ESU
Electronic Solutions Ulm

HORNBY®

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Contents

1. Introduction

The LokSound V4.0 decoder by ESU is a versatile digital decoder integrating a full-featured, 8 channel sound system, various lighting outputs and a 1.1A motor controller. This key component of your newly acquired "Class 08" is responsible for all functions, such as motor control, control of all lighting functions and all sound and special sound functions.

LokSound V4.0 decoders are compatible with all NMRA DCC standards & RPs, support short and long addressing, Advanced consisting, 14, 28, 128 speed steps and also support RailCom-Plus®. RailComPlus® allows for the automatic recognition of your locomotive by your DCC system on supported DCC systems. LokSound V4.0 decoders also support Märklin® Motorola® and can be used on legacy AC and DC layouts as well.

The "Class 08" is preset at the factory for immediate operation Nevertheless, we kindly ask you to first read these instructions before you set this locomotive onto a power track.

Please note that some aspects of this Decoder User manual may not be applicable to your particular purchase, dependant on choice of Controller, and also Functions available, such as Lighting.

1.1. Decoder ratings

The "Class 08" can be operated straight out of the box. The selection of the appropriate operating mode happens automatically. You do not have to change any parameters.

Track Voltage	47 Volts maximum
Operation modes	DCC, Motorola, AC & DC
Steady state motor current	1.1A
Function output current	0.25A each

Number of function outputs	4 + 2 logic outputs
Total current of function outputs	0.5A
Audio amplifier	2W @ 4Ohms load
Speaker impedance	4 - 8 Ohms
Memory capacity	32 MBit
Number of Sound channels	8
Dimensions	30.0mm x 15.5mm x 4.5mm

Important Warning:
● This LokSound decoder is designed for use in Hornby "Class 08" only.
● Do not expose to wet and humid conditions.
● Do not remove Heat shrink sleeve if fitted to Decoder.
● Always disconnect the circuit when installing the decoder. Please install the body shell before applying voltage.
● Make sure that not any blank wire ends may come into contact with the locomotive (a risk of short circuit!)
● Make sure that no wires are squeezed or cut by the model's transmission parts when reassembling the locomotive.
● Handle the speaker with extreme care: Do not touch the membrane or apply pressure!

2. Operation

2.1. Function assignments

Function Key Effect
F0: Directional Headlights
F1: Sound On / Off
F2: Airhorn
F3: Coupler Clank
F4: Compressor
F5: Brake Release
F6: Shunting Mode
F7: Short Airhorn
F8: Diesel Notch Up

The default address for DCC operation is "03".

2.2. Using your LokSound decoder under DCC

The default address assigned to the LokSound decoder is 3. Simply set your controller to this locomotive number and place it on the mainline. If everything is set up properly, the "Class 08" should react as shown on the table 3.1.

If you use a DCC system which supports RailComPlus®, it will most likely ask you to change the locomotive address. All function button icons will be displayed correctly after the assignment of the new address.

2.3. Using your LokSound decoder under Märklin® Motorola®

The default address assigned to the LokSound decoder is 3. Simply set your controller to this locomotive number and place it on the mainline. If everything is set up properly, the "Class 08" should react as shown on the table 3.1. Usually, under Motorola® system, you can control the function buttons F0, F1 to F4 only. However, you can enable a LokSound special feature. Besides the normal locomotive address the decoder then "listens" also for the next address. If you use this address with your 6021, you can activate the functions F5 to F8 by pressing F1 to F4. To enable the second Motorola® address, you may change CV49, Bit 3 (see programming table).

2.4. Using your LokSound decoder under DC or AC

Although we highly recommend the use of a DCC system in order to enjoy all features of the LokSound, you may also use your conventional DC or AC controller. You will be able to control the motor of the locomotive and will also hear the engine sounds. However, you can not control any additional sound effects such as horn because of the lack of any function buttons.

The table starting on page 10 covers setting of the most important parameters of the LokSound decoder. A full list of CVs can be found in the reference manual available for download under **www.esu.eu**

3. Decoder settings

3.1. Basics of DCC programming

The hardware determines some features such as the number of function outputs as well as the maximum permitted current of the motor output and therefore they are not programmable. Nevertheless, there are plenty of possibilities to influence the behaviour of the LokSound decoder by adjusting software-governed properties. There is at least one memory space within the decoder reserved for each adjustable parameter where numbers or letters can be stored.

You could visualise the storage spaces as index cards in a large file box. In order to enable you to find the right card again, they all have numbers and / or names outlining the properties of this particular card such as "locomotive address" or "maximum speed." Then imagine that you can write information onto these cards. Adjusting the settings means nothing else but erasing one entry and replacing it with another. Moreover, you could do that at any time. However, you cannot write onto every card: some bits of information like the manufacturer's code are firmly encoded.

Thus, you can determine the content of the storage spaces in the decoder even during operation and of course, the decoder will follow the instructions. Via the procedure known as "Programming", you can enter the desired data into the storage spaces.

3.1.1. Configuration variables (CV)

The LokSound decoders follow the CV concept developed in the US. CV stands for "Configuration Variable" and indicates that the storage cells described above are not only variable but they also determine the behaviour of the decoder.

3.1.2. Standardisation in the NMRA

The NMRA (National Model Railroad Association) has defined which CVs determine certain parameters of a decoder. The DCC standard allocates fixed numbers for certain CVs (adherence is obligatory). This greatly simplifies things for the user since decoders of most manufacturers comply with this standard and therefore dealing with CVs requires the same process with the same CV-numbers regardless of the manufacturer.

The DCC concept permits you to enter numbers ranging from 0 to 255 into CVs. Each CV carries only one number.

While the position number is predetermined, the range of values may vary. Not all CVs must accept values ranging from 0 to 255. The permitted values for LokSound decoders are listed in the table staring on page 10. showing the most important available CVs.

3.1.3. Bits and Bytes

Most CVs contain numbers: CV 1 for instance contains the locomotive address. This can be any number between 1 and 127. While most CVs expect numbers to be entered, some others are rather like a "collection point" of various "switches", that administer different functions in one CV (mainly "on" or "off"): CVs 29 and 49 are good examples: you must calculate the value for these CVs yourself. The value depends on which settings you want to programme:

Have a look at the explanations for CV 29 in the table on page 10: firstly, decide which options should be active. The column "Value" has two numbers for each option. If the option is switched off, the value is 0. Otherwise, it is a number between 1 and 128. Add all the values for the respective options to arrive at the correct value for this CV.

3.1.4. Programming methods

LokSound decoders support all NMRA programming modes as there are the programming track modes (Direct Mode, Register Mode, Paged Mode) and the mode for the main ("POM", "Programming on the Main").

3.1.4.1. Programming on The Main

Programming on the Main (also called "Operations Mode programming") enables you to programme your decoders comfortably without having to remove the locomotive from the layout. In this case, the command station talks directly to the decoder by using its locomotive address, for instance:

"Locomotive number 50, write the value 7 into CV 3!". Thus knowing the locomotive address is a precondition.

3.1.4.2. Service Mode Programming

This programming mode usually requires the locomotive to be placed on a special programming track output of the command station. CV's can only be read on the service track unless your DCC command stations supports RailCom. You can also reprogramme the locomotive address without knowing the old address since the command station simply transmits the command "Write value 7 in CV 3!"

In order to be able to read back the CV values from your decoder, the motor terminals must be properly connected to the motor. The motor is used to produce the "feedback" current detected by the command station.

3.1.5. Programming procedure using various DCC systems

As each DCC system is different, the procedure for changing a CV will vary depending upon the system. We are very sorry that we are unable to provide detailed instructions to cover every system on the market. We need to assume that you are familiar with your system. Please consult your DCC system manual for detailed specification. We tested the LokSound with almost every DCC system available on the market (as of end of 2010), so there should not be any general problem.

3.1.6. Programming with the ESU LokProgrammer

The LokProgrammer 53450 / 53452 offers the easiest and most comfortable way of setting the CVs of the LokSound decoders: simply by a few mouse clicks on an MS-Windows® computer. The computer helps you look for the various CV numbers and values. More information is contained in the manual for the LokProgrammer.

You can access all properties of ESU decoders with the LokProgrammer. You even can erase the sound and download a new soundpackage. Please see our website for more details.

3.2. Setting up your LokSound

3.2.1. Address Settings

Each LokSound decoder requires a definite address to be addressable for the central unit. Depending on the type of decoder and the digital system, there are several possibilities how to allocate addresses. The LokSound may be setup to listen to either the primary address (also called "short" address), which provides a range of 1 to 127 or the extended ("long") address, which has a range of up to 9999. Based on your preferences and your command station's capabilities, you may select either the primary address or the extended address for usage. Be aware that some DCC systems do not support the full range of available addresses. Bit 5 in CV 29 switches between short and long address. The decoder can only respond to one address at a time.

If CV 29, Bit 5 is cleared, the decoder listens to the primary address stored in CV 1.

If CV 29, Bit 5 is set, the decoder listens to the extended address stored in CV 17 AND CV 18.

3.2.1.1.Primary Address

Normally you would control LokSound decoders with the short address that is stored in CV 1. In DCC mode, the permitted values range from 1 to 127. In order to enable the decoder to "listen" to the short address you must delete bit 5 in CV 29.

Some digital systems (e.g.: ROCO® Lokmaus2, Lenz® digital plus, Lenz compact) only support the values 1 - 99 as short addresses.

3.2.1.2. Extended Address

You can also operate LokSound decoders with extended addresses (4-digit addresses). The supported values range from 128 - 10239. The extended address is stored in CVs 17 and 18. You must activate the usage of the extended address by setting bit 5 in CV 29.

If you want to use your LokSound with the extended address it is practical to programme this address directly with your digital system: most modern digital systems have a menu for programming long addresses. The command station not only programmes CV 29 correctly but also assures the correct storage of the values for the long address in CV 17 and 18.

Both the primary and the extended address may be changed at any time using service mode (on the programming track).

Some DCC systems (such as ESU ECoS, ESU Navigator) will allow the decoder address to be modified using Programming On The Main. LokSound will accept the programming commands, but the following restrictions apply:
● If the decoders primary address is enabled, the decoder will accept a new primary address and follow this immediately.
● If the decoders primary address is enabled, the decoder will accept a new secondary address (write of CV 17, 18)
● If the decoders extended address is enabled, the decoder will only accept a new primary address. You can not change an extended address to another number using Programming On The Main.

3.2.1.3. Motorola® Address

You can also operate LokSound decoders with the Motorola® format. The address for this operating mode is stored in CV 1.

This address is identical to the short address in DCC mode. The LokSound decoder responds both to commands in DCC and in Motorola® mode at the same time.

Märklin® digital devices (6020, 6021, Delta®) can only work with addresses from 1 to 80. Should you have entered a higher value in CV 1 you will not be able to drive this locomotive with these central units.

HORNBY®

DIGITAL SOUND
CLASS 08
Operating Manual
4/1373A

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Programming Table – List of most important CVs

3.2.2. Configuring the decoders behaviour

3.2.2.1. Acceleration / Deceleration

Acceleration and brake time can be set independently of each other. Therefore, you could for instance programme a short acceleration and a much longer brake time.

The time for accelerating from 0 to maximum speed is adjusted in CV 3 while deceleration is set in CV 4. Permitted values are 0 (no delay) to 63.

The times set in these CVs work speed dependant. Therefore, the acceleration distance and the brake distance are longer at high speeds. In other words, the faster the locomotive moves, the longer is the distance until it stops.

3.2.2.2. Starting voltage, Max and Medium Speed

LokSound decoders know 255 speed steps internally. They can be adapted to the characteristic of the locomotive and allocated to the actual available speed steps (14, 28, or 128):

Motor characteristic via CV 2, 5, and 6: enter the start voltage in CV 2 and the maximum speed in CV 5. CV 6 corresponds with the speed at a medium speed step. Thus, you can define a kink in the speed curve. This mode is active if bit 4 = 0 in CV 29.

The values of the start, mid and maximum speed are dependent on each other. Selecting a mid speed that is lower than the start speed or higher than the maximum speed could lead to some erratic driving performance. Therefore always adhere to the principle: start voltage < mid speed < maximum speed.

3.2.2.5. Shunting mode

The shunting mode reduces the speed to about 50%. Thus, you have smoother control of your locomotive in the lower speed ranges, which is important for shunting.

3.2.2.6. Analogue mode

The LokSound can also be used on conventional layouts. By default, this option is enabled. If you don't want to use the LokSound on conventional layouts, please disable the analogue mode by clearing bit 2 of CV 29. Disabling this mode is useful if you plan to use some automatic braking modes.

3.2.3. Brake Sectors

Brake sectors have the purpose to slow down the locomotive independently from the commands issued by the command station. Frequently, this function serves for stopping a train in front of a red signal. If a LokSound detects a brake command, it will slow down with the programmed deceleration and then stop. After this enforced stop, the locomotive will accelerate again as per the programmed values in CV 3.

Depending on the type of digital system, there are several options] on how to influence the decoder so that it stops the train.

3.2.3.1. DC Brake Mode

In order to activate the DC brake mode you must set bit 3 in CV 27. The decoder will start brake once it moves from a digital sector into a DC sector provided the brake mode is active and the polarity of the track voltage does NOT match the current direction of travel. The locomotive will stop taking into account the programmed deceleration.

3.2.3.2. Märklin® Brake Mode

In principle, the Märklin® modules 72441 / 72442 apply a DC voltage to the track instead of the digital signals. Provided bit 3 and bit 4 in CV 27 is set, then LokSound decoders detect this voltage and will stop the train (CV 27 = Value 24). The signal generated by these modules looks the same as DC from conventional DC-transformers. The LokSound could possible misinterpret this and switch to the analogue mode instead of brake. If you wish to control the decoder with DCC signals and keep your Märklin® brake sectors then you should switch off the DC analogue mode by deleting bit 1 in CV 50.

3.2.3.3. Lenz® ABC Brake Mode

LokSound V4.0 decoder support the ABC braking technique introduced by Lenz®. In order to use this function a group of anti-parallel diodes will be soldered to one half of the track. The resulting voltage drop generates an asymmetrical DCC signal. LokSound decoders will detect the difference between the left and right half of the signal. If desired, the decoder will be stopped.

To be able to use the ABC technique you also need, beside the adequate LokSound V4.0 decoder, an appropriate brake module. The ABC technique can only be operated with boosters offering an exact symmetrical output. We do not recommend the use of Boosters that do not offer the above facility.

● If you wish to stop the LokSound decoder when the track signal is stronger on the right side than on the left side (the diodes are also installed on the left side), set bit 0 in CV 27.

● If you wish to stop the LokSound decoder when the track signal is stronger on the left side than on the right side (the diodes are also installed on the right side), set bit 1 in CV 27.

● If you want to stop the decoder no matter in which half of the track the diodes are set, please set bit 0 and bit 1 in CV 27 (CV 27 = 3).

3.2.4. Adjust the sound volume

The LokSound allows the individual volume control of each sound. Please refer to the following table to see which CV you need to change:

Function	Slot	CV	Value
Master volume control		63	180
Diesel motor (prime mover)	1	259	128
		267	-
Horn Volume Control	3	275	128
Coupler	4	283	120
Compressor	5	291	128
Brake Release	6	299	128
Short airhorn	7	307	128
Random sounds	-	451	128
Brake squeal	-	459	128

> Before you change any of the volume control CVs, please make sure that the **CV 31 is set to 16 and CV 32 = 1!** These two CVs are used as index selection registers to distinguish between the real function of CV 257 - 511.

The master volume control CV 63 controls all sound effects. The resulting sound volume for each individual sound effect therefore is a mixture of the master volume control settings and the individual volume control sliders.

When you adjust the volume levels, please keep in mind that you should not exceed the maximum mixer levels to avoid a condition called "clipping" which occurs when the sum of two or more signals exceeds the capacity of the output channel.

CV	Name	Description	Range	Default
1	Locomotive 03 address	DCC/Motorola® address of locomotive		1 - 127
2	Start voltage	Sets the minimum speed of the locomotive	0 - 75	03
3	Acceleration	This value multiplied by 0.869 is the time from stop to maximum speed.	0 - 64	35
4	Deceleration	This value multiplied by 0.869 is the time from stop to maximum speed.	0 - 64	35
5	Maximum speed	Maximum speed of locomotive	0 - 64	64
6	Vmid	Medium speed of locomotive	0 - 64	24
13	Analogue mode F1-F8	Status of functions F1 to F8 in analogue mode	0 - 255	01

Bit	Description	Value
0	Function F1	1
1	Function F2	2
2	Function F3	4
3	Function F4	8
4	Function F5	16
5	Function F6	32
6	Function F7	64
7	Function F8	128

CV	Name	Description	Range	Default
17 18	Extended locomotive address	Long address of the loco. CV 17 contains byte with higher value, CV18 contains byte with lower value. Only active when function in CV 29 is switched on (see below).	192 - 9999	192
19	Consist Address	Address for consist operation. 1 - 127 consist address active, normal direction 129 - 255 consist address active reverse direction	0-255	0
27	Brake mode	Allowed brake modes		28

Bit	Function	Value
0	ABC braking, voltage higher on the right hand side	1
1	ABC braking, voltage higher on the left hand side	2
2	ZIMO® HLU brakes active	4
3	Brake on DC, if polarity against driving direction	8
4	Brake on DC, wenn Polarität gleich wie Fahrtrichtung	16

CV	Name	Description		Default
28	RailCom® Configuration	Settings for RailCom®		131

Bit	Function	Value
0	Channel 1 Address broadcast disabled	0
	Channel 1 Address broadcast enabled	1
1	No data transmission allowed on Channel 2	0
	Data transmission allowed on Channel 2	2

CV	Name	Description		Default
29	Configuration register	The most complex CV within the DCC standards. This register contains important information, some of which are only relevant for DCC operation.		14

Bit	Function	Value
0	Normal direction of travel	0
	Reversed direction of travel	1
1	14 speed steps DCC	0
	28 or 128 speed steps DCC	2

Bit	Function	Value
2	Disable analogue operation	0
	Enable analogue operation	4
3	Disable RailCom®	0
	Enable RailCom®	8
4	Speed curve through CV 2, 5, 6	0
	Speed curve through CV 67 - 94	16
5	Short addresses (CV 1) in DCC mode	0
	Long addresses (CV 17 + 18) in DCC mode	32

CV	Name	Description	Range	Default
31	Index register H	Selection page for CV257-512	16	16
32	Index register L	Selection page for CV257-512	0, 2, 3	0
49	Extended Configuration #1	Additional important settings for LokSound Decoders	0 - 255	19

Bit	Description	Value
0	Enable Load control (Back-EMF)	1
	Disable Load control (Back-EMF)	0
1	DC Motor PWM frequency 20kHz motor pulse frequency	0
	40 kHz motor pulse frequency	2
2	Märklin® Delta Mode Disable Märklin® Delta Mode	0
	Enable Märklin® Delta Mode	4
3	Märklin® 2nd address Disable Märklin® 2nd address	0
	Enable Märklin® 2nd address	8
4	Automatic DCC speed step detection Disable DCC speed step detection	0
	Enable DCC speed step detection	16
5	LGB® function button mode Disable LGB® function button mode	0
	Enable LGB® function button mode	32
6	Zimo® Manual Function Disable Zimo® Manual Function	0
	Enable Zimo® Manual Function	64
7	Reserved	0 128

CV	Name	Description	Range	Default
50	Analogue mode	Selection of allowed analogue modes	0 - 3	3

Bit	Function	Value
0	AC Analogue Mode (if implemented, refer to section 7.3.) Disable AC Analogue Mode	0
	Enable AC Analogue Mode	1
1	DC Analogue mode Disable DC Analogue mode	0
	Enable DC Analogue Mode	2

CV	Name	Description	Range	Default
52	Load control parameter «K» for slow driving	"K"-component of the internal PI-controller for the low speed steps. Defines the effect of load control. The higher the value, the stronger the effect of Back EMF control.	0 - 255	32

CV	Name	Description	Range	Default
53	Control Reference voltage	Defines the Back EMF voltage, which the motor should generate at maximum speed. The higher the efficiency of the motor, the higher this value may be set. If the engine does not reach maximum speed, reduce this parameter.	0 - 255	125
54	Load control parameter "K"	"K"-component of the internal PI-controller. Defines the effect of load control. The higher the value, the stronger the effect of Back EMF control.	0 - 255	48
55	Load control parameter "I"	"I"-component of the internal PI-controller. Defines the momentum (inertia) of the motor. The higher the momentum of the motor (large flywheel or bigger motor diameter, the lower this value has to be set).	0 - 255	32
56	Operating range of load control	0 - 100% Defines up to which speed in % load control will be active. A value of 32 indicates that load control will be effective up to half speed.	1 - 255	255
63	Sound volume	0 = low, 192 = max. volume	1 - 192	192
124	Extended Configuration #2	Additional important settings for LokSound Decoders	-	21

Bit	Description	Value
0	Bi-directional bit: Enable driving direction when shifting direction	1
	Disable driving direction	0
1	Disable decoder lock with CV 15 / 16	0
	Enable decoder lock with CV 15 / 16	2
2	Disable serial protocol for C-Sinus	0
	Enable serial protocol for C-Sinus	4
4	Adaptive regulation frequency	0
	Constant regulation frequency	16

CV	Name	Description	Range	Default
125	Starting voltage Analogue DC		0 - 255	90
126	Maximum speed Analogue DC		0 - 255	130
127	Starting voltage AC		0 - 255	90
128	Maximum speed Analogue AC		0 - 255	130

4. Decoder Reset.

You can reset the decoder to the default settings at any time. Enter the value 08 in CV 08.

5. Appendix

5.1. Programming Long Addresses

As described in chapter 3.1.1.2 the long address is split into two CVs. The byte with the higher value of the address is in CV 17. This byte determines the range in which the extended address will be located. For instance, if you enter the value 192 in CV 17 then the extended address may be between 0 and 255.

If 193 is written into CV 17 then the extended address will be between 256 and 511. You can continue this up to addresses with values of 9984 and 10239. The possible values are shown in the table below.

5.1.1. Write address

To programme a long address you first of all need to calculate the values for CV 17 and CV 18 and then programme it. Please note that it is not possible to programme addresses via the programming mode "POM".

To programme the long address proceed as follows:

● First you determine the desired address, for instance 4007.

● Then you look for the appropriate address range in the table below. The value to be entered into CV 17 can be found in the column on the right. In our example, it is 207.

The value for CV 18 is established as follows:

	desired address	4007
minus	first address in the address range -	3840
equals	value for CV 18	167

● 167 is therefore the value to be entered in CV 18. Thus your decoder is now programmed to address 4007.

5.1.2. Read out address

If you wish to read out the address of a locomotive please read the values of CV 17 and CV 18 one after another and proceed then in reverse order:

Let's assume you have read:

CV 17 = 196; CV 18 = 147. Look up the corresponding address range showing in the table below. The first possible address within this range is 1024. Then you have to add the value from CV 18 and you arrive at the locomotive address:

1024 + 147 = 1171

AddressRange			AddressRange			AddressRange		
from	to	CV17	from	to	CV17	from	to	CV17
0	255	192	3584	3839	206	7168	7423	220
256	511	193	3840	4095	207	7424	7679	221
512	767	194	4096	4351	208	7680	7935	222
768	1023	195	4352	4607	209	7936	8191	223
1024	1279	196	4608	4863	210	8192	8447	224
1280	1535	197	4864	5119	211	8448	8703	225
1536	1791	198	5120	5375	212	8704	8959	226
1792	2047	199	5376	5631	213	8960	9215	227
2048	2303	200	5632	5887	214	9216	9471	228
2304	2559	201	5888	6143	215	9472	9727	229
2560	2815	202	6144	6399	216	9728	9983	230
2816	3071	203	6400	6655	217	9984	10239	231
3072	3327	204	6656	6911	218			
3328	3583	205	6912	7167	219			

6. Support and Assistance

Your model train dealer or hobby shop is your competent partner for all questions regarding your LokSound decoder. In fact he is your competent partner for all questions around model trains.

There are many ways to get in touch with us. For enquiries please use either email or fax (don't forget to provide your own fax-no. or email address) and we will reply within a few days.

Please call our hotline only in case of complex enquiries that can't be dealt with by email or fax. The hotline is often very busy and you may encounter delays. Rather send an email or fax and also check our website for more information. You will find many hints under "Support / FAQ" and even feedback from other users that may help you with your particular question.

Of course we will always assist you; please contact us at:

USA & Canada (English support), please contact:
- **Phone:** +1 (570) 649-5048 Tuesday & Thursday 9:00am - 3:00pm (CT)
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