1
1	2	2
2	3	4
3	4	8
4	5	16
5	6	32
6	7	64
7	8	128

Each bit which is not set and therefore deleted, has the value '0'.

To determine the correct decimal number follow this rule:

Add up the value of all bits which are to be set.

Example:

Bit 1 and Bit 4 are to be set, all other bits are to be deleted. Therefore the values of the two set bits are to be added up: The decimal value which you have to enter into the CV is therefore '9'.

Bit	Value
1	1
4	8
Sum total:	9

14.5 Glossary

The most important terms of the **Digital plus by Lenz®** system:

Locomotive Address	The locomotive number, comparable to a telephone number
Features of the locomotive decoders	Address, starting voltage, acceleration rate and deceleration rate are examples of features which can be customized within the locomotive decoder. You will find detailed information on the features of Digital plus locomotive decoders in their respective manuals, available from your dealer or direct from Lenz Elektronik GmbH (send a stamped addressed C5 envelope).
Throttle position	The range between the minimum and maximum speed is divided into individual sections. These sections we call Throttle positions.
Throttle-notches	Determines whether a locomotive is controlled with 14, 28 or 128 speed step mode.
Track format	The way in which the information is transmitted over the tracks.
Stack	"Index-card box" enabling fast selection of a locomotive address.
NMRA	National Model Railroad Association
NMRA DCC Standards and RPs	A standard developed by the NMRA based on Lenz Digital plus, which determines the transfer of information to locomotive decoders and accessory decoders. These standards define the interchange of decoders produced by different manufacturers.
XpressNET	High speed network for connecting DIGITAL plus input devices
XpressNET-input devices	Devices by which the model railway of the Digital plus system is controlled: handheld controls, Tower Cabs, computer interface etc.

15 Troubleshooting Guide

Malfunction	Possible cause	Correction
LH200 is not operational (LED on LV101 does not light up)	Power supply is interrupted, transformer is not plugged into an outlet or "U", "V" wires are not connected to the transformer.	Ensure that the transformer is on, has not overloaded or shut off, check wiring from transformer to LV101
	There is a short circuit on the layout.	Remove the cause of the short circuit.
LED on LV101 flashes Display lit on LH200	There is a power overload.	Divide the layout into several supply sections and power these with additional power stations/transformers.
	The emergency Stop key has been pressed	Press the emergency stop key again
	You are in programming using a programming track	When finished programming turn the power to the LH200 on and off
LED on LV101 flashes and LH200 Display blank	The connection between LV101 and command station LH200 is broken, or there is a short circuit (terminals C and D)	Check and correct these connections.
	The Transformer does not have sufficient voltage and or current to power Set/02	Replace the transformer with a higher amp transformer that provides a minimum of 15 volts AC
LV101 is operational (LED lights), but locomotives do not run	The connection from Power Station to track is broken (terminals J and K).	Test and correct connections.
LV101 is operational (LED lights), ER 96 on LH200 display	The system is in program track mode	Exit form programming mode or re-power system
	Wire A or B is not connected on the XpressNET	Fix the wiring
Throttle notch setting can not be altered	Speed of the locomotive is not 0	Before setting the throttle position mode turn the rotary control-knob as far to the left as possible
Locomotive does not run when throttle notch mode 128 has been selected	Locomotive decoder does not support 128 speed step mode	Set running-notch mode 14 or 28

<p>Locomotive lighting (F0) can not be switched on</p>	<p>Locomotive decoder is set at running-notch mode 28. The relevant address is to be found in the LH200 in running-notch mode 14.</p>	<p>Alter the throttle position mode of the LH200 to 28 set the locomotive decoder to 14 Throttle notch positions</p>
<p>Locomotive lighting (F0) is switched on and off when the rotary control-knob is turned</p>	<p>Locomotive decoder is set at throttle notch mode 14. The relevant address is to be found in the LH200 in running-notch mode 28</p>	<p>Alter the throttle position mode of the LH200 to 14 notches or set the locomotive decoder to 28 Throttle positions</p>
<p>Locomotive does not work using its basic address</p>	<p>Locomotive is perhaps integrated in a multiple traction/ multi unit</p>	<p>Control the locomotive using the multiple traction/ multi units address</p>
<p>Locomotive does not work after programming an address greater than 99</p>	<p>It is possible that the decoder does not support extended addressing or does not support "Direct CV Mode" programming</p>	<p>Set the address for this locomotive to be 99 or less or perhaps use register mode to set the extended address.</p>
<p>Locomotive address on the LH200 display flashes</p>	<p>Selected address is already invoked on a different Handheld control</p>	<p>Select a different locomotive or take over the locomotive by placing the rotary control-knob and the direction switch in the correct position and moving the rotary control-knob briefly.</p>
<p>The desired menu does not display on the LH200</p>	<p>The command station you are using does not support this feature</p>	
<p>An ER 98 is on the display</p>		

16 Radio And Television Interference

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

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

You may also find helpful the following booklet, prepared by the FCC: "How to Identify and Resolve Radio-TV Interference Problems." This booklet is available from the U.S. Government Printing Office, Washington D. C. 20402.

Changes and modifications not expressly approved by the manufacturer or registrant of this equipment can void your authority to operate this equipment under Federal Communications Commissions rules.

17 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.

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.

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.

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

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FC 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!