Designed for use on all XpressNet systems
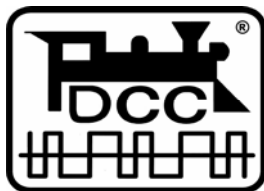
Digital plus
by *Lenz* ®

XpressNet ®

LH90 Engineer's Throttle

Version 3.1
art. no. 21090
November 2005

DCC ®

THIS PRODUCT CONFORMS TO ALL APPLICABLE NMRA STANDARDS ®

Contents

Welcome!

Congratulations for purchasing the *Digital plus by Lenz*® LH90 throttle. We wish you much enjoyment with using this XpressNet based throttle with your NMRA DCC model rilroad control system.

The LH90 hand held controller is a universal data input device in the *Digital plus by Lenz* ® system. With it you can:

- operate your locomotives
- use smart-consisting to assemble, operate, and disassemble multi-unit consists.
- throw turnouts, set signals or activate uncoupling tracks
- program locomotive and accessory decoders as well as feedback devices
- read out and set handheld configurations

This operation manual is intended to make using the LH90 easy for you. To get started, first read the section "First Steps". After you have understood the basic locomotive control, you can familiarize yourself with the full range of functions of this hand held controller step by step and put them to use.

If after reading this operating manual you have unanswered questions, please contact your dealer or Lenz directly. You can contact us in the following ways:

	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	++1 978 455 LENZ
Email	info@digital-plus.de	support@lenz.com

Do you have everything?

Please check whether all the components have been delivered:
- Hand held controller LH90
- Coil cable with phone plug on one end and
  5-pole DIN plug on the other end
- Operation manual (this booklet)

If an item is missing, please contact your retailer or Lenz to have the item replaced.

Lenz
ELEKTRONIK GMBH

1   Important advice, please read first!

Your **LH90** hand held throttle is a component of your *Digital plus by Lenz*® system and was submitted to intensive testing before delivery. Lenz Elektronik GmbH guarantees fault-free operation if you follow the advice given below:

The **LH90** is authorized for operation only with a system that fully supports **X**press**Net** such as any *Digital plus by Lenz*® system. Any use other than the one described in this operating manual is not permitted and all guarantees become invalid if the **LH90** is used in an inappropriate way.

The operation of **LH90** requires Digital plus system version 3 or greater. The **LH90** cannot to be used with devices which use older software versions.

> ☞ *Do not connect the* **LH90** *to any other device. Even if other devices use the same connectors, you must not operate the* **LH90** *with those devices. The fact that the connectors are similar does not automatically mean that you may use them for operation, even if you are dealing with other model railroad control systems.*

Do not expose the **LH90** to moisture or direct sunlight.

1.1   Notations and symbols:

(⇨P. 23)   This shift indicates particular pages of the operating manual which contain further information on the subject under discussion.

> ☞ Texts marked with this symbol and a frame contain information and advice of special importance.

2   Connecting the LH90 to your DCC System

Plug one end of the coil cable with the phone connector into the socket of the LH90. Pug the end of the cable with the 5 pin din plug into your *Digital plus by Lenz*® **X**press**Net**.

As is the case with all **X**press**Net** devices, your LH90 can be disconnected and reconnected during operation. To make use of this feature of **X**press**Net**, install several LA152 adapters or din sockets around your layout. If you do this, you will always be able to use your LH90 at the scene of action.

Connecting to a LZ100 or LZV100 command station

Plug the 5-pole DIN-plug

-    into the 5-pole DIN-socket at the rear of your LZ100/LZV100
      or
-    into a LA152 adapter (or Atlas Panel #322), or din socket that is connected to the LZ100/LZV100.

Connecting to a SET02

Plug the 5-pole DIN-plug into a LA152 adapter, or din socket that is connected to the SET02.

Connecting to a "compact" or Atlas Commander

Plug the 5-pole DIN-plug into a LA152 adapter or din socket that is connected to the "compact" or Atlas Commander.

Alternatively you can use the adapter LY009 to connect the LH90 directly to the "compact" or use an LY006 coil cable with phone plugs on each end.

Setting the XpressNet address

For fault-free exchange of information with the command station, each input device connected to the **X**press**Net** must have its own unique *device address.* It is necessary to ensure that all connected devices have different addresses. Up to 31 devices can be connected to the **X**press**Net**, i.e. the addresses 1 to 31 can be used. From the factory each LH90 throttle is set to the address 02. If you are already operating another **X**press**Net** device with this address, you will have to assign a different address to your LH90. You will find information on the setting of the **X**press**Net** address in section 14.1 (⇨P. 35).

3   Your first LH90 session

We assume in this example that you are operating a locomotive with the address "3". On delivery you can access the addresses 1 to 8 quickly and easily by pressing key "A" repeatedly.

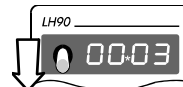1.   Connect your LH90 to your Digital plus system (⇨P. 5)

2.   Place the locomotive with address 3 on the track.

3.   Turn the rotary control-knob to the left-hand limit-stop.

4.   **A✓**   If the number 3 is not on the display, press the "A" key repeatedly until address "3" is shown on the display.

5   5.1   If there are no flashing dots on the display, set the direction switch to up. (direction of locomotive is forward)

5.   5.2   If you see a flashing dot in the centre of the display "0003", the LH90 is instructing you which way the direction switch must be set to control the locomotive. To control the locomotive, set the direction-switch as follows:
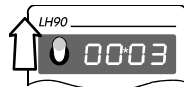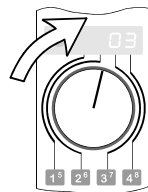
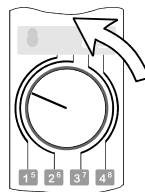Up, when the upper dot flashes.   Down, when the lower dot flashes.

5.3   Turn the rotary control-knob to the right. The locomotive speeds up.   Turn the rotary control-knob to the left. The locomotive slows down.

5.4   Turn the knob as far to the left as possible: the locomotive stops.
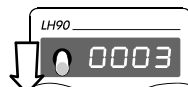
5.5   Flick the direction-switch downwards through the centre position. This will change the direction of motion of the locomotive from forwards to backwards.   If you flick the direction-switch to the centre position while the locomotive is in operation, the locomotive will stop with the amount of delay in braking which is set in the locomotive decoder. If you afterwards flick the switch in a different direction, the locomotive will speed up again, also with the amount of delay that is set in the decoder.

6.   **0 M**   In order to switch on the light function of the locomotive decoder, press key "0^M ". Press the key once and you will turn the light on, press it again and you will turn it off.

4   The range of functions of the LH90

- With the LH90 you may control up to 9999 digital locomotives independently. With address 0 you control a conventional locomotive without a decoder with your system.

- You can address up to 9 functions in locomotive decoders.

- Depending on the command station used (LZ100, LZV100, SET02/03, "compact"), you can control, assemble and delete multiple units (consists).

- You can set the running-notches (speed step) mode for the locomotive address currently displayed.

- Locomotive features such as starting and braking delay can be set through "programming on the main" (operations mode programming) or through "programming in service mode".

- The LH90 can also switch turnouts. Depending on the command station used, you can switch up to 999 turnouts (and signals).

The functions of the LH90 are described in more detail in the next section.

5   Overview of the operational controls of LH90

In this section you will learn about:

- the display information and how it is presented in the operating manual
- the functioning of the LH90 rotary control-knob
- the functioning of the direction switch
- the functions of the LH90 keys

5.1   The LED display

The LH90 has a luminescent, 4-digit LED display. Each digit is able to display the numbers 0 to 9 as well as other special symbols.
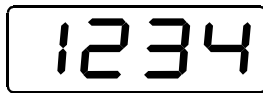
In normal operation the address of the locomotive which you are presently controlling is constantly shown.
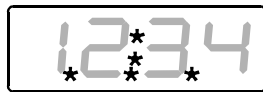
Dots below left, in the centre and below right are helpful for
- adjusting the direction switch when you take over a different locomotive.
- showing the functions which are on
You will find more detailed information on this below.

In this operating manual the display is presented as follows:

LED displays that shine continuously are depicted in black.

LED displays that flash are depicted with framing lines.

Dots that shine continuously are depicted as solid dots.

Dots that flash are depicted as stars.

5.2 The rotary control-knob

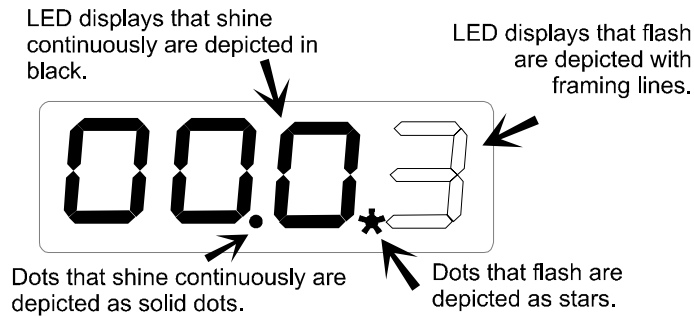Turn it to the right and you increase the speed of the locomotive. Turn it to the left and you decrease the speed of the locomotive. Since the rotary control-knob has a limit-stop to the right and to the left, you will know without actually having to look, when you have reached the maximum speed or have come to a complete stop.

5.3 The forward/brake/reverse switch

The direction switch on the LH90 has 3 positions:

Switch up: The locomotive moves forward when the control knob is set to a speed other than stop.

Switch to centre: causes the locomotive to slow down and stop using the pre-programmed braking rate. Turning the rotary control-knob does not influence the locomotive.

Switch down: locomotive moves backwards when the control knob is set to a speed other than stop.
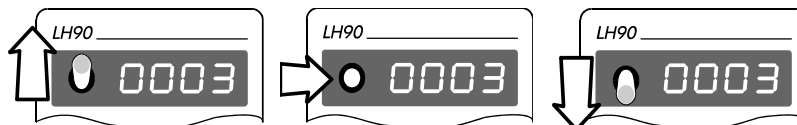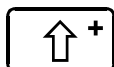
5.4   The keys

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

A✓ With this key you scroll through the addresses which are saved in the "stack". If the key is held down the number of the stack location is displayed. When using menus this key is used to confirm a specific action.

⇧ + "Shift" key: when you press this key, the numbers and symbols in smaller print on the other keys become active. This key is comparable to the "Shift" key on a typewriter or computer.
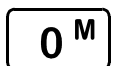
0 M Function 0 on/off. Function 0 is used by most decoders for the front lighting which is dependent on the direction of motion. If the "shift" key has been pressed, then this key is used to scroll through the menus.

1 ⁵   2 ⁶   3 ⁷   4 ⁸

These 4 keys are used to switch functions of the locomotive decoder. The large number is the primary number and the small number is the shifted number.

When using a menu, these keys are used to alter the value of the digits.

◎ Emergency stop. The function of this key is settable: switching off the voltage on the track, stopping all locomotives, or stopping the locomotive indicated.

6   Emergency Stop

If you want to immediately stop operation press the **◎** key.

The voltage on the track will be switched off, and all locomotives will immediately stop. During an emergency stop, the LED of the power station LV101 flashes, and in the LH90 display flashes.

$$\boxed{\textsf{OFF}}$$

☞   Whenever "OFF" flashes in the display the system has been shut off. To resume operation, press the **◎** key again.
☞   You can customize the operation of the Emergency Stop key. See section 14 (⇨P. 34)

7   The menus

In this section, all existing menus are listed. Whether you can access all the menus listed, will depend on the command station (LZ100, LZV100, SET02, "compact") to which you have connected your LH90.

All the LH90 menus are accessed in the same way:

|	
⇧ +	First press the "shift" key. On the display a dot will appear on the upper right hand side.
0 M	You can now scroll through the menus using this key. Press the key briefly to scroll "forwards" (sequence as shown below). Press the key a little bit longer to scroll "backwards".

Key	**Display**	**Description**
0 M	Adr˙	Used to enter a new loco address into the stack.
0 M	ΠU	Used to add a locomotive to a multi-unit.
0 M	ΠU-	Used to remove a locomotive from a multi-unit.
0 M	Pro	Used to access the programming sub menu when you want to read or set specific values within a decoder.
0 M	SYS˙	Used to read or set specific system or LH90 settings
0 M	Sch˙	Used to switch turnouts and signals.
0 M	SPE	Used to display or set the current number of throttle notches being used by the LH90 for the locomotive address that was being displayed before the menu was entered.
0 M	Adr˙	When you have scrolled once through all menus you return to the display of the locomotive controlled last.

The "A" key is always used to select the menu that is shown on the display. Once selected refer to the instructions specific to that menu.

☞ The LH90 "remembers" the menu which was chosen last, even after the LH90 has been switched off. Whenever you change a menu, the menu last selected is displayed first.

☞ If you wish to leave the menu selection and return to the last operation, press the ⬆ **+** key

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7.1   Entering a number into the menu

To enter numbers (such as a locomotive address) within a menu, always follow the same procedure:

Use key 1 to alter the first digit from the left; use key 2 to alter the second digit from the left and so on. Use key 4 to alter the fourth digit from the left.

See the illustration opposite for the allocation shown on the LH90. The lines show you which key controls which digit.
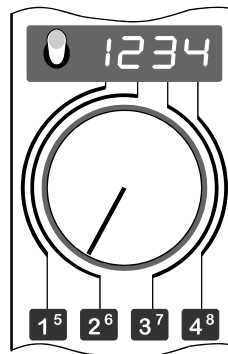
Press the key briefly to increase the displayed value by 1. Press the key and keep it pressed: the value keeps increasing automatically.

8   Choosing a new loco address

In this section you will learn about:
- how you select a locomotive address that is in the stack
- how the rotary control-knob and the direction switch can be adjusted to the speed of an operating locomotive
- how you enter a new loco address into the LH90 stack

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 currently in the stack, enter a new address in the stack.

8.1   Scrolling through the stack

The LH90 has a frequently used locomotive address stack of between 2 and 8 positions. This stack facilitates quick access to up to 8 locomotive addresses. Each position within of the stack can be assigned to any locomotive address between 0 and 9999. This will ensure that you have fast and reliable access to the locomotives which are most important for the current operating session. From the factory the stack size is set to 8 and the loco addresses 1 to 8 are located in the stack. Changing these locomotives is easy and is shown in the following sections The stack size can be changed by changing a system setting. See section 14 (⇨P. 34). The locomotive addresses entered in the stack are remembered by the LH90, even if it is switched off.

A✓	When pressed, this key causes the LH90 to display the next locomotive address in the stack. Having reached the bottom of the list, the following key stroke will again display the locomotive address at the top of the list. This means that you are scrolling through the stack in a forwards direction.
A✓ hold	When you hold the "A" down, the current stack location is displayed.
⇧ + **A**✓	Press "Shift" and then "A" to switch to the previous address in the stack or scroll backwards through the stack.

> ☞ **You can immediately take over control of the locomotive address that is in the display by moving the rotary control-knob once the direction switch is in the correct position. You will know that this is the case when one of the dots in the centre stops flashing.**

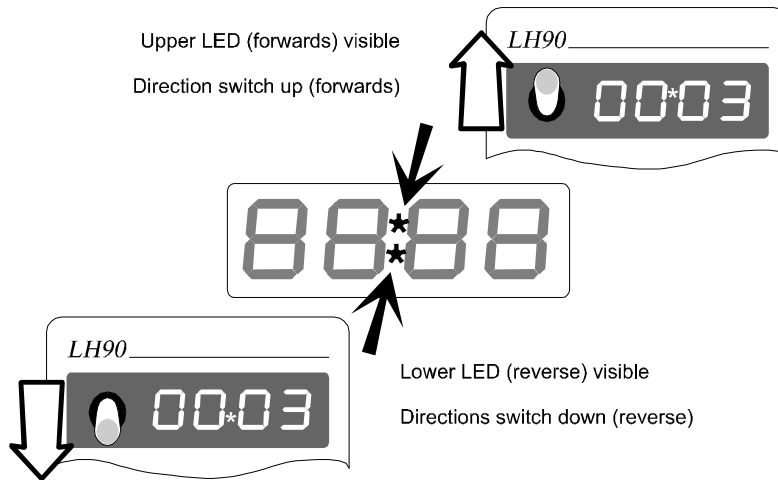|	
00.03	**00*03**
Dot is not flashing: direction switch is in correct position. Take over the locomotive by turning the rotary control-knob.	Dot is flashing: direction switch is in wrong position. In order to take a locomotive over, simply change the position of the direction switch.

If the locomotive was moving before you take control the speed may change unless the knob is in the correct position. It is often better to adjust the position of the rotary control-knob in the manner described in the following section before taking control.

8.2   Adjustment of the rotary control-knob position to the speed of the selected locomotive

After having selected the desired address, set the direction switch to the centre position to set the rotary control-knob to the current speed of the locomotive. This is only necessary if the position of the knob is different from the speed of the locomotive you wish to control.

Move the knob to the approximant position to corresponding to the actual speed of the new locomotive you wish to control.
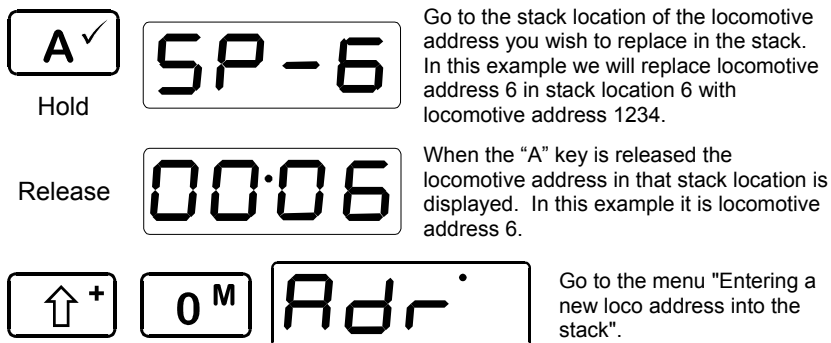
Once the knob is in the correct position, you can place the direction switch in the correct position, up (forwards) or down (backwards). If the upper dot appears in the middle of the display, then you must flick the switch up (the forwards position). If the lower dot appears in the middle of the display you must flick the switch down (the backwards position).

Upper LED (forwards) visible

Direction switch up (forwards)

LH90

Lower LED (reverse) visible

Directions switch down (reverse)

LH90

8.3 Entering a new loco address into the stack

From the factory addresses 1 to 8 are stored in the stack. The following procedure is used if you want to enter a different address in one of the 8 stack positions.

In the following example the address 1234 is entered in stack location 6.

Hold — SP-6

Go to the stack location of the locomotive address you wish to replace in the stack. In this example we will replace locomotive address 6 in stack location 6 with locomotive address 1234.

Release — 00·06

When the "A" key is released the locomotive address in that stack location is displayed. In this example it is locomotive address 6.

Adr

Go to the menu "Entering a new loco address into the stack".

A ✓   When working with menus the "A" key is used to confirm a menu selection. In this example confirm the change address menu selection by pressing the "A" key.

A ✓   **0006** *   The dot on the top right indicates that you are in address entry mode. The address shown is the address of the locomotive in the display before you entered the address selection menu.

4 8   **0004** *   Alter the number in the right most digit by pressing the 4 key. Press it twice for a long time. Doing so will alter the value to 4.

3 7   **0034** *   Alter the number in the tens digit by pressing key labeled "3". Press it a short time and the number will increase, press it for a longer time and the number will decrease. Hold the key down for longer than one second and the number will cycle through the digits quickly. In this example change the tens digit to have a value of 3.

2 6   **0234** *   Alter the number in the hundreds digit by pressing key 2 twice briefly. Doing so will alter the value to 2.

1 5   **1234** *   Alter the number in the hundreds digit by pressing key 2 once briefly. Doing so will alter the value to 1.

A ✓   **1234** *   After pressing the "A" key, you can adjust the position of the rotary control knob as described above.

Up to the point when you press key "A" to confirm the selection of the address, you can alter the value of any digit as often as you like until the desired address is set correctly.

☞ You do not have to alter all 4 digits of the display. If certain digits already have the correct value, you can leave them as they are and go to the next digit.

☞ The new locomotive address will only be entered into the stack when you actually control this newly selected locomotive.

☞ The new locomotive address will replace the address in the stack that has not been used for the longest time.

9   Switching the locomotive decoder's functions on and off

The LH90 can address up to 9 functions of a locomotive decoder. The status of the functions is displayed by dots on the display. The status of Functions F0-F4 are normally displayed. After the shift key has been pressed and released the status of F5-F8 are displayed instead of F1-F4 until another key is pressed.

Function 0

Function 1(5)
Function 2(6)
Function 3(7)
Function 4(8)
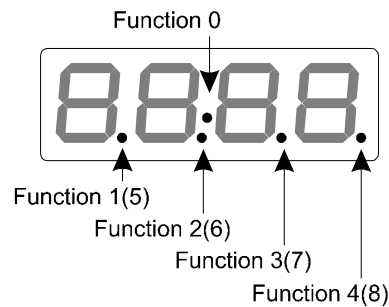
The functions 0 to 4 can be switched on and off by pressing the key once.

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 to 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 you can only use these functions if the decoder installed in the locomotive has corresponding function outputs and if these are connected to specific functions within the locomotive (lighting, smoke generator, coupling, sound and so on).

☞   Note: using the LH90 with the LZ100 or LZV100 command station: Momentary functions that have previously been set up by an LH100 can be utilized by the LH90. If the function is momentary it will stay on so long as the function key remains pressed.

10 Matching the LH90'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 LH90 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 LH90 rotary control knob has internally 256 different throttle positions to provide the maximum smoothness in operation.
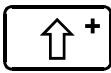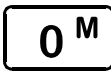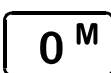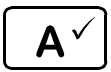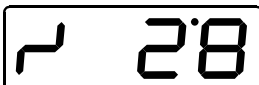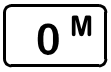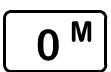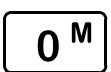
DCC decoders support a variety of speed step modes. The most common are 14, 28, and 128. Speed step modes reflect the number of throttle notches that the decoder will support. The LH90 supports all three of these speed step modes. Since different commands are sent to the decoder in all three modes it is necessary to match the number of LH90 throttle notches to the decoder's speed step mode. The LH90 default is 28 throttle notches which in combination with the smoothness of the LH90 rotary control knob provides the smoothness that most modelers desire.

With the LH90 you can set the throttle-notch setting to be a different value for each locomotive. The "SPE" menu is used to set or display the current number of throttle-notches being used by the LH90 for the specific locomotive address that was displayed prior to entering the menu. Possible values are 14, 27, 28 or 128 throttle-notches. The modes which are available depend on the command station used.

Scroll through the stack until you reach the address whose throttle-notch you want to display or alter. Turn the rotary control-knob as far to the left as possible (throttle-notch 0).

> ☞ If the running notch of the locomotive is not 0 (rotary control-knob not at the left-hand limit-stop), you can display the current throttle-notch mode, but you cannot alter it.

Now go to the "Display/Set Throttle Notch" menu.

⬆ +	0 M	**Adr**	Press the "shift" key and the "0" key to enter menu mode.
	0 M	**SPE**	Press the "0" key to scroll to the menu "Display/ Alteration of throttle-notch mode"
	A ✓	**⌐ 28**	Press the "A" key to select the menu. The current throttle-notch mode for the selected locomotive address is displayed.
	0 M	**⌐ 128**	Press the "0" key to scroll through the available modes to change the setting.
	0 M	**⌐ 14**	
	0 M	**⌐ 27**	When the mode you desire is displayed, confirm your choice by pressing the "A" key.
	A ✓	**0003**	Now the locomotive address whose throttle-notch you have altered is displayed again.

☞   While in the "SPE" menu. if you only wish to display the current throttle-notch mode for the selected locomotive address and do not wish to make a change, press the ⬆+ key to exit the menu.

☞   For locomotive addresses 100-9999, only the 28 and 128-throttle-notch modes are available for use.

☞   The locomotive decoder's speed step mode (set via CV29) must match the LH90 throttle-notch mode. The default for all current production decoders is 28 speed steps.

When setting the running notches for a particular locomotive, you have to ensure that the locomotive decoder "understands" the running-notch mode selected. The following correspondence between system and locomotive decoder must be maintained:

System throttle Notches	Locomotive decoder speed step mode
14 or 27 throttle-positions:	14 speed steps
28 or 128 throttle-positions:	28 speed steps

Setting the locomotive decoder to a particular speed step mode is done in CV29 of the decoder. For details, see the *Digital plus by Lenz* [®] decoder manuals.

You must make sure that the locomotive decoder also "understands" the programmed speed step mode. Digital plus decoders support the following speed step modes.

DIGITAL plus locomotive decoder types	supported speed step modes
Decoders with 4 digit model numbers, XF and XS-series NMRA conforming decoders	14, 27, 28, 128
Other Digital plus NMRA-conforming decoders	14, 27, 28
all other older Digital plus decoders	14, 27

If unsure, please check in the decoder's operation manual. NMRA-conforming *Digital plus by Lenz* [®] decoders can be recognized by the following symbols on the title page of the operation manuals:

Lenz
ELEKTRONIK GMBH
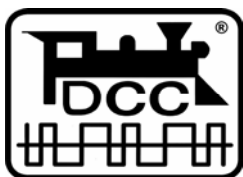
11 Switching turnouts and signals

You can switch up to 999 turnouts and/or signals with the LH90 (depending on the command station used).
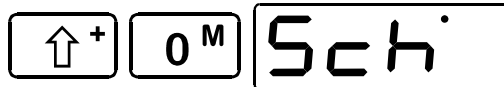
Enter the menus by pressing the shift key followed by the "0^M" key and scroll through the menus using the "0^M" key to the turnout menu "Sch" which is used to control turnouts.
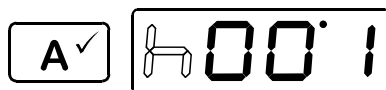
Confirm the selection by pressing the "A" key. The display flashes "h" to indicate that you may now enter the desired turnout address.

Use keys "2", "3", and/or "4" to enter the desired address of the turnout or signal.

Confirm your selection by pressing the "A" key.

Key "4" switches the turnout to straight "+". Key "1" switches the turnout to diverge "-".
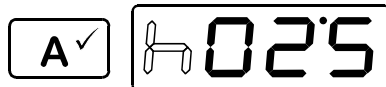
Press the "A" key again to select a different turnout address.
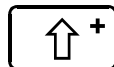
Use the "shift" key to return to the display of the locomotive address.

☞ While you are in the "Switching" menu, you can use the rotary control-knob to control the speed of the locomotive whose address was shown on the display when the switching menu was entered.

12 Multi-unit/consisting (MU)

In this section you will learn:

- what a multi-unit actually is
- how to add a locomotive to a multi-unit and how to delete it afterwards
- how you set the functions of the locomotive while it is in a multi-unit

The abbreviation "MU" stands for "Multi Unit" which describes a collection or a consist of locomotives which are operated together as a single unit.

> ☞ The MU function requires the use of a LZ100, LZV100 or a "compact/commander" version 3.2 or greater.
> When using SET02, locomotives may only be added to or deleted from a MU using the LH200 which functions as a command station. All other functions for multi-units such as the controlling and accessing of functions of locomotives within a MU, are available from any connected LH90.

12.1 What is a multi-unit/consist?

A multi-unit is a group of locomotives that is controlled as a single unit by using a common address, referred to as the **multi-unit or consist address**. This multi-unit address always has two digits (1-99).

During the assembly of the MU each locomotive forming part of the MU is allocated this multi-unit address, and this is saved by the locomotive decoder in addition to its individual address. Once given a MU address, locomotive decoders forming part of the MU no longer "listen" to their own unique addresses for speed and direction commands. Instead these commands are sent to their multi-unit address. Never fear, the locomotive decoders do not forget their own unique addresses, these are saved and used when the locomotive is removed from the MU.

The speed and direction of motion of all the locomotives in the MU are controlled at the MU address. If a locomotive which is tied into the MU has switchable functions (lighting, smoke generator), you can control these functions only via the respective loco address.

When you break up the MU, the multi-unit address in the locomotive decoder is deleted and the locomotive again listens to its own address.
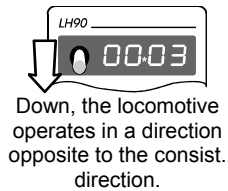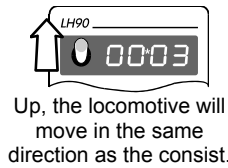
☞ All locomotives which you wish to add to or delete from a MU **have to be located on the track** while you are in the "MU" menu**!** Special MU commands, are sent via the track, to locomotives during this operation. This is especially important when removing a locomotive from a multi-unit: if the remove command does not reach the locomotive decoder (due to a bad contact or because you have taken the locomotive off the track), the MU address in the decoder will not be deleted and the locomotive cannot be run at its own address**!**

12.2   Adding a locomotive to a multi-unit (MU)

Move the locomotive that you want to add into the MU to the place on your track system where you want to start controlling the MU.

Make sure that the locomotives will operate in the **same direction** as the MU when you add them to the MU. If your MU is supposed to run to the right when you select the forward direction then each locomotive has to be set in this same direction when it is added to the consist. This is done by using the direction switch. When you confirm the locomotive being added to the consist if the direction switch is up the locomotive will operate in the same direction as the consist. If the switch is down the locomotive will operate in the reverse direction when you operate the consist in a forward direction.

A✓ (possibly more than once)	`0003`		Scroll through the stack until the first locomotive that you want to tie into the MU is shown.
⇧+ 0 M	`Adr`		Enter the menus by pressing the shift key followed by the "0ᴹ" key.
0 M	`MU`		Scroll through the menu until "MU" is shown in the display and confirm the selection with the "A" key.
A✓	`M 01`		You are now asked to enter the desired multi-unit address. A multi-unit address must be between 1 and 99.
4 8	`M 05`		Use the "4" key to alter the value of the ones digit.
3 7	`M 55`		Use the "3" key to alter the value of the tens digit.

Up, the locomotive will
move in the same
direction as the consist.

Down, the locomotive
operates in a direction
opposite to the consist.
direction.

Before confirming the
selected multi-unit address
ensure that the locomotive
direction is correct.

Confirm the selected MU address by
pressing the "A" key. The locomotive with
address 3 has now been added into the
multi-unit with multi-unit address 55.

Scroll further through the stack until you reach the next locomotive that you
want to tie into the MU or enter the loco address. Again, change the menu
and repeat the steps that you have already executed in order to tie the first
locomotive into the MU. Proceed until you have tied all locomotives into the
MU according to plan. Locomotives can be added or removed from a MU at
any time.

☞   You must operate a locomotive before it can be entered into a MU. If
       the locomotive has not been operated first you will get an ER03
       message and the operation will not be performed.

☞   With Set-01, Set90, Set100 and Set-02, you can control the speed and
       direction of the MU from any individual locomotive address that is
       within the MU. Locomotive functions can only be controlled at the
       specific locomotive address.

☞   If you want to operate the MU from the new MU address, you must
       enter this new address into the stack. See section 8.3 (⇨P.14).

☞   Pressing the [⇧ +] key before you have entered the new MU address will
       exit the MU operation

## 12.3   Removing a locomotive from a multi-unit

Scroll through the stack until the MU is displayed or enter the address of the MU in the stack.   You can also begin this operation by selecting any locomotive that is within the MU.

Use the shift "A" sequence to scroll through the addresses within the MU until the first locomotive that you want to remove from the MU is shown.

Enter the menu and scroll to the display "MU-" (Removing a locomotive from a MU).
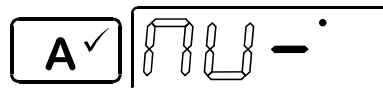
The display flashes. Now you have the possibility to interrupt the removal process. Press "shift" if you wish to cancel the process.

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

At the completion of the operation, the multi-unit address is displayed again. When you have deleted the last loco address from the MU, the next loco address in the stack will be displayed.

12.4   Preconditions for using multi-units:

Multi-units can be used with any decoder that supports "advanced consisting". All locomotive decoders of the Digital plus system which have NMRA C&I warrants support this feature.

> ☞   To use MU operations, locomotive decoders have to be set to run with 28/128 speed steps (CV29 Bit 2 is set).

12.5   Displaying a multi-unit address

If you use the LH90 with an V3 or later LZ100or LZV100 command station, all multi-unit addresses are marked with the letter "M":

```
∏  55
```

If you wish to view the locomotive addresses that are currently within the MU, proceed as follows:

⇧ +   A ✓   Whenever you see the address of the MU on the display, you can scroll through the locomotives in the MU by pressing the shift key followed by pressing the "A" key.

After the last address in the MU has been displayed, the multi-unit/ multi unit address will be displayed when you press the shift "A" key sequence again.

> ☞ If the upper center LED is on in the display, the locomotive address displayed is part of an MU. To
>
> ```
> 00˙03
> ```
>
> determine the MU address and other members of the MU use the shift "A" key sequence to scroll through the members of the MU.

12.6   Controlling functions of a locomotive within a multi-unit

The speed and direction of all the locomotives within a MU is controlled via the multi-unit address or via controlling the speed and direction of any locomotive within the multi-unit if the system implements "Smart Consisting". Controlling locomotive functions for a locomotive within the multi-unit can only be done via their respective locomotive address.

If you have the MU address on the display you can scroll through the MU using the shift "A" sequence until the individual locomotive address is on the display.. Now you can control the functions as desired. (as described in section 9 ⇨P.16).

13 Programming specific decoder features

In this section you will learn:

- which programming methods can be used
- how to proceed when programming
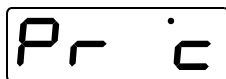
> ☞ The menu "Programming" is only available when the LH90 is operated with a LZ100 or LZV100 command station.
>
> ☞ Pressing the ⬆⁺ key multiple times during programming will return the LH90 to normal operation.
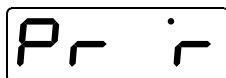
There are five different methods for using the LH90 for programming specific decoder features:
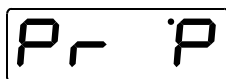
Adr.	Smart Addressing-One step process for programming the locomotive address on the programming track, with an address of between 1 and 9999. The system will set all the necessary CVs for you.
Pr c	Programming using "Direct Mode" on an isolated programming track.
Pr r	Programming using "Register Mode" on an isolated programming track.
Pr P	Programming using "Page Mode" on an isolated programming track.
PoN	Programming using "Operational Mode Programming" anywhere on the layout..

The LH90 "remembers" the last programming method used and will display this mode first during the next programming session.

13.1 The difference between "Service Mode" and "Operations Mode" programming methods

During **"Programming in operational mode"** the locomotive with the decoder can be situated 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 the 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 in Service Mode",** a dedicated section of track is used for the programming function. It is not necessary to know the address of the decoder. During this procedure the decoder receives the order:

"Enter value 15 in CV4!"

Every decoder which receives this order will also execute it. To make sure that only the desired locomotive receives the command, it is necessary to use an isolated programming track. If you wish to alter the address of a locomotive decoder then you must use "Programming in Service Mode". It should also be noted that not all *Digital plus by Lenz* ® decoders have the "Programming in operational mode" feature.

13.2   Reading and writing a locomotive address using "Service Mode"

The LH90 implements a one step programming mode for reading and writing a locomotive address. Using this mode all the relevant CVs are read or written in one user operation. Make sure that the locomotive whose address you wish to program is located on an isolated programming track and that this programming track is connected correctly to your command station.

|			
⇧ +	0 M	Pro	Enter the menus by pressing the shift key followed by the "0^M" key and scroll through the menus using the "0^M" key until the display reads "Pro".
A ✓	0 M	Adr˙	Confirm by pressing the "A" key and scroll, if necessary, using the "0^M" key until the display reads "Adr"
A ✓		A – – ˙–	Confirm the selection by pressing the "A" key.

At this point you must decide whether you wish to read out the address first or whether you wish to enter a new address directly.

If you wish to read out the address, proceed with the next section. If you wish to program a new address directly, proceed to section 13.2.2.

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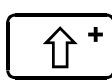### 13.2.1   Reading out a locomotive address

A✓   `rEAd`   Confirm again by pressing the "A" key. "READ" is shown during the reading out process.
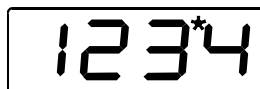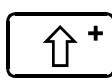
`1234`   The result of the read operation is displayed. The example shows locomotive address 1234 was read.

If you wish to alter this address, proceed with section 13.2.2. If you wish to terminate the reading procedure, press

⇧⁺   `Adr`   Press the "0^M" key. You have now returned to the selection of the programming mode.

⇧⁺   `0003`   Pres the "0^M" key a second time. The locomotive address that was last controlled last again displayed.

13.2.2   Setting a locomotive address

First press one of the keys "1" to "4" to begin selecting the new address to be written into the decoder.

1⁵ ... 4⁸   `0001`   The display shows the result if the "4" key is pressed first.

Now, alter the respective digits in the display with keys "1" to "4". Proceed as if you were entering a new locomotive address:
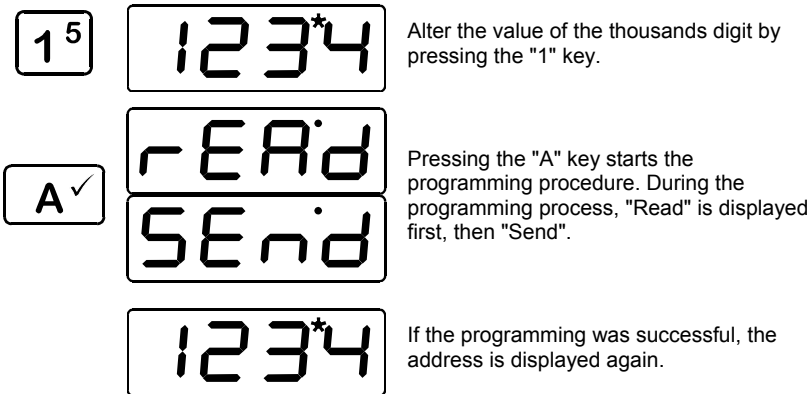
4⁸   `0004`   Alter the value of the ones digit by pressing the "4" key.

3⁷   `0034`   Alter the value of the tens digit by pressing the "3" key.

2⁶   `0234`   Alter the value of the hundreds digit by pressing the "2" key.

1⁵	`1234`	Alter the value of the thousands digit by pressing the "1" key.
A ✓	`rEAd` `SEnd`	Pressing the "A" key starts the programming procedure. During the programming process, "Read" is displayed first, then "Send".
	`1234`	If the programming was successful, the address is displayed again.

If an error occurred during the programming procedure, a corresponding message is displayed. See section 13.3.5 (⇨P 33). Delete the error message by pressing the "A" key.

13.3   Reading and writing CVs or registers - step by step.

Reading and setting decoder features is always carried out as follows:

1. Select the programming mode (CV, register, page)
2. Select the CVs or registers to be read out/programmed
3. Read out the content of the CV/the register
4. Set a value into the CV/the register.

Make sure that the locomotive whose address you wish to program is located on the programming track and that this programming track is connected correctly.

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13.3.1   Selecting the programming mode

Enter the menus by pressing the shift key followed by the "0^M" key and scroll through the menus using the "0^M" key until the display reads "Pro".

Confirm by pressing the "A" key. Press the "0^M" key to scroll through the programming menus until the desired programming mode is displayed.

Confirm your selection with the "A" key. In the example above, the "CV" mode was selected.

13.3.2   Selecting the CV or the register

The section shows the options in CV mode. This same display will also be shown during the selection of "Page" mode. If the "Register" mode is shown, a "r" is displayed instead of the "c".
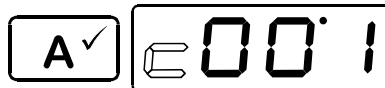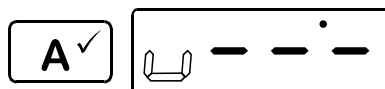
"c" flashes to indicate that you may enter the desired CV. If you have chosen programming in the "register" mode, a "r" will flash instead.

Press the "4" key to alter the value of the ones digit.

Press the "3" and "2" keys to alter the number of tens or hundreds. For this example CV3 was chosen.

Confirm your selection by pressing the "A" key.

If you wish to read out the content of the CV/the register, proceed with the next section. If you wish to enter a different value into the CV/the register immediately, proceed with section 13.3.4.

13.3.3   Reading out the content of the CV or the register

☞ Carry out steps in sections 13.3.1 to 13.3.2 if you have not yet done
so.

A✓   ⌐EAd   Start the reading out procedure with key
"A".

⌐001   The read out value is displayed.

If an error occurred during the programming procedure, a corresponding
message is displayed. See section "Error messages during service mode
programming " starting on page 33. Delete the error message with key "A".
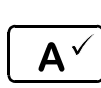
If you wish to do so, you may enter a different value into the CV by
proceeding with the next section.

13.3.4   Programming a value into the CV/ the register

☞ Carry out steps in sections 13.3.1 to 13.3.2 if you have not yet done
so.

4 8   ⌐000   Press the "2", "3", or "4" key to get to the
value enter display. You are now asked to
enter the desired value. A "u" flashes on
the display. In the following example the
value 10 is to be entered.

3 7   ⌐010   Press the "2" to "4"keys to enter the
desired value.

A✓   SEnd   When you have the value you want to
program press the "A" key to confirm.
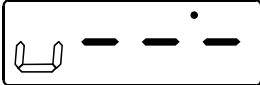"Send" is displayed during the
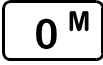programming procedure.

⌐010   If the programming procedure was
successful, the entered value is displayed.

You can alter the value again or return to the selection of a different CV with
the "shift" key.

13.3.4.1 Setting individual bits

Some CVs have specific feature which are set by altering specific bits within the CV. In this case, it is much easier to alter the required setting by setting and deleting the respective bit, instead of calculating the relevant decimal value and programming it into the CV (which is of course also possible).

To alter individual bits in a CV (or register), proceed as if you were entering a value (sections 13.3.1 to 13.3.4) up to the point where you are able to enter a value for the CV. You will see the following displays

(during programming on the programming track)

or

(during PoM)

Press the "0" key to tell the LH90 you wish to program individual bits.

Use the "2" key to select the bit which you wish to set or delete.
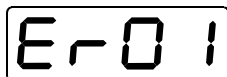
During "programming on the programming track" you can read out the selected bit by pressing key "A". This is not currently possible to read using PoM. In the following sequence a "0" is shown instead of the line in the single digit space.

Use the "4" key to choose whether you wish to set (1), delete (0) or read out (-) the bit.

Press the "A" key to program (set or delete) or read out the bit.

Press the "shift" key repeatedly to return to controlling locomotives (The LH90 displays the locomotive address).

13.3.5   Error messages during service mode programming

If an error occurs during the reading or writing procedure, you will receive one of the following messages:

```
Er01
```

A Short-circuit or overload was detected on the programming track. The locomotive or decoder is drawing power when it is not supposed to do so.

Check the wiring of the decoder, maybe the decoder is defective or there are external loads that must be disconnected

```
Er02
```

No decoder acknowledgement was received during the programming operation. Possible cause is a bad contact between the locomotive on the programming track, a faulty connection or a decoder defect.

When an error message is displayed, press the "A" key to return to the selection of the programming mode.

13.4   Programming in operational mode - PoM

PoM (or Operations Mode Programming) allows you to set the value of a CV while the locomotive is anywhere on the layout. Please read the operational manuals of your locomotive's decoder to verify whether the decoder is capable of PoM. Locomotives which are not capable of PoM must be programmed on the programming track using service mode.

The procedures for using PoM are identical with the programming of a CV on the programming track. To enter PoM, select "PoM" during the selection of the programming method. Then

1.   select the CV which is to be programmed

2.   program a value into the CV

During PoM, it is also possible to set or delete individual bits in CVs. It is not currently possible to read out values in a CV using PoM.

The step-by-step procedure or setting the value of a CV is described in section 13.3.

☞ During PoM, values can only be entered in a CV, but not read out. Check the success of your programming procedure by testing the actual alteration of the feature.

14 <u>LH90 system settings</u>

LH90 system settings are settings that affect the control of all locomotives, rather than an individual locomotive. The function of the emergency stop key or the current software version are examples of system settings you can display any or adjust.

The reading or setting of all system features is performed in a similar way:

Enter the menus by pressing the shift key followed by the "0ᴹ" key.

Scroll through the menu, until "SYS" for System Settings is displayed.

Confirm your selection with key A.

"y" flashes to indicate that you may alter the figure value.
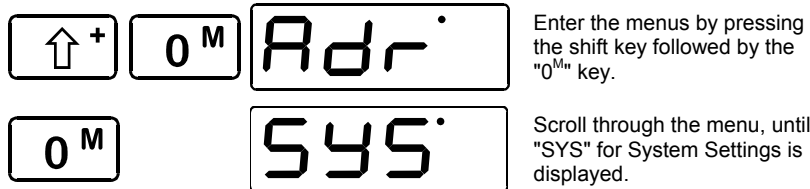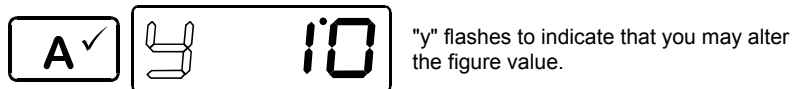
From here onwards the numerical values are altered in the same way as for other menus. Now choose the desired system feature:

Y	Generates
7	Pressing the emergency stop key causes the voltage on the track is switched off.
8	Pressing the emergency stop key causes only the locomotive with the address shown on the display to be stopped.
9	Pressing the emergency stop key causes all locomotives to be stopped, but the voltage on the track remains on.
10	Alteration of the XpressNet – address.
11	Version number of LH90 is displayed.
12	LH90 Software release is displayed.
13	Version number of the command station is displayed.
14	Stack size – The stack size can be set by entering a value of between 2 and 8.
99	The configuration of LH90 is reset to factory default: 1. Addresses 1 to 8 are entered in the stack. 2. The XpressNet address is set to 2. 3. The voltage will be switched off when the emergency stop key is pressed. 4. The stack size is set to 8.

14.1 Altering the XpressNet address (Sys 10)

☞ When setting the XpressNet address, please bear in mind which device your LH90 is connected to.
The LZ100 and LZV100 command stations use XpressNet addresses 1 to 31.
SET02, uses XpressNet addresses 1, 2, 3, 29, and 31.
The address selected must not be used by any other XpressNet device connected to your layout!

To set the XpressNet address, proceed as follows:

⇧ +   0 M   **Adr·**   Enter the menus by pressing the shift key followed by the "0M" key.

0 M   **SYS·**   Scroll through the menu, until "SYS" for System Settings is displayed.

Confirm your selection by pressing the "A" key.

A ✓ | Y   10 |
"Y 10", the setting of the XpressNet address, is shown first.

A ✓ | LH02 |
Press "A" to display the current XpressNet address of the LH90.

| LH04 |
Alter the address by using the "3" and/or "4" keys to set the desired address.

A ✓ | SYS |
Confirm by pressing the "A" key. The menu "SYS" will be displayed again. Use the "shift" key to view the display of the last locomotive address.

15 Technical appendix

15.1   Error messages on the display

```
Er01
```

LH90 always shows a message if you have done something which is not permissible at the time or if a certain function cannot be executed. To undo the relevant step, simply press

```
 A ✓
```
.

The following is a list of possible messages:

|	
Er 01	During service mode programming an overload (short-circuit) was detected. Perhaps the decoder is not connected properly or it is defective.
Er 02	During the programming or reading a decoder CV no decoder confirmation was received. This can be caused by the decoder not being properly connected to the programming output, the decoder is defective or not installed correctly, or the programming track is not connected properly.
Er 03	1. If displayed immediately after you plug in your LH90: the command station uses a software version which is older than version 3.0. 2. If displayed during adding a locomotive to a MU: You have not operated this locomotive address. You must operate a locomotive before you can add it to an MU.
Er 97	The LZ100/LZV100 has encountered a data processing error. All information on speed, direction and special functions of the locomotives as well as on the status of turnouts and occupation detectors has been deleted. If this error occurs repeatedly, it may be the result of the power supply or it might be that the battery of the LZ100/LZV100 needs replacing. This battery makes sure that data are kept when the command station is switched off. Please contact your dealer or contact Lenz for further instructions..
Er 98	The command sent from the handheld to the command station is not recognized by the command station. Normally this happens if the software version of the command station does not support this feature. Typical example You are trying to use Service mode Programming, but you have connected your LH90 to a Set-02.

Lenz ELEKTRONIK GMBH

15.2   Glossary

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

Address	The number of a locomotive, comparable to a telephone number.
Acceleration and deceleration delay	Setting on a locomotive decoder. The acceleration delay determines how fast a locomotive reaches the speed belonging to a higher speed step, the deceleration delay determines how fast a locomotive reaches the speed connected with a lower speed step.
Configuration Variable (CV)	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 from our WWW site (www.lenz.com) or direct from Lenz Elektronik GmbH (send a stamped addressed C5 envelope).
DCC	Abbreviation for "**D**igital **C**ommand **C**ontrol". This term has come to refer to the digital model railroad control system developed by Lenz and standardized by the NMRA.
Locomotive address	see address
Locomotive stack	"Index card box" that allows quick selection of a locomotive address.
Multi-unit consist	Controlling several locomotives at the same time with a common address
NMRA	**N**ational **M**odel **R**ailroad **A**ssociation, North American model railroaders organization
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.
Packet format	The manner and method by which the information is transmitted from the command station to the decoder.
Decoder settings	see CVs
Throttle positions	The area on the handheld between the minimum and maximum speed is divided into individual sections called throttle positions.
Throttle-notches	Determines whether a locomotive is controlled with 14, 27, 28 or 128 speed step mode.
XpressNet	High speed data communication network for connecting DIGITAL plus input devices together

| XpressNet input devices | Devices that are used to control the model railroad. In the DIGITAL plus system these are: hand held controllers, computer interface, etc. |

16 Help in trouble shooting

Problem	Possible cause	Solution
Controlling locomotives:		
Locomotive does not run	Wrong locomotive address in the display	Enter the correct locomotive address.
	The system is set for 128 speed step operation and the decoder does not support this mode.	Change the system setting for this decoder to 14, 27 or 28 speed step operation depending on the capabilities of the decoder.
Locomotive does not react to the turning of the rotary control-knob.	Direction switch is in centre position.	Place the direction switch in the forwards or backwards position.
Locomotive does not react to the turning of the rotary control-knob.	Direction switch is in wrong position during the take over of the locomotive.	Place the direction switch in the position indicated by the flashing dot (⇨P. 8)
Unable to change the speed step mode	The speed of the locomotive is not 0	Set the speed to 0 **before** setting the speed step mode.
Locomotive does not react when speed step mode 128 is selected	The locomotive decoder does not comprehend this mode	Select the 14, 27 or 28 speed step mode for the use of this decoder.
Locomotive does not run using its basic address.	Locomotive is perhaps integrated in a multi-unit/consist	Control the locomotive using the multi-unit/consist address.
Locomotive address on the display flashes.	Selected address is already being used on a different manual control.	Select a different locomotive or take over the locomotive: place the rotary control-knob and the direction switch in the correct position (see "Adapting the rotary control-knob position") and move the rotary control-knob briefly.

Locomotive lighting		
(F0) switches on and off when the rotary control-knob is turned.	Locomotive decoder is set at running-notch mode 14. In the LH90 the relevant address is allocated to the running-notch mode 28.	Alter the running-notch mode in the LH90 to 14 notches or set the locomotive decoder to 28 running-notches (set CV29 Bit 2).
The locomotive lights (F0) do not respond when the ⌈0⌉ key is pressed.	Locomotive decoder is set at running-notch mode 28. In the system the relevant address is allocated to the running-notch mode 14.	Alter the running-notch mode in the system to 28 notches or set the locomotive decoder to 14 running-notches (delete CV29 Bit 2).
	Locomotive decoder is set at running-notch mode 14. In the system the relevant address is allocated to the running-notch mode 28.	Alter the running-notch mode in the system to 28 notches (set CV29 Bit 2).
Emergency stop and off:		
The display shows a flashing "OFF"	An emergency off was initiated by another hand held controller	End the emergency off by pressing the ⊚ key.
	A power station has shut down because of a short circuit or overload.	Remove the cause of the short circuit. If the cause is an overload, consider dividing the layout into several power districts. Refer to "Power supply for a large model train layout" in the system operation manual.

17   North American Warranty

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

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

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

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

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

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

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Warning: This product contains chemicals known to the State of California to cause cancer, birth defects or other reproductive harm.

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

CE Please save this manual for future reference!