Unleashing the Power of DCC

Digital *plus*
by Lenz

XpressNet

SET-02/4
Operations Manual

DCC®

Submitted to the NMRA for
Conformance and Inspection testing

Welcome!

Thank you for purchasing our SET-02. We would like to congratulate you on your acquisition of the *Digital plus by Lenz*® SET-02 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 Set and its components 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 SET-02's entire range of functions. It is not necessary to understand or use all the system's features. Select the set of features you are comfortable with and enjoy your model railroad.

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:

	Europe	North America
Postal address:	Lenz Elektronik GmbH Huettenbergstrasse 29 D-35398 Giessen	Lenz Agency PO Box 143 Chelmsford, MA 01824
Phone	++49 (0) 6403 900 133	++1 978 250 1494
Fax	++49 (0) 6403 900 155	++1 978 250 1494
Email	info@digital-plus.de	support@lenz.com

All present and correct?

Please check, whether all the components of the SET-02 have been delivered:

> LH200 - Knob based Engineer's Throttle
>
> LV101 - Power Station (Booster)
>
> LE103XF or LE077XF - locomotive decoder
>
> black coil cable with phone plugs at each end
>
> one 4- and one 3-terminal green connector attached to the rear of the LV101
>
> one additional 4-terminal green connector
>
> operating manual (this booklet)

If any component is missing, please ask your supplier for a supplementary delivery.

1   Contents

2   Quick Start Users Guide

In this section you will learn about:
- the few steps that you need to know to operate your SET-02
- how to start your first test run

In the later sections, the whole range of functions of the SET-02 will be explained in detail.

2.1   Connection and initial operation

1. Plug one side of the coil cable into the socket of the LH200, and the other side into the socket labelled I/O Port located on the back of the LV101. This connection must not be interrupted during operation.

2. Connect terminals J and K of the LV101 power station to the tracks of your model railway. You can pull off the green terminal connector on the back of the LV101. This will facilitate the installation of cables. Make sure that no other transformers or operating controllers are connected to the tracks.

3. Connect terminals U and V of the LV101 to a model railway transformer with a 14-18 VAC voltage. For initial operation virtually any transformer with a current rating of greater than 13 VA will work. To operate the maximum number of locomotives a transformer with a minimum capacity of 60 VA should be used. See page 50 for more details on suitable transformers.

4. 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)

5. 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.

6. Plug the power cord of the transformer into a wall socket. The display on the LH200 lights up and the red led on the LH200 turns on solid red.
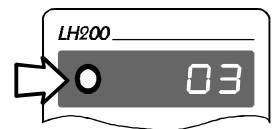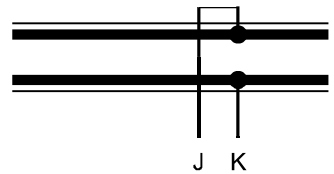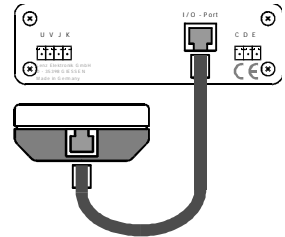
   You can now start operating trains! (Yes, already!)

2.2   Your first operation of a DCC train

Let us assume that the decoder which was delivered together with SET-02 has been installed into your locomotive (either by you or by someone else) and is now on your layout. This decoder is shipped from the factory with 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.

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

Flick the direction switch into the upward position (forward is up)
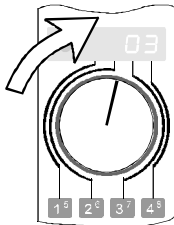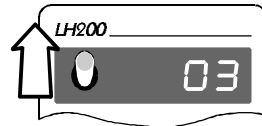
Turn the rotary control-knob to the right. The locomotive moves forward, and the more you turn the knob to the right, the faster the locomotive will move (Throttle positions increase in size).
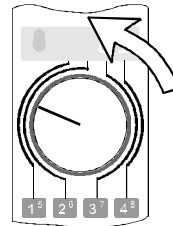
Turn the rotary control-knob back to the left. The locomotive slows down, the further you turn the knob to the left the more it will slow down (Throttle positions decrease in size).

Turn the knob as far to the left as possible: the locomotive stops.
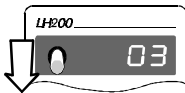
Flick the direction-switch switch downwards through the centre position. This will change the direction of motion of the locomotive from forwards to backwards.

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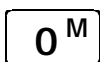
$\mathbf{0}^{\ M}$	In order to switch on the light function of the locomotive decoder, press the key "0^M". Press the key once and you will turn on the light, press it again and you will turn it off. With LH200 you can control up to 9 functions in locomotive decoders.

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 SET-02 has to offer.

3   SET-02 Capabilities Overview

In this section you will learn :
- the range of functions of SET-02
- the possibilities which this range of SET-02 functions opens up to you in controlling your model railway

The use of the SET-02 functions is explained in detail at the end of this section.

> In SET-02 the LH200 Knob based Engineer's Throttle works as both an input device and command station at the same time. It produces the track format, which is amplified by the power station (LV101) and sent to the tracks. This is why the LH200 has to be connected to LV101 at all times during operation.

3.1   Range of possible addresses for your locomotives

With SET-02 you may control any 4 digit locomotive address. This means that a locomotive address can have any value from 1 to 9999.

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 .

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 20.

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. SET-02 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 21.

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.

SET-02 remembers a lot of information about multi units even between operating sessions. With SET-02 you can configure a maximum of 24 locomotives in 12 multiple multi unit consists.

You will find detailed information on the assembly and controlling of an MU in the section "Multiple Unit (MU) Consisting" which starts on page 30.

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. SET-02 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 37.

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 24.

3.6   Power Station capabilities

The power station, LV101, which is part of SET-02 can provide a maximum current output of 52 volt amps. Depending on the demand for current of the locomotives in operation, this is sufficient for 4 - 8 locomotives. If the capacity of a single LV101 power station is not sufficient, you can add additional power stations. You will find information on such expansion in the section "More power through more power stations", which starts on page 46.

3.7   Expanding your system

You can connect up to 5 additional devices, such as additional handhelds, to your SET-02. Which of the devices you decide to choose from the Digital plus family is entirely up to you.

Examples:

Additional **LH200**s may be added for a more engineers.
Additional **LH100** keypad based dispatchers throttles may be added for operating locomotives or for switching turnouts or signals.
A **tower cab LW100** may be added to switch not only individual turnout but entire turnout systems.
The **computer interface, LI100,** may be added to control your model railway from your PC.

More detailed information on this can be found in the section "Adding XpressNET to allow additional input Devices" which starts on page 43.

3.8   Controlling turnouts

Although the possibilities opened through SET-02 features are many and varied, SET-02 does have some limits. The LH200 contained in SET-02 is not able to control turnouts or switch magnetic articles on and off. This capability was omitted to keep the LH200 easy for a train operator. Should you desire to be able to control turnouts or other similar devices this can be achieved easily by connecting an LH100 or a similar XpressNET device which contains these capabilities. More detailed information on this can be found in the section "Special information on operating XpressNET devices " which starts on page 44.

3.9   Expanding beyond SET-02

SET-02 is part of our overall DIGITAL plus family. Should you ever need more capabilities, (such as the ability to use more handhelds or layout feedback) you can upgrade a SET-02 to our full professional series by installing an LZ100 command station. When the LZ100 is installed it becomes the command station and the LH200, used as a command station in SET-02, becomes an additional handheld for use anywhere on the installed XpressNET.

Gathering feedback about the switching of turnouts or the occupation of track sections is possible only when SET-02 is upgraded with the command station LZ100 . You will find more information on this in the section Expanding beyond the capabilities of SET-02 using an LZ100 Command Station" which starts on page 48.

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:

1234

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

1234 *
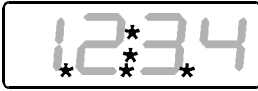
Points below left, in the centre and below right are helpful for adjusting the rotary control-knob and the direction switch when you take control of a different locomotive. Diverging positions of rotary control-knob and direction switch are indicated by flashing lights. You will find more detailed information 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 knob does not influence the locomotive's speed.

Switch down: locomotive moves backwards

LH200   03   LH200   03   LH200   03
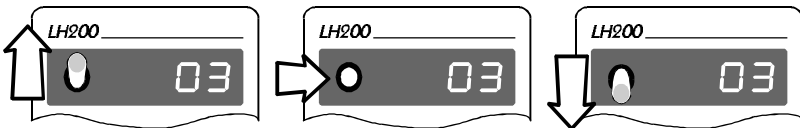
4.4   The keys

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

A ✓	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.
⇧ +	"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.
0 M	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.
1 5 **2** 6 **3** 7 **4** 8	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.
⊙	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.

5   Emergency Stop

If you want to immediately operation press the ⊙ key. stop

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.

$$OFF$$

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 SET-02" which starts on page 36

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

Key	Display	Description
0 M	Adr˙	Enter a new locomotive address in the LH200 stack in order to control a new locomotive.
0 M	┌ 28˙	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.
0 M	PoП˙	Programming on the main (operations mode programming): allows changing of the features of the locomotive decoder while on the operational layout.
0 M	ПU ˙	Multi unit operation. With this menu you can add remove or display locomotives that are within multi unit consists.
0 M	SYS˙	System configuration settings
0 M	03	After scrolling through all the menus, the LH200 returns the display to the last locomotive controlled.
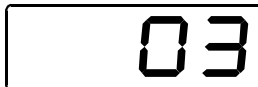
Use the $\boxed{\mathbf{A}^{\checkmark}}$ key to confirm selection of any menu.

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.
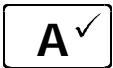
$\boxed{\mathbf{A}^{\checkmark}}$ When pressed this key switches over to the next locomotive address in the stack, and the address is shown in the display. Having reached the top of the list, the following key stroke will again display the digit address at the bottom of the list.

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:

⇧ +   0 M   **Adr**·   Go to the menu "Enter a new digit address into the stack"

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

A✓   **03**·   Now the entire right digit of the address (the ones digit) flashes on the display.

🎛   **06**·   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 6.

3 7   **06**   Now select the 10s digit. The value 6 is now valid as the ones digit and the 10s digit begins to flash.

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

A✓   * **46**   *   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:

⇧ +   0 M   **Adr**·   Go to menu " Enter a new locomotive address into the stack"
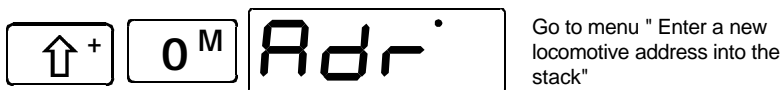
Now confirm the address menu selection with the "A " key:
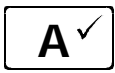
A✓	46	The furthest right digit of the address display now flashes.
⟳	44	Alter the value of this digit by turning the rotary control-knob to the right (value increases) or to the left (value decreases). In this example the value is altered to 4.
3⁷	44	Now select the next digit you desire to alter. The value 4 is now valid as the ones digit and the 10s begins to flash.
⟳	34	Turn the rotary control-knob until the desired value is shown.
2⁶	0034	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.
⟳	0234	Turn the rotary control-knob until the desired value for the second digit from the left is shown, here 2.
1⁵	0234	Pressing the "1" key causes the left hand digit to flash indicating that this is the digit you desire to change.
⟳	1234	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.
A✓	12*34*	Now adjust the position of the rotary control-knob and the direction switch as described above.
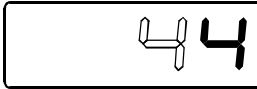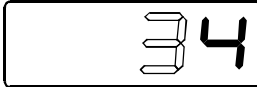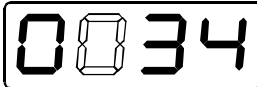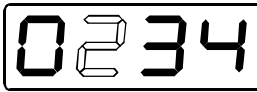
Until you press the check key (the "A   " key), which indicates that your selection is complete, you can switch back and fourth between the individual digits as often as you like by pressing keys 1 through 4 until the desired address is correctly displayed on the LH200 display.

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.
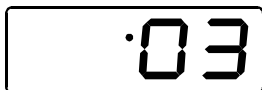
·**03**	*****03**
Dot is not flashing: direction switch is in correct position. Take over the locomotive by turning the rotary control-knob.	Dot is flashing: direction switch is in wrong position. In order to take locomotive over, simply change the direction-switch.
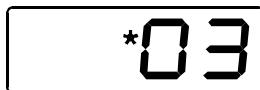
Such actions might result in a change the speed of the locomotive. It is better to adjust the position of the rotary control-knob in the manner described in the following section.

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:

When this LED flashes turn knob clockwise

When this LED shines the speed knob is in the correct position

When this LED flashes turn knob counter clockwise
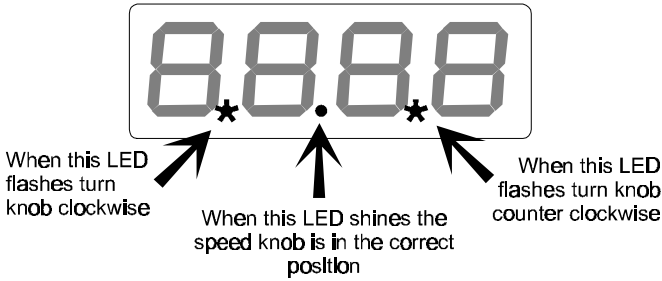
Now place the direction switch in the correct position, up (forwards) or down (backwards). If the upper dot appears in the middle of the display, then you must move the switch up (the forwards position). If the lower dot appears in the middle of the display you must move the switch down switch it down (the backwards position backwards).

Upper LED (forwards) visible

Direction switch up (forwards)

Lower LED (reverse) visible

Directions switch down (reverse)
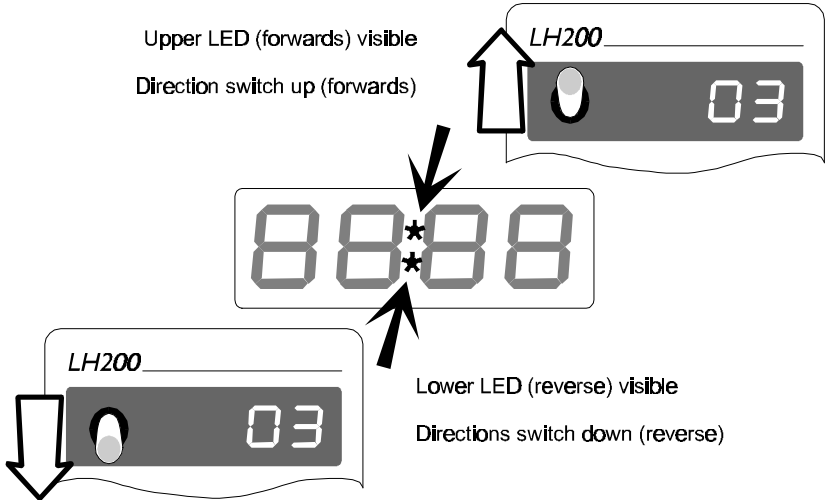
8.2   Switching the locomotive decoder functions on and off

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). | 1 5 | switches function 1 on or off |

| 2 6 | switches function 2 on or off | 3 7 | switches function 3 on or off |

| 4 8 | switches function 4 on or off |

For functions 5 through 8 you need 2 keystrokes.

| ⇧ + | 1 5 | switches function 5 on or off | ⇧ + | 2 6 | switches function 6 on or off |

| ⇧ + | 3 7 | switches function 7 on or off | ⇧ + | 4 8 | 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.
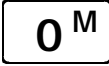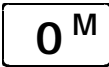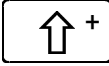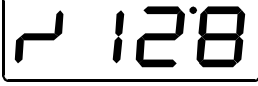
DCC decoders support a variety of speed step modes. The most common are 14, 28, and 128. Speed step modes reflect the number of throttle notches that the decoder will support. SET-02 supports all three of these speed step modes. Since different commands are sent to the decoder in all three modes it is

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.

⇧ +	0 M	Adr⋅	Change the menu and scroll with key "0M".
	0 M	⌐ 14	Now the present throttle notch mode for the previously selected address is displayed.
⇧ +		⌐ 28	Now you can scroll through the various throttle notch modes.
⇧ +		⌐ 128	When the mode you desire is displayed, confirm your choice with key "A ".
A✓		03	Now the locomotive address whose throttle notch node 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. A decoder is built to NMRA standards if you see one of the following symbols on the front page of the operating manual:

The decoder which is included within SET-02 is a decoder of the XF-series and complies fully to NMRA standards.

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 37.

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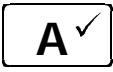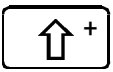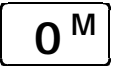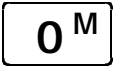
10.3   Which locomotive decoders can have their features altered with the help of PoM?

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.
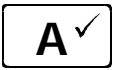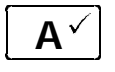
Locomotive decoders which are not PoM capable must be programmed on a special programming track. For further information on this please read the section "Programming on the programming track" which starts on page 37.

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.

A ✓	(possibly more than once)	03	Scroll through the stack until the address 03 is displayed.
⇧ +	0 M	Adr·	Change the menu.
0 M	2x	PoП·	Scroll through the menu until PoM is displayed.

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

A ✓	c00̇0	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.
⟳	c00̇3	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.
A ✓	⊔00̇0	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.

3 **7**   ⎣⎦0⎕0

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.

(rotary control-knob)   ⎣⎦0 10

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

A ✓   c00∃

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.

0 **M**   03

If you don't want to alter further CVs, press the "0M" 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.

A ✓   (possibly more than once)   03

Scroll through the stack until the address 03 is displayed.

⇧ **+**   **0** **M**   Adr

Change the menu.

0 **M**   **2x**   PoП
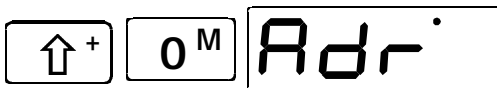
Scroll through the menu until PoM is displayed.

Confirm your selection with A key.

A ✓ | `c000`

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.

(rotary knob) | `c009`

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.

3 7 | `c009`

Select the second digit from the right.

(rotary knob) | `c029`

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 nor are ready to alter CV29.)

A ✓ | `u000`

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.

⇧ + | `b   1`

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

(rotary knob) | `b2  0`

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

4 8 | `b2  0`

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

4 8 | `b2  1`

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

Set the desired condition.

A ✓

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.

0 M | `03`

If you don't want to alter further CVs, press the "0M" 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
- how multi-traction / multi-units are organized in SET-02

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 locomotive 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.
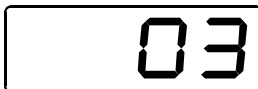
$\boxed{\text{A}^{\checkmark}}$	(possibly more than once)	$\boxed{\text{03}}$	Scroll through the stack until the first locomotive (#3) that you want to tie into the MU is shown. At this point make sure the speed is set to stop (knob turned full counter clockwise).
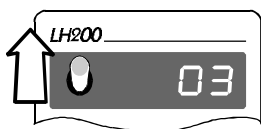
Set the direction switch so that the locomotive will operate in the proper direction when added to the consist. In this example #3 will operate in the same direction as the consist.

Enter the LH200 menu.

Scroll through the menu until the MU is shown and confirm the selection with "A " key.
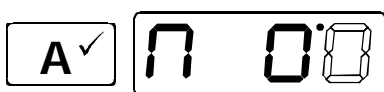
The multiple traction/ multi unit address must be between 1 and 99. At this point enter the desired multi unit address.
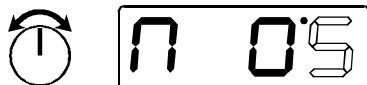
Alter the value of this digit by turning the rotary control-knob to the right (value increases) or to the left (value decreases). In this example the value is being altered to 5.
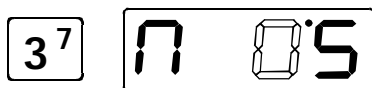
Select the next digit by pressing key 3. The value of the 10s digit is now confirmed as 0. The 10s digit now flashes.
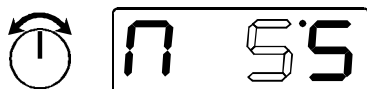
Again, alter the value of this digit with the rotary control-knob.
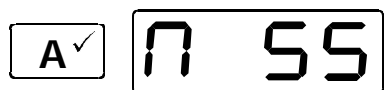
With the correct MU address in the display confirm the selection by pressing the "A " key. The locomotive with address 3 has now been added to the multi unit consist with MU address 55.
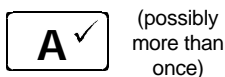
(possibly more than once)
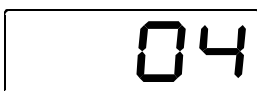
Scroll further through the stack until you reach the next locomotive that you want to tie into the MU or enter the new locomotive address. In this example it is locomotive #4. As before set the speed to stop (knob turned full counter clockwise).
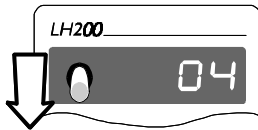
Set the direction switch so that the locomotive will operate in the proper direction when added to the consist. In this example #4 will operate in the reverse direction as the consist.
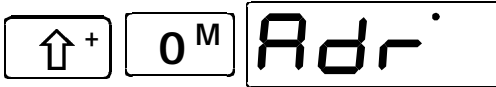
Enter the LH200 menu.

Scroll through the menu until the MU is shown and confirm the selection with the "A " key.
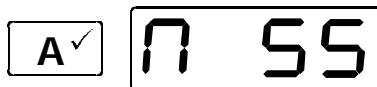
This time MU address 55 is shown in the display since this is the last consist you were working with. You could change the address as above but in this example we want to add the locomotive to this consist address so confirm the selection with the "A " key
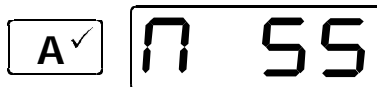
The locomotive with address 4 has now been added to the multi unit consist with MU address 55.

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.

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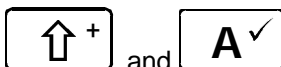
Use this key sequence to scroll through the locomotives in the MU, until the address of the locomotive whose function you want to change is displayed. Now you can set the functions of this locomotive (as described in the section "Switching the locomotive decoder functions ").

11.7 Removing a locomotive from a MU

In this example we will delete Locomotive 3 from Consist 55
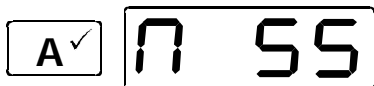
A ✓   ∏ 55   Scroll through the stack until the MU is displayed or enter the address of the MU in the LH200 display
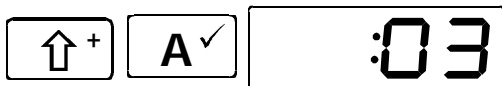
⇧ +   A ✓   :03   Scroll through the locomotive addresses within the MU until you reach the address of the locomotive that you want to delete from the MU.

⇧ +   0 M   ∏U-·-   Go to the MU menu, the deletion of this locomotive from the MU is offered to you.
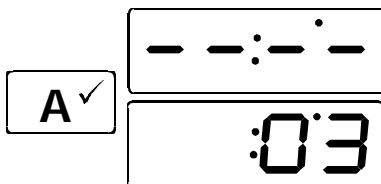
A ✓   _ _:_ _ / :03   In the display the relevant digit address alternates with 4 horizontal bars. At this stage it is still possible to stop the deletion. To do so press the "0"key.
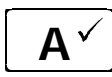
To delete the locomotive from the MU irreversibly, press the "A " key a second time.

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   Managing the LH200 MU memory

In addition to the stack the LH200 command station also stores information on each consist in the MU-memory. In this memory are stored the locomotive addresses which are within the MU. There is a 24 locomotive addresses limit in this MU-memory. You can divide this memory in a very flexible way:

You can set up to 12 multi units. 24 locomotives can be distributed to them in an fashion. The number of multi units possible therefore depends entirely on the sum of locomotives in any single MU. Possible combinations are for example:

Number of MUs	Number of locomotives	Number of MUs	Number of locomotives	Number of MUs	Number of locomotives	Number of MUs	Number of locomotives
1	12	1	12	1	3	1	3
2	12	2	6	2	5	2	5
		3	6	3	7	3	4
				4	9	4	6
						5	6

11.9   Preconditions for multi unit operation

SET-02 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 SET-02

In this section you will learn about:

-    configuring your LH200

The SET-02 can be configured by setting values in the system menu. SET-02 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:

⇧ + 0 M **Adr·**	Select the LH200 menu.
0 M **4x** **SYS·**	Scroll through the menu, until "SYS" is displayed.
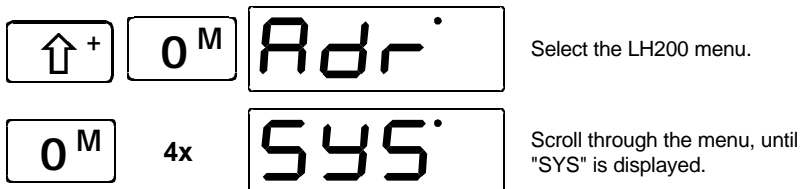
Confirm your selection with "A " key.

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 for1 locomotive
2	Stack size is stack is set for 2 locomotives
3	Stack size is stack is set for 3 locomotives
4	Stack size is stack is set for 4 locomotives
5	Stack size is stack is set for 5 locomotives
6	Stack size is stack is set for 6 locomotives
7	Striking the emergency stop key causes the voltage on the track is 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 (only necessary when the LH200 functions as a XpressNET device and is not functioning as a command station)
11	Version number of LH200 is displayed
99	The factory set configuration of LH200 is reset: - 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:

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 "Enter value 15 in CV4!" All decoders that receive this command will change CV4 to have a value of 15.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?

The connection points of the programming track with SET-02 are the terminals **J** and **K** of the power station LV101. In practice you proceed as follows: disconnect the two wires which lead from the terminals **J** and **K** of LV101 to your track system and instead connect only the programming track to the LV101. A second 4 terminal green connector is provided for this purpose. Alternatively you can use a DPDT switch for this purpose.

If you want to program a DIGITAL plus accessory decoder, a separate part of the track is not necessary since the decoder is connected directly to the **J** and **K** outputs during programming.

Installation of a programming track
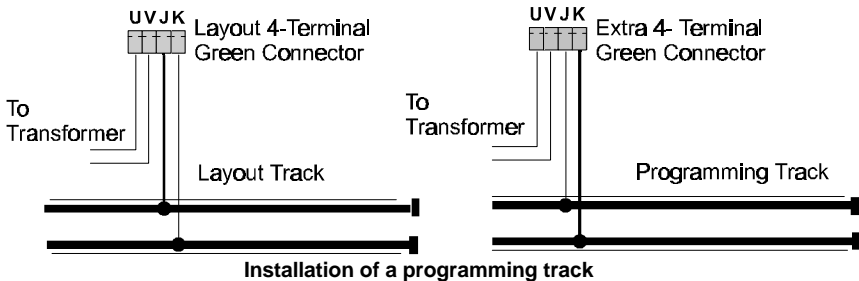
13.5 Programming on the programming track" – step by step instructions

Pull out the 4-terminal green connector UVJK of the power station LV101 which is connected to your LH200. This disconnects the tracks of your model railway from the power station and switches off the power supply. If you have more power stations connected, then also pull out the terminal green 3 terminal green connector **CDE**.

Caution make sure you disconnect the "**CDE**" connector from the LV101 that is connected to the LH200 as track signals will also transverse down these wires to other connected LV101s.

SET-02 contains a second 4-terminal green connector. Connect terminals J and K to the programming track. This track must be separated electrically from the rest of your track system. If you want to program a switch decoder, you can connect it directly to the terminals **J** and **K**.

Connect the terminals allocated to U and V to your model railway transformer and plug this into the LV101. You can also use a switch to disconnect the LV101 from the layout, but you must ensure you switch it before you enter program track programming mode.

To begin unplug the black coil cable from the LH200, press the "STOP"-key of LH200 and keep it pressed.

IMPORTANT NOTE:
Do not press the stop key until the coil cable is unplugged.
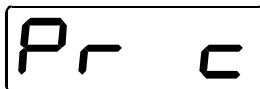
While you are still pressing the "STOP"-key, replug the black coil cable into the LH200 ("programming on the programming track" can be accessed only if you start operating SET-02 while pressing the "STOP"-key).

First, it is suggested that you program the address (CV1) of a locomotive. If you wish to do this, confirm with "A ".key.

You are now asked to enter the value that you want to program.

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.

$A^{\checkmark}$ **Ad**   Press key "A " key once more and you will see "Ad" again.

Programming a DCC locomotive's address with SET-02 is different than from other DCC command stations. With SET-02 you simply set the desired new locomotive address. The SET-02 automatically decides which CVs to program on your behalf. To accomplish this SET-02 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 63.

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 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 63.
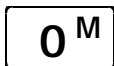
O ^{M} You can stop the programming mode at any time by using the menu key (it may be necessary to press twice). After doing so you will once again see a locomotive address on your display.

---

14 Expanding SET-02
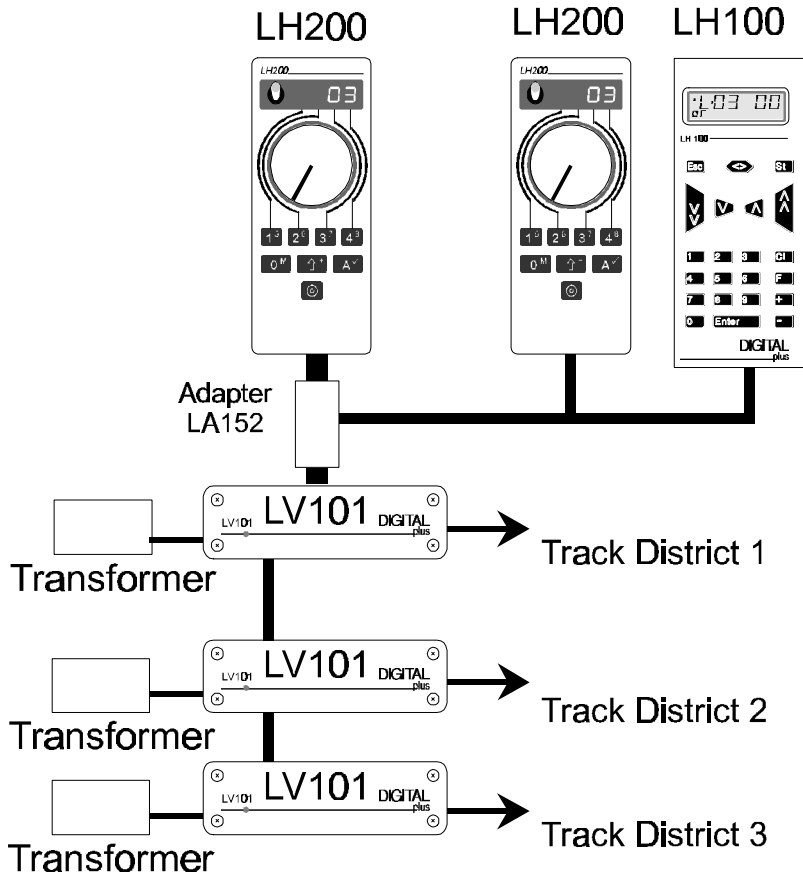
In this section you will learn:
- how to connect more input devices (handheld controls etc.) to your SET-02
- how you satisfy a larger power requirement for your model railway
- how to expand beyond the capabilities of SET-02 by adding an LZ100 command station in order to increase the amount of saved locomotive data, to be able to evaluate feedback and to utilise more handhelds or power stations.

14.1   Adding XpressNET to allow additional input devices

Your *Digital plus by Lenz ®* SET-02 has the ability to easily expand using its support of XpressNET. XpressNET is a leading model railroad high speed network protocol. It is based on the electronic industry standard RS-485 hardware.   The key advantages of this protocol are its expandability and the fact that it is supported by a growing number of Model Railroad manufacturers. For wiring SET-02 to support XpressNET refer to "Wiring XpressNET" starting on page 61.

XpressNET input devices cover a wide variety of options including a variety of handhelds, Tower Cab, interface and compiler modules, that is, all devices from which you control your model railway. In SET-02 the LH200 is an input device and command station at the same time, as described above. In its capacity as command station, it not only generates the track format, but also evaluates information from other XpressNET-input devices and converts them into control commands for locomotive decoders and turnout decoders. The XpressNET network itself is the link between additional input devices and the command station LH200.

In order to be able to connect these XpressNET input devices to the LH200, you need an adapter LA152. This adapter is fitted into the connection between the LH200 and the LV101. If necessary, you connect further XpressNET devices to the LA152 using additional LA150 adapters or 5 pin din plugs described later.

Via this XpressNET, information can be exchanged between the additional connected input devices and the command station. So that the command station in the LH200 can distinguish these devices from each other and address them, each device on the XpressNET has to have its own number, referred to as an XpressNET address.

Up to 5 additional XpressNET devices can be connected to SET-02. SET-02 supports the following XpressNET addresses: 1; 2; 3; 29; and 30. The addresses 1 to 3 are intended for the connection of further handhelds LH200 or LH100 as well as the Tower Cab LW100, the addresses 29 and 30 are intended for the connection of the interface and the computer modules. If these are not used additional handhelds can be use these addresses.

To assign an XpressNET address to a specific device please refer to the operating manuals for these devices.

The LH100 and LH200 handhelds operating as additional devices on the XpressNET of SET-02, are what is referred to as a walk around device. This means that they may be unplugged and plugged in again as often as desired during operation. If you do this you can achieve a high level of mobility through these devices. You can attach as many XpressNET connectors to your model railway layout as desired, so that you can always plug in your input device where you need it at the time. You will find information on this in the section "Wiring XpressNET which starts on page 61.

14.1.1   Special information on operating XpressNET-devices

While operating with XpressNET devices on your SET-02 please note the following:

Additional LH200 knob based engineer throttles:

- With version 3.0 multi-traction / multi units can be run, but can not be assembled or disassembled.
- the programming of locomotive decoders and turnout decoders is not possible from the XpressNET when used with SET-02.

Keypad based dispatchers throttle LH100 Version 2.1:

- you can switch points and signals
- multi-traction / multi units can be driven, but not be assembled or disassembled.
- double traction can not be set up and operated. Use, multi-traction / multi unit, which you can assemble on the LH200 and then operate it on the LH100.
- SET-02 does not have a connection for the feedback bus. Feedback elements cannot, therefore, be accessed.
- the programming of locomotive decoders and turnouts is not possible when used with SET-02.

Tower Cab LW100

If you connect a Tower Cab, you will be able to switch turnouts and magnetic articles comfortably on your model railway. The use of switching sequences (a sequence of several switch commands which are executed in succession) is also possible. These switching sequences can be accessed via the LW100 keyboard or via a connected track-plan control-panel. However, with SET-02 it is not possible to access switch sequences automatically by means of feedback messages. This is because SET-02 has no connection for the feedback bus. Because of this you must not enter conditions for creating or dissolving your switching

sequences.

14.2   More power through more power stations

As is the case with conventional systems, a sufficient power supply is required for reliable functioning of your *Digital plus by Lenz*® system. Locomotives, coach lighting, points, signals, etc. receive their power and their control information from the power station. If the total electricity consumption of everything connected to the LV101, exceeds 52 Volt Amps the LV101 protective system is activated.

The power consumption of your model railroad arises from:

- locomotives in operation – 200 mA to 2000 mA depending on the size and the freight attached. You should plan on 500mA per locomotive for size N, on 8000mA for size H0, and on 2000mA for larger gauges. If you use these guidelines you will usually still have reserves left.
- locomotives which are not in operation – without lighting draw only 2.5 mA, with lighting approx. 50mA per bulb
- coaches with lighting –approx. 50 mA per bulb

With a LV101, the power consumption of all locomotives in operation at the same time (plus the power consumption for the lighting in the coaches) must not exceed 52 volt amps. If the power consumption needs of your model railway is greater and if as a result the power from the LV101 that comes with the SET-02 is not alone sufficient for the supply of your system, it will be necessary for you to divide the track system into several supply areas (called power districts). Further LV101s can supply each additional power district with a current of approx. 52 volt amps each.

The number of power stations you need depends on the total power requirement of your model railroad. To calculate the total power requirement simply add up the total used by each of the individual power consumers. You can use the approximate values given above. Divide the total power requirement by 3 and round the result up to the next whole number. Now you have the number of LV101 power stations which are needed.

The additional LV101s receive their control signals from the terminals C and D of the first LV101. Each LV101 should be connected to its own transformer. It is absolutely necessary that the electrical circuits of all LV101s connected to each other have the same polarity. This means that terminal J of the first LV101 and terminal J of the following LV101s must be connected to the same side of the track. Otherwise there will be short-circuits when

the sectioning gaps between power stations are crossed.

14.2.1   Connecting an additional LV101

Connect terminals C,D (and optionally E) of the first LV101 with terminals C,D and E of the next LV101. Feed each LV101 with its own transformer.

Important: SET-02 can control a maximum of four LV101s

Isolate both rails of the track at the junction of the single supply areas and make sure the polarity is the same.

You will find further information in the operating manual of the additional LV101.

14.3   Expanding beyond the capabilities of SET-02 using a LZ100 Command Station.

If you want to
- have layout feedback about the position of turnouts and occupied tracks
- have a larger locomotive memory at your disposal
- read out features of the locomotive decoders CVs
- support up to 30 operators and more than 4 LV101

for your model railway, you will have add the command station LZ100 to your SET-02.   This expands your system to a full professional *Digital plus by Lenz*® **SET-01** system.

Once you add an LZ100 to your system the LH200 is relieved of its command station tasks. The LZ100 is now the "heart" of your model railway. The LZ100 takes over the generation of the track format (the digital voltage on the track), the LH200 is no longer connected directly to the LV101, but is connected to the LZ100 just like any other XpressNET device.

During this process some of the menus and some features of LH200 are altered. You will also need a different cable for your LH200 you used as the SET-02's command station. Please order this together with a separate operating manual from your DCC supplier or directly from Lenz Elektronik GmbH.

The features of your DCC system will now be determined by the software version of LZ100. Version 3 will have the following features:
- 9999 digital locomotives
- 1 non decoder equipped conventional locomotive
- operation with 14, 28 and 128 throttle positions
- up to 9 functions switchable in locomotives
- storage of data for 200 locomotives

- multiple traction/ multi unit:
- storage of setting of up to 256 turnouts
- faster, integrated feedback bus for the acquisition of messages such as track occupation and switching of points
- up to 30 input devices connectable to the XpressNET
- separate connection of a programming track for the entering and reading out of decoder features

15 Technical Appendix

In this section you will find:

- information on the stack
- valuable information on the Set-02's, LV101 power station
- information on the wiring of your model railway
- information on wiring the XpressNET network
- further help on terminology and procedures

15.1   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 $\boxed{\mathbf{A}^{\checkmark}}$ 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 SET-02" on page 36. 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.

15.2   Messages on the display

$$Er\ 10$$

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

A✓ .

The following is a list of possible messages:

   Er 10   You have exceeded the range of values permitted in this situation.

   Er 24:   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.

15.3   Selecting a suitable transformer for Set-02

It is important that to select a suitable transformer for powering your Set-02. The starting voltage of the transformer should be between 14 and 16V for H0 and smaller scales. Voltage that exceed this is wasted in excess heat which reduces the effective capacity of the unit. In order to make it possible for the LV101 power station to deliver the complete 52 volt amps, and power the XpressNET, the transformer also has to be able to deliver a amperage of at least 4A (64 VA). You can use a transformer that delivers less current, but then you will not be able to operate as many trains. The permitted maximum and effective starting voltage of transformers must not exceed 18V AC voltage or DC voltage.

The following transformers are recommended:

- Digital plus TR100 (order-no. 26000).(220 volts)

- Digitrax "PS515" Power supply (110 volts)

- Lionel "Trainmaster PH1" (note this transformer can power 2 LV101s) (110 volts)

If you wish to use a different transformer, please note that it should be a model railroad transformer with a 'UL,'GS' or 'CE' symbol.

15.4   Power Station LV101

In SET-02 the power station LV101 provides DCC power to the tracks. Features include user selectable DCC track voltage, a fault detection LED, and a RJ-45 plug-in connector for connecting the

LH200 command station and XpressNET.

The DIGITAL plus Power Station LV101 provides clean and safe DCC power to the track. New circuitry has been developed to reduce noise, which provides exceptionally clean power to operate your DCC equipped trains. Safety features include:

- Short/overload detection that turns off the power to the track whenever a short or overload condition is detected. This protects both your trains and the LV101 electronics.

- Opto-isolation to safely isolate your control bus wiring from your track wiring. This eliminates any possibility for hidden ground loops through your power station.

- Fail Safe runaway protection is provided by requiring a 7 volt signal on the DCC Control Bus (the C and D wires). This prevents the LV101 from accidentally sending out power to the track when the command station stops transmitting packets.

The LV101 provides a fault detection LED located on the front of the unit. When the power station is in use, the LED on the front is lit. In case of an overload of the power station, the LED will flash. In addition, the LED will also flash if no information is being transmitted over the Control Bus (connections **C** and **D**), The LH200 command station is disconnected, the LH200 command station is off or one of the wires in not connected.

The LV101 Power Station was designed to meet all NMRA Standards and RPs including the new the NMRA Control Bus draft RP.

15.4.1   Connecting the LV101 Power Station to the layout

For maximum power, the LV101 should be located near the track being powered, so that the connection between the LV101 and the track is kept as short as possible. Connect the transformer to terminals **U** and **V**. For maximum output power, the transformer voltage should be selected to be close to the DCC track voltage. For HO scale and smaller, a 16V AC or DC transformer is ideal. In order for the Power Station to give off its full 52 VA current, the transformer also needs to be able to deliver a minimum of 4 amps. **The allowed maximum effective output voltage of the transformers must not exceed 18V AC or DC.** See "Selecting a suitable transformer for Set-02" starting on page 50 for more information.

The track is connected to terminals **J** and **K** (see Figures 2 and 3). Use only wire of sufficient gauge to connect to the tracks (minimum 18 gauge) and either use parallel wires or twist the wires to reduce radio interference.
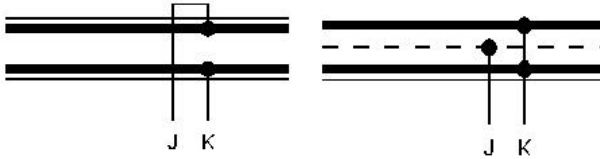
Connecting 2-rail track   **Connecting 3-rail track**

The Power Station receives command information from the Command Station via terminals **C** and **D**. These terminals are connected to the corresponding terminals on Command Station LZ100 with a 2-wire cable. To reduce radio interface, these wires should be twisted.

Terminal **E** is only used in conjunction with the LZ100 Command Station. It has no effect for Set-02.

When an overload occurs only the track power district that the LV101 is connected to will shut down. The overload will not affect the LH200 command station nor any other power stations on the layout. After a certain time (when the Power Station has cooled down again) the Power Station automatically turns the power supply back on to its Power District. If the overload still is present, it will turn off again after an additional short time.

15.4.2   Details of the six-pin I/O - port

The six-pin phone type jack located on the rear of the LV101 is provided for connection to the LH200 command station. The wire connections for this I/O port are shown in the following figure.
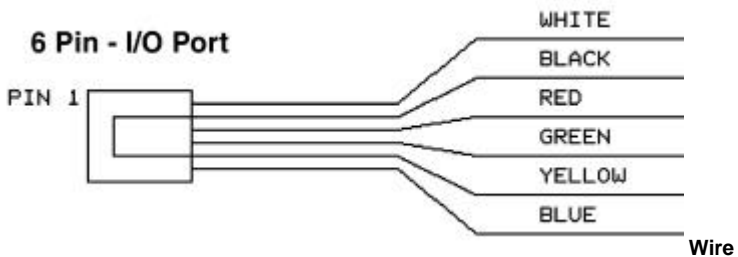
Wire connections for the LV101 6 pin -I/O port

Pin #	Color	Description
Pin 1	White	"**C**" Control Bus Connection
Pin 2	Black	Ground "**M**"
Pin 3	Red	- RS-485 "**B**"
Pin 4	Green	+ RS-485 "**A**"
Pin 5	Yellow	+12 volts "**L**"
Pin 6	Blue	"**D**" Control Bus Connection

15.4.3   Installation considerations

There must not be a capacitor connected to the track for interference control. A capacitor is only needed for conventional operations to prevent radio interference. In DCC operation a capacitor corrupts the data format and the error free data transfer is disturbed.

It is normal for the Power Station to get warm during operation. Ensure sufficient airflow around the Power Station to prevent the internal safety circuit from activating during normal operations.

Never allow your layout to operate without supervision! If there is an unnoticed short, the heat build-up could present a fire hazard!

15.4.4   Supplying power to a large model train layout

As in conventionally operated layouts, a sufficient power supply is prerequisite for the safe function of a digital layout.

Locomotives, interior lights in rolling stock, turnouts, signals etc. all get their power from the Power Station, along with their commands. If the devices you have connected to an LV101 together require more than 52 volt Amps, the safety circuit of the LV101 will activate. You will have an overload situation as described in the section "Connecting the Power Station" above.

The current use of your layout is the sum of the following:

- locomotives in operation: depending on scale and load .2 Amps to 2 Amps. In N-scale, calculate ½Amp, for H0 scale estimate 1 Amp and for larger scales 2 Amps per locomotive, and you will normally have some reserves.

- standing locomotives: without lights 1.5mA, with lights approximately 50mA per light bulb

- rolling stock with lights: per light bulb approximately 50mA

If the output of a single LV101 is not enough to supply the layout, then divide the layout into several power districts. Additional LV101 units then will supply those areas with approximately 52 VA each (one LV per power district)

In the supply area of one LV101, the current load of all simultaneously operating locomotives must not exceed 52 VA (including the current used for lighting in rolling stock).
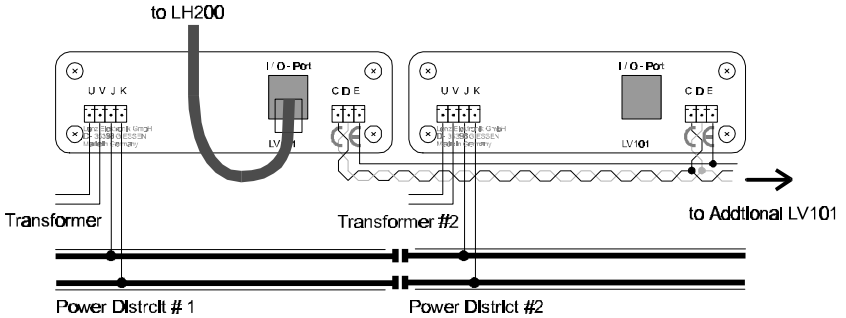
Connecting 2 LV101s to the layout

The command signals reach additional LV101s through terminals **C** and **D** of the first one. Each LV101 must be connected to its own transformer. The number of transformer/Power Station combinations needed for the layout thus depends on the power needs of your layout.

The power blocks of several LV101 must necessarily have the same polarity. Terminal J of one and terminal J of the next LV101 must therefore be connected to the same rail. Otherwise there will be a short when passing a dividing gap. (See Figure 1)

15.4.5   Setting the track voltage

If desired you can set the level of the DCC track voltage. This setting is handy if, for example, you desire a lower starting voltage in the area of gauge N. You can choose an range between 11.5V and 22V.

You have to open the LV101 up to set the track voltage. On the printed circuit board you will find 4 switches. Depending on the position of the 4 switches there is a different starting voltage for the terminals J and K. You will find the positions of the switches needed for each particular voltage printed on the LV101circuit board and in the following Table. The bold line is the factory default DCC rack voltage.

DCC Track Voltage	SW 1	SW 2	SW 3	SW 4
11.5 Volts	On	On	On	N/A
13 Volts	Off	On	On	N/A
14.5 Volts	On	Off	On	N/A
16 Volts	**Off**	**Off**	**On**	**N/A**
17.5 Volts	On	On	Off	N/A
19 Volts	Off	On	Off	N/A
20.5 Volts	On	Off	Off	N/A
22 Volts	Off	Off	Off	N/A

In order to reach the desired starting voltage, you have to use a transformer whose starting voltage is as high as the desired track-voltage. But do not overdo it: the voltage of the transformer should be adjusted as closely as possible to the desired track-voltage. A transformer voltage which is too high only produces an unnecessary loss of heat in the power station, which would lead to a premature switching off before the maximum amperage is reached.

15.4.6   Connecting the LV101 to other DCC power stations

The LV101 has been designed to be used with a broad range of NMRA DCC systems. Following are diagrams to assist you in connecting the LV101.
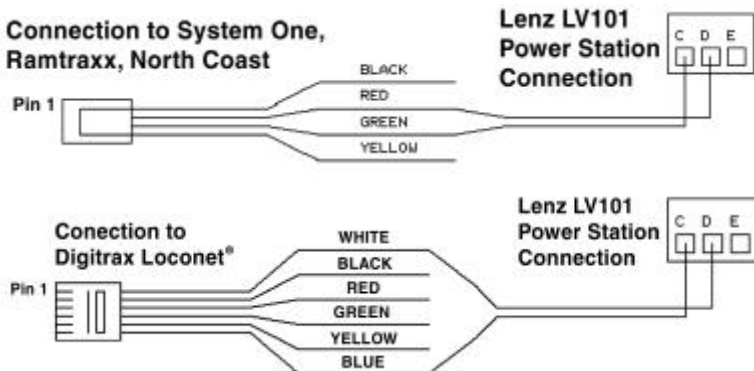
15.5   Advice on the wiring of the model railway

For the connection of the tracks, use only wires with a sufficient cross-section to carry the intended load and slightly twist these cables around each other. The power station (booster) should always be placed as close to the first track feeder as possible.

For extended routes you will need additional feeders at regular distances from each other. Here the following rule of thumb applies:

Size	Feeder every	Minimum cross section of the cable
N	5 ft	18 AGW
H0 / TT	6 ft	16 AGW
S and larger	9 ft	14 AGW

No radio interference suppression capacitor may be in the track system. This capacitor is necessary only for the interference suppression in conventional operation. If used with the *Digital plus by Lenz*® system, however, it would only distort the data format and interfere with the fault-free transmission of data.

Important:

A mixed digital operation using overhead and track lines is not permitted. In such a mode of operation, if the locomotive is sitting on the track facing in the wrong direction (which might be the case for example after having driven through a terminal-loop), the installed locomotive decoder can be destroyed by over-voltage! We recommend operation using track pick-up (wheel contacts), because the reliability of contact (and therefore the transmission of digital signals to the locomotive decoder) is substantially greater than it is when operating with overhead lines.

The heat produced by the amplifier in operation is normal. You must provide sufficient air circulation around the amplifier in order to prevent the internal protective system from reacting prematurely, that is, during normal operation.

Do not leave your model railway system unsupervised when it is in operation! If a short-circuit goes unnoticed, the heat produced creates a fire risk!

15.5.1   Connecting a reverse loop

Lenz GmbH produces an automatic reversing module (LK100) which can be used to easily wire complex automatic reversing

sections. While these units are invaluable in some cases they are

not absolutely needed for DCC operations. Following is an example on how a very simple reversing section can be built.

Example:

Using isolated track contacts and a twin-coil relay, the polarity inside a reverse loop is switched such that when crossing the gaps, there is no short. For example; consider the following figure when the train travel is in clockwise direction (turnout is set to diverging route).
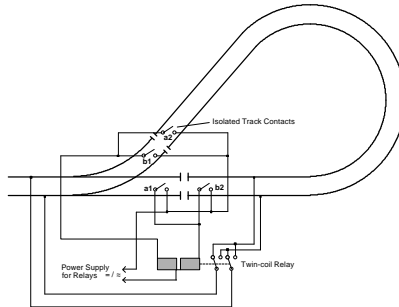
Wiring of Reverse Loops

When passing track contact b1, the polarity of the loop is set to allow the train to cross the gap without a short. As the reverse loop is traversed, track contact 2 will switch the polarity in the loop, and the adjoining gap can be crossed safely. Since in digital operations the direction of travel is dependent on the locomotive and not track polarity, the locomotive will not change its direction of travel when the polarity within the reverse loop is changed.

Travelling the reverse loop counter-clockwise is done in a similar manner, now contacts a1 and a2 ensure that proper polarity is set.

Notes:

The distance between track contacts a2 and b2 must be longer than the longest train that travels the reverse loop.

If the reverse loop is only traversed in one direction, then either contacts a1 and a2 or contacts b1 and b2 are not needed.

The track contacts used in this example can actually be auxiliary contacts set by the switch machine for the switch.

If you wish to traverse the reverse loop with a locomotive without a decoder (analog locomotive), proceed as follows:

- drive the entire train into the reverse loop (the train must be between contacts a2 and b2)

- stop the train and change direction with your handheld (LH100).

- now manually change the polarity in the reverse loop (for example by using push buttons connected in parallel with track contacts a2 and b2)

- continue driving the train through the reverse loop.

You must use this sequence with analog locomotives (non-decoder equipped), since their direction of travel is dependent on track polarity.

15.5.2 Common rail wiring

Normally both rails are gapped between power stations. This provides complete isolation. However, in some scales there exist locomotives that have pickups that are offset from each other. For example many steam locomotives have power pickup from one rail in the locomotive and the other rail in the tender. When such a locomotive bridges the gap between isolated power stations, the locomotive will stall. The solution to this problem is to provide a common wire between all the power stations. All systems of command control need to have a such a common provided, if offset pickup locomotives are to be operated.

Lenz has chosen to leave the option of the location of the common up to the individual operator. The LV101 is completely opto-isolated. This allows you to use one of the rails (called common rail) for your common. Common rail wiring is also compatible with many existing signalling systems. While common rail is the preferred place for a common, you may rather connect all the power station **U** or **V** wires together. This is called common power supply wiring.

> Caution: If you decide to install a common, it is important that you only have a single common. Multiple commons (such as common rail and common transformer) should be avoided.

15.6 Mixed operation: conventional DC and digital DCC

Conventional and digital electric circuits must always be thoroughly separated from each other, for example, by installing contact-breaker gaps or insulating rail joiners between digital and analog DC blocks.

In order to prevent the digital operation from being influenced by the normal DC and vice versa, when a sectioning gap is being driven over, install the sectioning module LT100.

At the gap dividing digital from analog operation, you must take steps to prevent interference between the 2 systems when a locomotive crosses the gap. One approach is to use a Digital

Circuit Breaker such as the LT100. If a locomotive bridges the insulated gap, the module immediately interrupts the analog power supply.


Warning:

Mixed digital/analog operations using both rails and catenary (overhead wire) is not allowed. In this mode of operation, if the locomotive is on the track in the wrong direction (for instance after going through a loop), the built-in locomotive decoder could be destroyed by excessive voltage! We suggest you operate with current pickup from the rails (wheel pickups), since that contact is more reliable (and thereby the transmission of the digital signals to the locomotive decoder) than with catenary.

15.7   Wiring the XpressNET Data Network

The XpressNET data network consists of 4 wires, 2 are for the signal and two are for power that is used to power plugged in XpressNET devices.

To install an XpressNET for SET-02 you need to insert an LA152 between the LH200 command station and the LV101 power station. The 4 terminals on the LA152 labelled. L,M,A and B are the 4 connections for the XpressNET. Connect these 4 wires to the terminals with the same name on the LA150 connection board.

You can also solder the 4 wires to the DIN-sockets yourself. These sockets are available in electronic-shops or in groups of five as part XP-5 . The assignment of the five-pin DIN-socket is shown in the following figure:
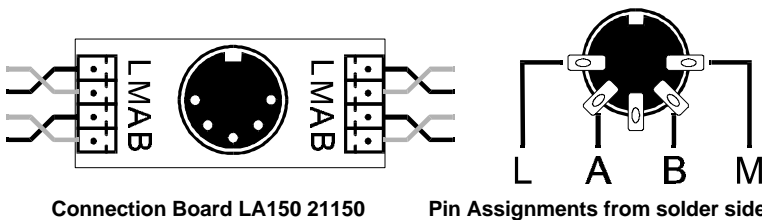
**Connection Board LA150 21150**   **Pin Assignments from solder side**

Make sure that you do not mix up the cables of the terminals L and M. This could result in a short in the connected input devices.

The devices exchange information with the command station via the cables at the terminals A and B. The devices are supplied with electricity via the terminals L (plus) and M (minus).

The XpressNET wiring must be installed so that the line starts at the Command Station and ends somewhere on your layout. (Daisy chained from Command Station via intermediate input locations to the last input location.) Between the start and end you may insert connecting panels or 5-pin DIN connectors anywhere. You must not route the wire as a closed loop. Under all circumstances you must ensure that the wires that are connected to terminals **A** and **B** are twisted.
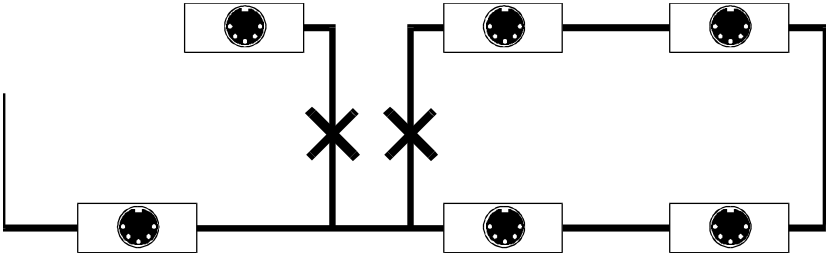
The ends of the XpressNET Network lines A and B should be connected to the resistor which is enclosed with the LA152 adapter The resistor has a value of 120 Ohm.
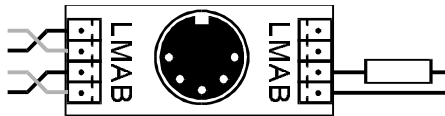
Terminating the XpressNET with a resistor

Which cable is to be used for the XpressNET?

The minimum gauge of the wire in the XpressNET should be 24 gauge. You will have to make sure that the cables which you have connected to the terminals A and B are twisted. In practice so-called "bell wire" has proved efficient. This can be acquired cheaply. It is sufficiently twisted and available in various colors.

How long may an XpressNET network be?

For reasons of physics the maximum length of the XpressNET depends on the kind and size of the wires used for the XpressNET. With normal telephone wire the length should not exceed 300 ft. If you install a twin-core, twisted cable for the signal lines of the XpressNET you can increase the length to up to 3000 ft. without problems.

15.8   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, SET-02 supports Register Mode programming.

First, proceed as described in the section "Programming on the programming track" starting on page 37 and set up an isolated programming track.

To begin unplug the black coil cable from the LH200, press the "STOP"-key of LH200 and keep it pressed.

> IMPORTANT NOTE:
> Do not press the stop key until the coil cable is unplugged.
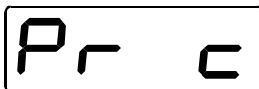
While you are still pressing the "STOP"-key, replug the black coil cable into the LH200 ("programming on the programming track" can be accessed only if you start operating SET-02 while pressing the "STOP"-key).
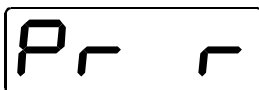
To reach the mode "Programming with Register information" use the ""2" key.

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 entering the 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
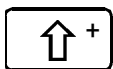
Now you can scroll using the "Shift" key or determine the number using the rotary control-knob. Confirm your selection again with key "A " key and now you can enter the value.
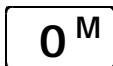
You can stop the programming mode at any time by using the menu key (it may be necessary to press twice). After doing so you will once again see a locomotive address on your display.

15.9   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 cannot 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**

15.10 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.

16 Troubleshooting Guide

Malfunction	Possible cause	Correction
SET-02 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 program-ming 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.
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
Locomotive lighting (F0) can not be switched on	Locomotive decoder is set at running-notch mode 28. The relevant address is to be found in the LH200 in running-notch mode 14.	Alter the throttle position mode of the LH200 to 28 set the locomotive decoder to 14 Throttle notch positions
Locomotive lighting (F0) is switched on and off when the rotary control-knob is turned	Locomotive decoder is set at throttle notch mode 14. The relevant address is to be found in the LH200 in running-notch mode 28.	Alter the throttle position mode of the LH200 to 14 notches or set the locomotive decoder to 28 Throttle positions
Locomotive does not work using its basic address	Locomotive is perhaps integrated in a multiple traction/ multi unit	Control the locomotive using the multiple traction/ multi units address
Locomotive does not work after program-ming an address greater than 99	It is possible that the decoder does not support extended addressing or does not support "Direct CV Mode" programming	Set the address for this locomotive to be 99 or less or perhaps use register mode to set the extended address.
Locomotive address on the LH200 display flashes	Selected address is already invoked on a different Handheld control	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.

17 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 case 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.

18 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

Hüttenbergstrasse 29	Lenz Agency of North America
35398 Giessen	PO Box 143
Germany	Chelmsford, MA 01824
Hotline: 06403 900 133	USA
Fax: 06403 900 155	Phone: 978 250 1494
www.digital-plus.de	Fax: 978 455 LENZ
	support@lenz.com
	www.lenz.com

Lenz Elektronik GmbH

C€ Please save this manual for future reference!