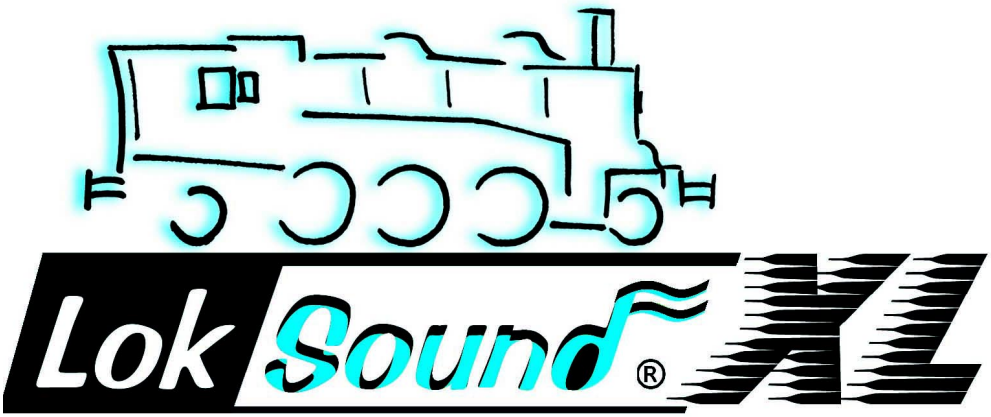
Electronic Solutions Ulm

User Manual

LokSoundXL

Version 2.1
May 2002



Contents

Not suitable for children under 3 years of age. Inappropriate use may result in injury due to sharp points and edges.

1. Introduction

Congratulations on your acquisition of a LokSoundXL decoder. With LokSoundXL your locomotives may finally sound like the prototype. You will soon notice that your LokSoundXL equipped vehicles will become the center of attraction.

Of course, you would like to install this decoder in your locomotive immediately, but first a request:

Please read this manual carefully before carrying out the installation!!! Although LokSoundXL decoders are very robust, incorrect connection may destroy the module!

Important Warning:

- LokSoundXL decoders are designed for use in model railways only
- Avoid mechanical force and impact on the decoder
- Do not expose to wet and humid conditions
- Never solder on the circuit board
- Never wrap the decoder in insulation tape, since this may cause overheating
- Always disconnect the circuit when installing the decoder
- Make sure that neither the LokSound decoder nor any blank wire ends may come into contact with the locomotive (a risk of short circuit). Cover any blank ends of unused wires.
- 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! Solder speaker connections quickly and only at the intended places! Pay close attention to the instructions for installing the speaker as outlined in this manual!

If you adhere to these warnings you will be rewarded by long life and trouble-free operation of your LokSoundXL decoder.

ESU electronic solutions ulm GmbH, May 2002

This manual has several chapters. Chapter 2 is an overview of the characteristics of LokSoundXL decoder. Chapter 3 is about installing and connecting. Chapter 4 deals with operational functions of the LokSoundXL decoder. This chapter provides information how programming parameters must be modified in order to get certain functions. The fifths chapter is about error analysis and gives answers to frequently asked questions. The appendix however includes a detailed list of all programming parameters as well as technical data. For every paragraph in chapter 3 (installing, connecting) there is a corresponding paragraph in chapter 4, which gives advice on programming.

2. Characteristics of the LokSoundXL decoder

The LokSoundXL decoder is a universal electronic module for installation in model locomotives for gauge G and I. LokSoundXL was esecially developed for gauge G and I and combines two components that had to be acquired separately in the past:

- A full-feature digital decoder with outstanding characteristics:

  Multi-protocol operation: LokSoundXL decoder understand both, the common Märklin® / Motorola® - format and the format of NMRA/ DCC-system. Thus LokSoundXL may be used with almost all presently available modern digital systems. LokSoundXL was tested among others with:

  - Arnold Digital (DCC operation)
  - Lenz Digital Plus,
  - ROCO digital is cool
  - Märklin® 6021
  - Uhlenbrock Intellibox (DCC+Motorola®)
  - ZIMO MX-1 (DCC-operation)

  The change over between protocols during operation happens automatically.

  Universal motor connection: All types of motors may be attached to the LokSound module:

  - Direct current (DC) motors (e.g. Bühler, Mabuchi)
  - Coreless motors (e.g. Faulhaber, Maxxon)
  - Alternating current (AC) motors

  High motor pulse frequency: By using a pulse frequency of 22 kHz (!) the motor is operated very carefully. Thus the motor is not only quiet (no motor whine), but also heat generation is minimized and motor life is enhanced. Even coreless motors may be operated with the LokSoundXL decoder without problem.

  Motor regulation: LokSoundXL offers second generation load control for direct current motors

and coreless motors. It may be adjusted to the each individual motor. Your locomotive will always keep the selected speed, no matter how large the load is or whether it is traveling up or down gradients.

Eight (!) function outputs: In addition to the two lighting outputs, another six function outputs are available for your choice of operation: you may switch on smoke generators or interior lighting or uncouple trains by pressing a key at your central processing unit or hand held controller! With blinking light effects and individually dimmable lamps your trains look real and give you a lot of enjoyment.

Brake tracks: LokSoundXL decoders understand (and react to) all available brake systems: besides the Lenz brake generator, Märklin® brake track is supported too.

Protecting functions: the motor output as well as all function outputs are protected against overloads.

Analogue operation: LokSoundXL decoders may be operated on AC- and DC systems without problems.

Easy programming: Even with Märklin® 6021 all functions may be changed easily without opening the locomotive.

- A digital, two-tone sound module with unique characteristics:

Prototype sounds: sounds of prototype locomotives were sampled using high quality microphones and recorded digitally onto a memory module. Thus your locomotives sound as accurate as the prototype!

Two channels: in addition to steam impact or diesel sounds, a further sound may be generated at the same time. Steam whistles, bells, horns, etc. will sound just like the original.

Steam, diesel and electric locomotive sounds are possible: LokSoundXL may imitate every type of locomotive you may think of. For each type of locomotive there is a prototypical operational sequence:

Steam locomotive: There are two, three and four-cylinder steam locomotives, whose steam impacts increase in frequency as the speed of the model locomotive increases!

Diesel locomotive: The engine may be turned on and off and rotates while stationary or driving based upon the speed of the locomotive! The LokSoundXL decoder may now also support Diesel electric locomotives.

E-Locomotives: Historical electric locomotives supply sound effects that are well worth listening to: from the motion of the pantograph to the clicking and cracking of the switchgear during acceleration! Even a wheel synchronized squeaking of the brakes is possible!

Sounds by pressing a key: Pressing a function key (F1 to F12) emits the sounds!

Random noises: Both while stationary and while moving, sounds such as air pump, water pump, coal shovels, compressed air discharging, etc. at random intervals controlled by you.

Chapter 3

Connection of the LokSoundXL decoders

3.1 Preparing installation of the decoder

The locomotive must be tested for excellent operation: only a locomotive with impeccable mechanical performance may take maximum advantage of the decoder. A locomotive that does not perform smoothly will not operate satisfactorily even with the best decoder. Replace or clean worn out motor brushes, check wheel contacts, bulbs etc.
Remove the locomotive from the track, disconnect and isolate the motor. There must be NO electrical contact between the motor and the rail pickup.
The LokSoundXL decoders have fixed dimensions; make sure, that the decoder fits easily into the locomotive. Do not use any pressure when replacing the outer body onto the frame and touch no wires.

Further, make certain that flexible parts such as transmissions and trucks are not obstructed by wires.

Fasten the decoder inside the locomotive with double sided tape, hot glue or screws. The decoder gets very warm during operation. Never pack the LokSound2XL decoder in foam or similar materials. This impedes air circulation and causes overheating.

> The LokSoundXL Decoder comes as an open circuit board that freatly reduces overheating. Handle the LokSoundXL module with care.
>
> Electronic components are sensitive to electrostatic loads: always make sure that your work place is grounded. If necessary, use an earthed wristband.

When installing the decoder you must not allow any metal part of the locomotive to touch the surface components of the decoder.

The LokSoundXL module has more connections than common decoders, which are needed for sound generation and function outputs.

LokSoundXL comes with two robust terminal blocks to which you can connect the wires of your locomotive. Please note when connecting the wires to the terminals that:

LokSoundXL decoder has two terminal block (No. 1 and No. 2): make sure you are using the correct terminal block!

Make sure that the wire diameter is big enough for the terminal (at least 0,20 mm^2).

Solder the ends of the wires or crimp them.

Make sure that no short circuits occur while connecting the wires to the terminals.

Use a suitable screwdriver.

Hold the termimals while turning the screws to avoid pressure on the circuit board.

Check every wire for good connection (pull lightly on the wire).

Please check all connections with an ohmmeter.

Always install a capacitor of at least 47nF in parallel to the motor terminals. See figure 1 for an optimal example of RFI suppression. Please note there are several methods of RFI suppression: we recommend to leave any suppressor (e.g. inductors) in the locomotive.

Please check all connections with an ohmmeter, particularly if there are any short circuits between motor- and current pick-ups.

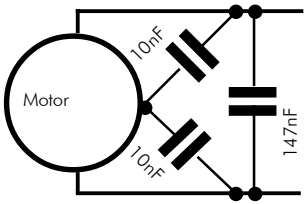


figure 1: RFI suppression

3.2 General circuit diagram

Figures 2 and 3 show the general connection scheme of LokSoundXL decoders:

The left terminal block (No. 1) has all connections that are needed for driving- and sound operation. The right terminal (No. 2) is only needed for function outputs.

Never mix up those two terminal blocks and always make sure the connections are correct. If you connect it the wrong way you may destroy the module.

Connect right rail to terminal 1-1, connect left rail to terminal 1-2.

Use terminals 1-3, 1-4 and 1-6 for the motor. When connecting DC or coreless motors only use terminals 1-3 and 1-6. See paragraph 3.3 and 3.4 for further details.

A wheel sensor can be connected to terminals 1-4 and 1-5. See chapter 3.9 for more details.

Connect the loudspeaker to terminals 1-8 and 1-9. See paragraph 3.6 for installation.

Terminal 2 is only for lighting and special functions. Please make sure that all outputs are connected against terminals 2-9 (positive supply voltage). Please see chapter 3.7 and 3.8 for details.

3.3 Connecting a DC or coreless motor

Always refer to the general wiring diagram on page 6 and bear in mind to keep any inductors connected.

For each type of motor (Buehler, Mabuchi, Faulhaber) there are different parameters needed for load control. They have to be adapted to optimize driving performance (see chapter 4.2.2).

For the motor connection use terminal 1-3 and 1-6, terminals in between are not connected.

3.4 Connecting a universal motor (AC motor)

For easy conversion of older gauge-I locomotives with universal motors (AC motor) the motors can be directly connected to the LokSoundXL-decoder (see Figure 4).

Connect the two motor terminals to terminals 1-3 as well as 1-5. Exchanging both wires will change direction of travel.

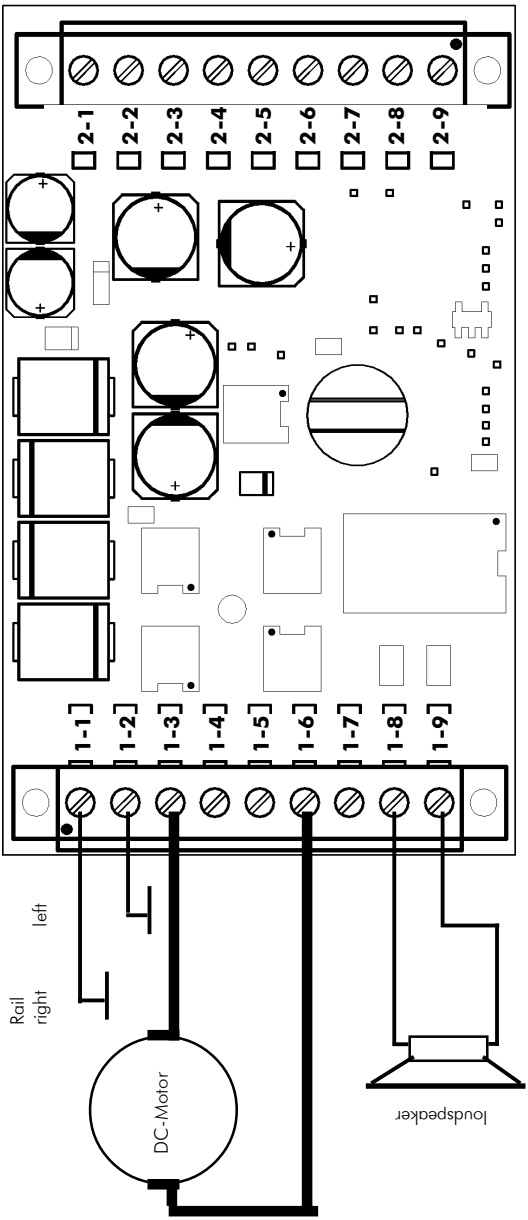


Figure 2: general wiring diagram

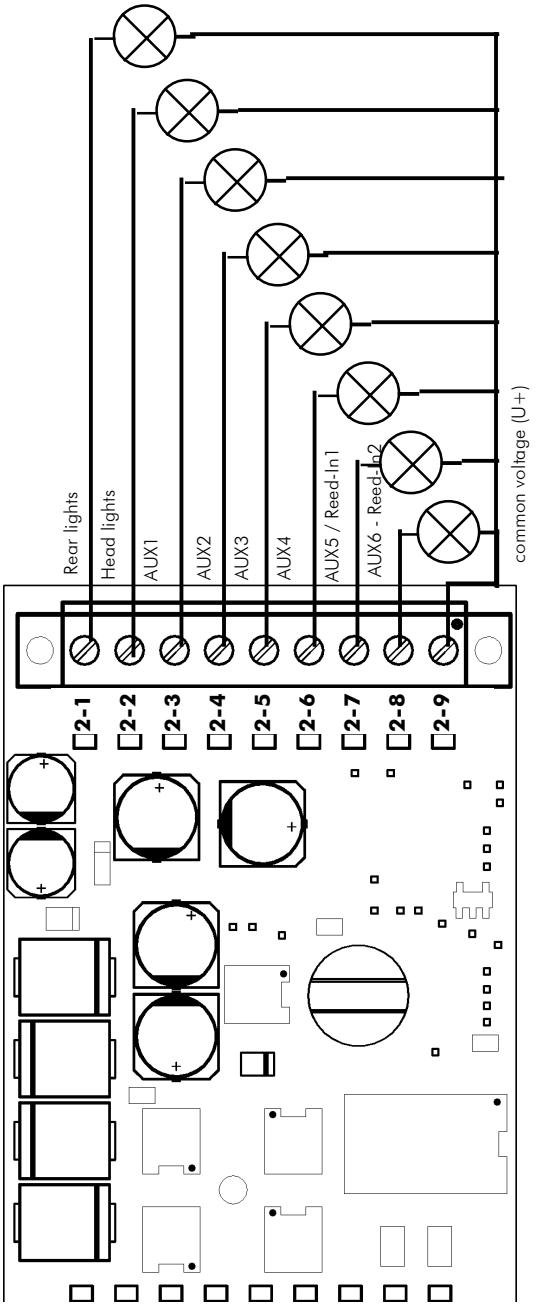


Figure 3: connecting the auxiliary functions

The RFI suppression inductor remains attached to the collector terminal of the motor. Solder the other one to terminal 1-4 of the decoder.

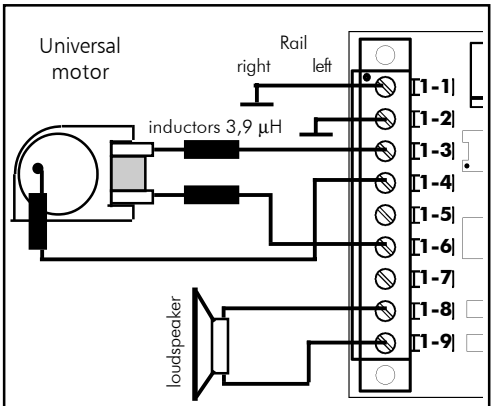


figure 4: connection to Märklin® Universal motor

Solder two inductors with at least 3,9 μH to the motor terminals. You may order these as spare parts from Märklin® under article number 516520.

For optimal operation the motor tact frequency has to be reduced from 22kHz to 87Hz. To achieve this set CV 9 to value 204.

Please note:

If a universal motor is connected, Back EMF Control will be automatically deactivated. The principle of Back EMF Control does not work with universal motors.

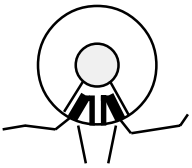
3.5 Connecting the speaker

The LokSoundXL decoder may only be used with the speakers offered by ESU electronic solutions ulm GmbH or with speakers with the same data (1 Watt, 16 - 32 Ohms). The use of speakers by others may cause considerable distortion and in extreme cases even destroy the LokSoundXL decoder. We also cannot recommend speakers that are actually designed for use with our H0 decoder.

The correct position of the speaker is crucial to achieve high quality sound. A speaker that is installed without a resonance chamber will not generate good sound. Therefore carefully select the location and sound chamber for the speaker.

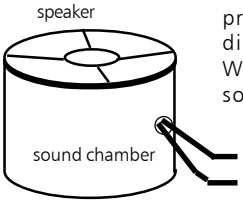
The speaker must be installed in such a way that the sound waves are not unduly blocked.

Please handle speakers with extreme care: don't put pressure on or touch the membrane. The speaker's magnets are very strong. Keep all metal items away and secure the speaker firmly when soldering. The soldering iron may pull the speaker due the magnetic field and destroy it.



Connect the speaker to the two terminals 1-8 and 1-9 of the LokSoundXL module. Make sure that you use a small soldering iron (max. 20 W) and only heat the marked spot as shown in the figure (close to the edge of the small contact plate). Polarity is not important. Make sure that no solder is dropped onto the membrane.

An optimal sound effect is achieved by putting the speaker into a sound chamber, which is supplied with the speaker.



This will increase the sound pressure and channel the direction of the sound. Without sound chamber the sound effect may be unsatisfactory. Feed the speaker wires through a small hole in the sound chamber.

3.6 Function outputs

LokSoundXL decoder has 8 (!) function outputs. Two are factory-set for directional headlights, the other six (AUX1 to AUX6) can be used for auxiliary loads.

With LokSoundXL you may dim the lamps in 15 steps to adjust the brightness optimally to your model. The brightness of each output may be adjusted separately. See chapter 4.2.4.2. Every function output can be set to various blinking light effects. See chapter 4.2.4.3.

All function outputs can be individually loaded with 0,6A current but cannot exceed a total load of 2,0A.

If the total current exceeds 2.0A or a short circuit occurs, then the overload protection switches off all function outputs. Once this problem is fixed all outputs are switched back on.

3.6.1 Connecting headlights

Connect headlights to terminal 2 as shown in figure 3. The light outputs provide the full, rectified track voltage (between 14 and 25V depending on the type of transformer). Therefore only use lamps for your locomotive suitable for this voltage.

In older style locomotives you may find that lamps are connected to the chassis. (ie.: Märklin®). In this case don't make a connection from the lamp back to the terminal 2-9 and the circuit will be completed via the chassis.

LED's or 1,5V-lamps are used in many locomotives and can be used with LokSoundXL decoders: Use a resistor of about 100 Ohm/0,5 Watt which has to be soldered between function output and lamp, for each light output that you want to connect to LED's or 1,5V-lamps. Additionally you have to lower the brightness of the individual function output per CV. See 4.2.4.3.

When using 1,5V-lamps it's not sufficient just to reduce the brightness per CV: for a short moment the lamp will get the full voltage due to the used PWM-mechanism.

3.6.2 Connecting auxiliary functions

You can use outputs AUX1 to AUX6 of LokSoundXL decoders for functions such as operating a smoke generator, switching lights, Swiss lighting mode etc. Please note that the outputs are used for switching of resistive loads like lamps, smoke generators, relays. Because of possible voltage peaks due to inductivity don't connect the motor directly to the output, use a relay.

Each output can be connected to terminal 2-9 or to the chassis.

Make sure that the sum of all currents for the function outputs does not exceed the permitted current rating and avoid short circuits between outputs. Although outputs of LokSoundXL decoders are protected, high voltage on the terminals or a short circuit may cause damage.

3.7 Connecting a wheel sensor

To synchronize the steam chuff an external sensor may (but does not have to be) used. The sensor input is terminal 1-7 on the LokSoundXL decoder. The LokSoundXL decoder supports reed switches or mechanical contacts as well as Hall sensors. In many locomotives mechanical wheel sensors have been fitted in the factory (e.g. Bachmann or Märklin®).

3.7.1 Connecting a reed contact with magnet

If a reed contact is to be used a miniature magnet (available at specialized hobby shops) must be attached to the driving wheel axle in such a way that the magnet releases the reed contact once every turn. Miniature reed switches have been proven to be very reliable. They may be obtained at any electronic specialist store.

Suitable magnets may be bought at model train shops. (e.g. Mini-track magnets) which might have to be shaped to fit.

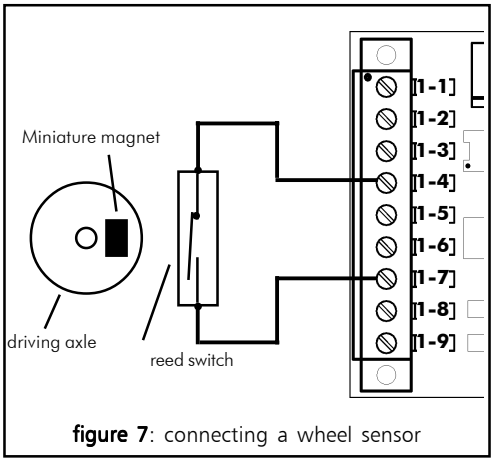


figure 7: connecting a wheel sensor

3.7.2 Connecting a mechanical contact

Many locomotives come with a factory fitted mechanical contact that is connected to terminal 1-4 and 1-7.

All double pole (mechanical) contacts that are isolated (not in contact with the chassis) may be used.

3.7.3 Connecting a Hall sensor

A Hall sensor is an electronic module that reacts to a changing magnetic field (like the reed switch but more

precise.) They are easy to install. A commonly used module is the Siemens / Infineon TLE4905 available at electronic stores.

Connect terminal Vs of TLE4905 to terminals 1-4, GMD to terminal 1-4 and Pin Output to terminal 1-7.

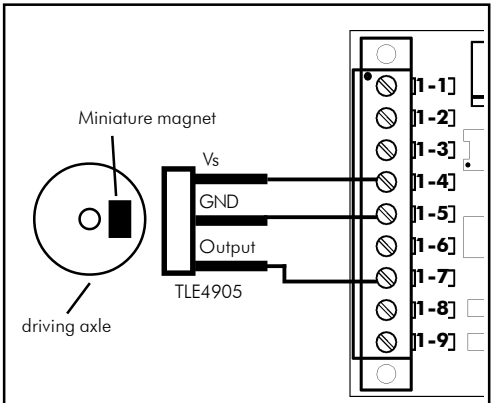


figure 8: connecting a Hall sensor

Before you can use the wheel sensor certain CVs have to be set. See chapter 5.2.4

3.7.4 Connecting auxiliary reed switches

As from version 2.0 the LokSoundXL decoder has two additional inputs. You can use them to release sound effects with the help of trackside magnets. Just connect a reed sensor to the inputs and place a magnet at the appropriate location on the layout. The required sound effect will be activated every time the locomotive passes the magnet.

With the aid if these inputs users of LGB MZS with Lokmaus may activate the multitude of sound effects generated by LokSoundXL decoders.

Both inputs REED-IN1 and REED-IN2 share terminal 2-7 as well as 2-8 with function outputs AUX5 and AUX6. If you want to use the REED-IN functions then AUX5 and 6 are not available.

Before you can use reed sensors certain CVs have to be set. See chapter 5.2.7

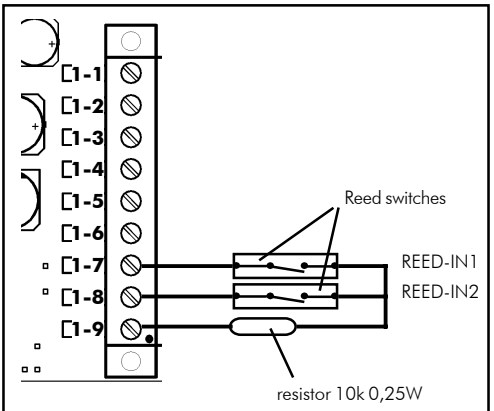


figure 9: connecting auxiliary reed switches

4. Set Up and installation of the decoder

After successful installation you may operate the decoder.

But first you will find out how to check your installation. In chapter 4.1 you will find instruction of how to operate the decoder in analogue mode. In chapter 4.2 you learn how to operate it with various digital systems.

Before changing any decoder settings (e.g. locomotive address, sound volume) we recommend to read chapter 5. There you find out which parameters are available and how they may be altered with the commonly available DCC command centers.

After installation you may test the LokSoundXL decoder as follows.

Please inspect all connections carefully using an ohmmeter: are there any short circuits between the motor terminals and the wheel pick-ups? Have all connections between motor terminals and the chassis been isolated? Are bulbs connected properly and isolated from the chassis? Is the decoder installed safely to avoid contact with the chassis? Is there sufficient space around the LokSoundXL decoder to allow for cooling? Could the LokSound 2 decoder or any of the wires be squeezed when refitting the housing? May sound emit from the locomotive without obstruction?

After you have checked above points you may switch on the power. We strongly recommend to carry out this initial test on a track section with overload protection. Programming tracks of modern digital systems offer this protection. Our LokProgrammer also offers extremely reliable overload protection.

- The pre-set locomotive address is 03.

- Does the locomotive travel in both directions?
- Turn the lights on: are they operating correctly?
- You activate sound by pressing function key F1, either the Diesel starts or you hear steam sounds. When pressing function key F2 you should hear the horn, whistle or bell, etc.

4.1 Analogue operation

4.1.1 DC Operation

DC operation using a conventional controller is possible without any problems but has one limitation. The locomotive will only start moving when the track voltage reaches 7 - 8 V. Maximum speed will be reached when turning the controller to the limit. This is absolutely normal and is due to the minimum voltage the LokSoundXL decoder requires for operation.

As factory default, sound effects cannot be activated in DC operation.

4.1.2 AC operation with conventional Märklin® controller

Operation with conventional Märklin® controllers works as usual: speed is controlled by turning the knob.

To change direction the knob has to be turned to the left beyond the stop position.

Please note:

The locomotive must have completely stopped before changing direction. Never change direction of a moving locomotive!

Press the knob slightly longer than usual (about 0,5 sec) in order to activate the command reliably.

As factory default, sound effects cannot be used with this type of operation.

4.2 Digital operation

4.2.1 Using Märklin® 6021

The LokSoundXL decoder may be used with all Märklin® products or compatible systems.

The functions F1 to F4 can only be activated with the "New Motorola Format". To activate this format put the DIP switches 1 and 2 of the 6021 to the upper ("On") position.

4.2.2 With DCC (Lenz, Intellibox, etc)

Remove capacitors that may be connected to the track section (e.g. in ROCO connecting track). They may impede normal operation of the decoder.

LokSoundXL can be run with any system that conforms to DCC. The automatic speed step detection has been tested with the following appliances: ROCO Lokmaus 2, Uhlenbrock Intellibox, Lenz Digital plus V2.3, ZIMO MX1.

The detection does not work properly when operated with Lenz Digital plus V3.0 if you wish to run 14 speed steps. Use 28/128 speed steps.

Each time that the LokSoundXL decoder receives a current (i.e. after the system is switched on) and the light is switched on it tries to detect the speed steps settings. If you switchover the speed steps settings during operation you must briefly switch off the current supply to the decoder so that the automatic mode functions as desired. The detection takes up to 30 seconds.

The detection can be switched off using CV 49 (please refer to section 7.1).

Operation with LGB Multi Train System (MTS)

LokSoundXL decoders also support the LGB Command Control system. Both Lok-Mouse and Lok-Handy may be used, but they have to be activated first.

LGB does not utilize the function keys specified in the DCC standards but has designed a procedure based

on multiple pressing of the F1 button: e.g. if you press F1 three times this will activate function F3. Therefore it is essential to "tell" the decoder, that it has to count how often the F1 button makes contact.

By setting bit 6 in CV 49 the LokSoundXL decoder will support the LGB operating mode.

Let's assume you want to use LGB MZS and activate load control as well. Simply enter the value 65 in CV 49.

5. Adjusting decoder parameters

Chapter 5 provides information on how to change the settings of LokSoundXL decoders. Please take your time to read and understand the occasionally somewhat complex explanations.
After the introduction into the world of decoder parameters (called CVs) in chapter 5.1, you will find all you want to know about which CVs have effect the properties of LokSoundXL decoders in chapter 5.2. Paragraph 5.3 explains how CVs may be set with various DCC and also the Märklin® command stations.

You find a complete list of all CVs in chapter 7.1.

5.1 CVs of the LokSoundXL decoders

LokSoundXL decoders are compatible with the NRMA / DCC standard. That means, that all parameters which change the properties of LokSoundXL decoders, are stored in so called CVs (Configuration Variables). LokSoundXL decoders support 121 variables. This large number of CVs shows the multitude of possibilities available with LokSoundXL decoders

To manage this large number of settings we recommend the use of our LokProgrammer. With LokProgrammer all CVs may be programmed with ease and comfort by using a PC. Please note that CVs that are not programmed properly could impede the performance of the decoder.

All CVs may be programmed without the LokProgrammer by using any DCC system that is NMRA/DCC compatible. Märklin® 6021 is also suitable. Chapter 5.3 explains, how it works.

In each CV values from 0 to 255 may be stored. The properties of the decoder change depending on the stored value.

If you have a look at the list of CVs in chapter 7.1 you will notice that most CVs have number values. CV 1 for example contains the locomotive address. This may vary between 1 and 127 (see range of values). The factory setting is 3. Please note that not all CVs have factory settings. Some CV values are different for different sound effects.

Other CVs represent storage locations that manage various functions at the same time (mostly turn on and off). CVs 29 and 49 are good examples: for these CVs the value has to be calculated individually, depending on the setting you want:

First you decide which option should to be turned on or off. In the column "value" you find 2 numbers for each option. The value 0 indicates the option is switched off, otherwise the value may range from 1 to 32. Add all values of the individual options to get the value of the CV.

Example 1: Let's assume, you want to use the Intellibox DCC with 128 speed steps and analogue recognition should be active (because you want to control some locos analogue mode). All other options are turned off. CV 29 shows the value 6 (0 + 2 + 4 + 0 = 6).

Example2: You want to activate the Märklin® brake module, Back EMF should be activated. You set CV 49 to 3 (1 + 2 + 0 = 3). We recommend to deactivate analogue recognition in CV 49, since the Märklin® brake track and analogue operation should not be activated at the same time. You set CV 29 to 0 (0 + 0 + 0 + 0) = 0.

Example3: You want to turn the volume of the decoder down. Set CV 63 to 1.

5.2 Important settings of LokSoundXL

Details of the most important CVs may be found in chapter 5.2. Please study these instructions carefully before you do any program changes. Careful deliberation will help you to find the optimal settings to achieve the desired effects with your LokSoundXL decoder.

5.2.1 Back EMF control (load control)

The LokSoundXL decoders utilize second generation load control which, when using DC motors, assures constant speed independent of the actual load. Load

control was optimized and tested with motors from ROCO, Bachmann (Liliput), BRAWA, Märklin®, LGB, Buehler, Mabuchi.

Load control may be deactivated completely (if so desired).

> Make sure that load control is always turned off when using AC motors - no matter what settings are used. AC motors are not suitable for load control.

How to switch on load control

Set the first Bit of CV 49. Read out the CV: load control is deactivated if the value is 0 or 2. To activate just add 1 to the actual value and enter.

Example: CV 49 reads 2.
To activate load control set CV 49 to 3.

You find a detailed description of all possible values for CV49 in chapter 7.1.1

Parameters of Back EMF control

The internally used PI-control algorithm of Back EMF control depends on 3 parameters: the control reference voltage is stored in CV 56, the control parameters are in CVs 57 and 58.

Reference voltage: In CV 56 you set the voltage that should come back from the motor. This value depends on track voltage and efficiency of the motor. An efficiency of 75 % and a track voltage of 16 V adds up to a voltage of 16 V * 75 % = 12 V, which needs to be written into CV 56. The voltage (here: 12 V) may be entered in 0.1 V-increments. This results in a value of 120 (12V * 10) for CV 56. If you don't know the exact efficiency of the motor you may obtain the value by the following experimental method:
Check, if the locomotive really reaches the top speed in the last speed step or if you cannot detect any speed changes at the higher speed steps. In the latter case you have to reduce the value for CV 56, in the first case increase the value.
If you enter '0" in CV 56, the LokSoundXL decoder will find a value, from track voltage and an assumed efficiency.
The internal PI-control of LokSoundXL decoders may be adjusted with CV 57 and CV 58. Depending on the type of motor the parameters may have to be adjusted achieve optimal driving performance.

> LokSoundXL decoders are factory pre-set for the use with Bühler motors, e.g. from LGB or other manufacturers.

- Parameter 'K", stored in CV 57, influences how strongly load control will effect the driving performance. The higher the value, the more the load control will respond to changes. Adjust this value with consideration, because higher values could lead to irregular and "hard" driving performance. If you prefer a smooth running try to reduce the value step by step until you reach an optimum.
- Parameter "I", stored in CV 58 provides important information to the LokSoundXL decoder regarding the type of motor used: certain electric motors respond differently to adjustments of the rpm's. The longer a motor takes to respond the lower the value in CV 58. However, it is not easy to recognize the grade of slowness. In general: the more poles a motor has and the bigger it is, the more fly wheels, the slower it is and the lower the value should be set in CV 58.

For optimal programming set CV 57 to a low value e.g. 50. Leave the value for CV 58 ("I) unchanged and start testing. Now change the value of CV 58 in steps of 25 upwards or downwards and see if you get a better driving performance. If there is no change leave the value of CV 58 and change the value of CV 57 (intensity of control) to reach the optimum.

> Please note, that incorrectly set parameters may impede the effect of Back EMF control and possibly cause the motor to stop altogether. Refer to our website http://www.loksound.de for a guide to some pre-calculated parameters for commonly used motor / drive combinations.

Parameters for Bühler motors

Locomotives with a motor made from Bühler are used by LGB and should be programmed as follows:

```
CV  57  (‘K’)  =   30
CV  58  (‘I’)  =  120
```

Parameter for for Mabuchi RS385SH

This motor is used by Märklin® in the Maxi ond Spur 1 or Bachmann.

```
CV  57  (‘K’)  =   50
CV  58  (‘I’)  =  110
```

5.2.2 Speed Curve

LokSoundXL decoder has 256 speed steps. They may be adjusted to the characteristics of each locomotive and assigned to the available speed steps (14, 28 or 128). NMRA allows two choices:

Speed curve via CV 2, 5 and 6 (figure 10). Set the starting voltage in CV 2 and the maximum speed with CV 5. CV 6 represents medium speed. You may define the shape of the curve (straight or with two different acceleration values). This mode is activated via CV 29 (see chapter 7.1).

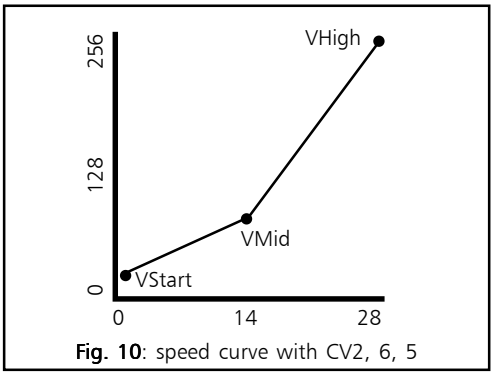


Fig. 10: speed curve with CV2, 6, 5

You may also define an individual speed curve: store the speed curve values in CVs 67 to 94 (as per figure 11). Those 28 values will determine the 256 speed steps. This method permits to optimize the driving performance. This mode is activated when CV 29 Bit 4 is set to 1. We recommend the use of the ESU LokProgrammer with software for easy calculation and programming.

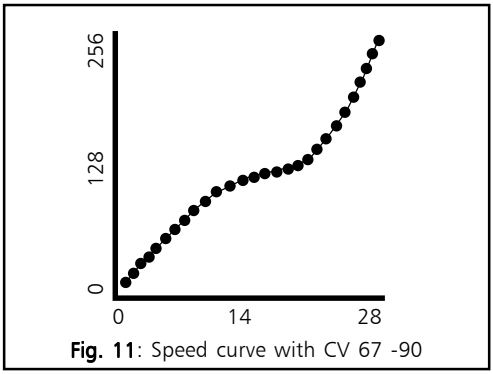


Fig. 11: Speed curve with CV 67 -90

5.2.3 Function outputs

The LokSoundXL decoder has eight physical function outputs, two for directional headlights, the other 6 (AUX1 to AUX6) for auxiliary loads.

In addition a further 8 "functions" may be activated by pressing a button to trigger various sound effects.

The functions "sound module on / off" and "acceleration on / off" are available. The latter function turns off the acceleration and deceleration and is often used for precise control of the locomotives particularly for shunting.

Function key assignment

The outputs may be assigned to the available function keys. Each function key is linked to a CV in which any number of events may be combined. Figure 12 shows the different possible combinations and also the ex-factory setting (marked by a dot).

Please note:

- Some function keys are linked to direction of travel.
- Possibly not all function keys are available on your DCC command station.
- As many sound functions are connected with function outputs not all function outputs and sound functions can be set separately. You have to decide which one you want to set. That's why each function output can be switched on or off separately using a further CV.

The value that has to be entered into each individual Control-CV is calculated as follows:

Add up the values of those functions that you want to activate with the corresponding function key. Then enter this value into the appropriate Control-CV.

Later we look at some examples to highlight the process, but first we have to explain two other features of the function outputs:

Switching on function outputs

Each of the three function outputs can / must be turned on, before it can be used.

You may program any of three available lighting effects for each output:

Function key	Description	Control-CV	Output "light forward"	Output "light rear"	Output AUX1	Output AUX2	Soundslot 1	Soundslot 2	AUX3 / Soundslot 3	AUX4 / Soundslot 4	AUX5 / Soundslot 5	AUX6 / Soundslot 6	Soundslot 7	Soundslot 8	Acceleration on / off	Sound on / off
F0	Light forward	#33	1 •	2	4 •		64	128							16	32
F0	Light reverse	#34	1	2 •	4 •		64	128							16	32
F1	Key F1	#35	1	2	4		64	128							16	32•
F2	Key F2	#36	1	2	4		64 •	128							16	32
F3	Key F3	#37			1		16	32•	64	128					4	8
F4	Key F4	#38			1		16	32	64 •	128					4	8
F5	Key F5	#39			1		16	32	64	128 •					4	8
F6	Key F6	#40			1		16	32	64	128					4 •	8
F7	Key F7	#41					1	2	4	8	16 •	32	64	128		
F8	Key F8	#42					1	2	4	8	16	32 •	64	128		
F9	Key F9 (F)	#43					1	2	4	8	16	32	64	128		
F9	Key F9 (R)	#47					1	2	4	8	16	32	64	128		
F10	Key F10 (F)	#44					1	2	4	8	16	32	64	128		
F10	Key F10(R)	#48					1	2	4	8	16	32	64	128		
F11	Key F11	#45					1	2	4	8	16	32	64	128		
F12	Key F12	#46					1	2	4	8	16	32	64	128		

Fig. 12 Function Mapping as per NMRA / DCC

- *Dimmer:* normal, continuously switched on load
- *Blinking light:* the output blinks with an adjustable frequency
- *Blinking light inverse:* the output blinks as usual but in opposite sequence.This permits to activate blinking lights in opposite sequence (lamp 1 = on, while lamp 2 = off and vice versa)

.

Starting with CV 114 each output has a CV that you can program with the desired mode. Please note that you may deactivate each output with "0" if not needed.

> The light outputs are factory pre-set to "on". All other function outputs AUX1 to AUX6 may be switched off by factory default, depending on the type of LokSoundXL-Decoder.

Dimming of lamps

With LokSoundXL you may dim the lamps in 15 steps to adjust the brightness optimally to your model. The lamps are pulsed, i.e.: they are continuously switched on and off. The brightness of each output may be adjusted separately. The desired dimming value (0 to 15) has to be added to the value of the corresponding Control-CV (113 to 120) that defines the function mode.

Blinking frequency and duration of "bright phase"

If a function output has been set to "blinking" or "blinking inverse", the duration of the "bright period" (defines blinking frequency) and the on / off ratio have to be taken from CV 121 (see paragraph 7.1).

The "bright period" is adjustable in 16 steps. It is always a multiple of 0,184 sec.

The On / Off ratio is adjustable in 16 steps from 1/16 to 16/16. A ratio of 8/16 indicates that the light output remains "on" for the same period as it is "off".

The value to be entered into the Control-CV 121 is calculated as follows:
Duration of "On" period (value: 0 - 15) * 16 + On / Off ratio

Examples:

- Example 1: smoke generator at AUX1 and F5.
  Let's assume you want to control a smoke generator with function key F5 that should be connected to output AUX1. Please refer to the installation instructions in chapter 2.5. The output AUX1 must be activated and assigned to the F5 key:

  First we activate the output. In this example we want to use the dimming function (the output must be active continuously) and set at 100% brightness. CV 115 controls output AUX1 (see paragraph 7.1).

  The value to be entered into CV 115 is calculated as follows: 16 (for dimming function) + 15 (for maximum brightness) = 31.

  Now we have to assign function key F5 to output AUX1: see figure 12: Control-CV 39 controls the F5 key (third column). In CV 39 we enter those functions that should be switched with the F5-key. We look at the table in figure 12, locate the intersection of the row for F5 and column AUX1 and find the number (in this case 1). Once we enter this value in CV 39 the F5key controls the output AUX1.

- Example 2: blinking light at AUX6 and F8
  We want to connect a "blinking light" to AUX6 and control it via the F8 function key. The brightness should be set to 6/15 of the maximum value. The "bright period" and the "on / off" ratio are set as described before
  First we have to activate output AUX6 and set it to "blinking". We achieve this by entering 32 (for blinking) + 5 (= 6/15 of maximum brightness) = 37 in CV 120.
  Next we assign output AUX6 to the F8 key. We enter the functions to be controlled via F8 into CV 42. Again we consult the table in figure 12, find the intersection between row F8 and column AUX6 and enter the number from the table in CV 42 (in this case 32). Now the F8 key controls the output AUX6

> Please note that sound slot 6 and AUX6 output are coupled: both the blinking light and sound, memorized in sound slot 6, are activated and can easily be modified using the LokProgrammer and a PC.

- Example 3: Deceleration on / off with F5
  Here we want to activate / deactivate the acceleration/deceleration with F5. This function represents a "logical" function and not a "physical" output and thus does not have to be configured. We only have to assign function "deactivate deceleration" to the F5 key by entering value 4 in CV 39 (see figure 12)

We recommend a PC and LokProgrammer for programming function outputs: the LoksoundXL-Decoder offers so many possible combinations that it is difficult to manage these without a computer.

5.2.4 Sound adaptation

LokSoundXL decoders offer many possibilities to adjust the sound effects. All parameters are stored in CVs that, like all others, may be modified.

Adaptation of revolutions for diesel and pitch for steam

The revolutions of a diesel motor may be modified with 2 CVs:

- Enter the revolutions of the idling diesel motor in CV 50. The standard value of 128 permits reproduction of the sound at original speed, while value 64 reduces this to half speed.
- Enter the revolutions at maximum speed in CV 51: value 255 means double the original speed.

Use the same parameters when adapting the pitch of the chuffs for steam locomotives: the interval of the chuffs should be shorter and vary in pitch with increasing speed.

Settings for diesel or electric locomotives

To simulate a diesel or electric locomotive the CVs 52 and 53 have to be set to 0.

Special settings for steam locomotives

To simulate a steam locomotive you have to synchronize the steam chuffs with the revolutions of the driving wheels. There are 2 ways:

- With an external wheel sensor
- Speed step dependent

Depending on the method selected, certain CVs have to be set accordingly. LokSoundXL is factory pre-set to speed step depend adjustment.

Using the wheel sensor

The wheel sensor must be connected as described in chapter 3.7.3 Then two more settings have to be done: set CV 52 to value 255 and enter a value $> =1$ in CV 53. CV 53 defines after how many pulses by the sensor the next steam chuff will be reproduced. Normally one chuff per pulse should be played, therefore CV 53 should read "1".

Speed step dependent method

With this method the interval between chuffs is set with CV 52 and CV 53. This method is recommended if an external wheel sensor cannot be used. The adaptation of this variable to the combination of wheel / gearbox may require some tests. It pays to spend some time in order to achieve an optimal result. This feature works best with Back EMF control. With Märklin® locomotives with universal motor (Back EMF is always switched off) only a compromise may be reached. In this case we recommend the use of an external wheel sensor.
For CV adaptation proceed as follows:

- Set CV 52 to 100 and CV 53 to 200.
- Put the locomotive onto the track and drive with speed step 1 (sound is switched on).
- Measure the time it takes in seconds for the driving wheel to do one turn at this speed.
- Divide the time by 0,04608.
- Enter a rounded value without decimal points in CV 52.
- Increase the speed and check whether the chuff-rhythm matches the turns of the drivers. If the chuff is too fast, increase the value in CV 53 gradually, if it is too slow, decrease the value in CV 53.

Adjusting the volume

The volume of LokSoundXL decoders may be adapted in 3 steps:

Enter the desired value in CV 63.

Permitted values are: 0 (quiet), 1 (medium), 2 (loud).

Random sound effects

CV 54 and CV 55 define the frequency of random sounds that are played while a steam locomotive is stationary. CV 54 contains the minimal time between 2 random sounds, CV 55 the maximum. Both represent an interval in which LokSoundXL randomly selects and plays sounds. The units of both CVs are 0.184 seconds.

Example: the minimum interval in CV 54 should be 1.5 seconds. Enter 1.5 / 0.184 = 8 into CV 54.

5.2.5 Brake sections

The LokSoundXL decoder responds to the two most commonly used brake generators, which are:

- Lenz and ROCO brake generators in DCC operation
- Märklin® brake track

As soon as the LokSoundXL decoder recognizes a brake command it brakes with a deceleration, which may be set independently. After this forced stop the locomotive begins to move again and accelerates to the previously set speed. The acceleration may be programmed separately from the standard acceleration / deceleration value (CV 61 and CV 62).

This feature is activated in CV 49.

Lenz LG100 / ROCO 10763

No settings are required. Both brake generators use the mechanisms recommended by the NMRA standards. They are always supported by LokSoundXL decoders. n.

Märklin® brake track

Instead of digital signals the Märklin® brake track supplies a DC voltage to the tracks. To activate this you must set bit 1 in CV 49.

> Do not activate the Märklin® brake track and the analogue DC operation at the same time, because the DC of the Märklin® brake track could be interpreted as analogue DC operation. With CV 29 you may switch off the analogue mode (see paragraph 7.1).

5.2.7 Reed switch inputs

***** new for version 2.0 *****

In order to activate special sound effects two inputs may be connected to reed contacts.

Typically this would be used to activate sound effects without using the command control station. If you install a magnet at a level crossing and a reed switchon the locomotive chassis, it is possible to configure the LokSoundXL decoder in such a way that every time the locomotive passes the crossing the whistle will be activated.

How to connect these reed contacts has been described in section 3.7.4. The following explains how to set the decoder for this application.

The inputs REED-IN1 and REED-IN2 share the terminals 2-7 and 2-8 with AUX5 and AUX6. Therefore you can only use either the inputs or the outputs but not both at the same time.

These inputs work as follows: If a contact is closed (by a magnet) then the effect is the same as if a function key had been pressed. For REED-IN1 this may be F5 or F9, for REED-IN2 it could be F6 or F10.

The effect you have set to be activated by the respective function key will now also be activated by the reed contact. How to allocate certain functions to specific function keys is described in section 5.2.3.

To activate REED-IN1 and REED-IN2 use CV 119 and 120. Depending on which function key should activate which input the appropriate value has to be entered in the CVs.:

Input	Key	Control-CV	Value
REED-IN1	F5	CV 119	14
REED-IN1	F9	CV 119	15
REED-IN2	F6	CV 120	14
REED-IN2	F10	CV 120	15

Fig. 13: Values for CV 119 and CV 120

Examples:

Let's assume, you want to activate a whistle via REED-IN1. The appropriate sound is stored in sound slot 1. This simulates pressing the function key F5.

Enter 14 in CV 119. Then allocate the whistle (sound slot 1) to function key F5 (respectively to REED-IN1). CV 39 controls F5 (refer to fig. 12 on page 26). To activate sound slot 1 set CV 39 to 16.

Let's assume, you want to activate the bell via REED-IN2. This sound effect is stored in sound slot 2. This simulates pressing function key F6.

Enter 14 in CV 120. Then allocate the bell (sound slot 2) to function key F6 (respectively to REED-IN2). CV 40 controls F6. To activate sound slot 2 set CV 40 to 32.

5.3 Adjusting CVs

After having been introduced to the effects controlled by CVs in paragraph 5.1 and 5.2 we now need to clarify how to set the CVs. There are 3 possibilities:

- With a PC and LokProgrammer
- With a DCC compatible digital command station (e.g. Intellibox, Lenz digital plus)
- With Märklin® 6021

Depending on the product used the procedure varies.

5.3.1 Using LokProgrammer

The LokProgrammer by ESU electronic solutions ulm GmbH offers the easiest method to modify CVs of all LokSound decoders: with a click of the mouse using MS-Windows®. The PC helps you to find the various CV numbers and values. With the LokProgrammer you can also modify the sound effects of LokSoundXL decoders and you may create your own sound effects.

You may purchase the LokProgrammer at Model Train outlets complete with detailed operating instructions.

5.3.2 Using DCC systems

There is no "one fits all" instruction for programming of CVs with various DCC systems. There are too many differences between the popular DCC systems.

Whenever possible you should use the DCC direct mode (CV programming by setting individual bytes with Uhlenbrock) or DCC paged mode.

Refer to chapter 9 "programming" of the user manual for the Intellibox. In particular read chapter 9.5 "programming of DCC decoders" very carefully. Programming should be done in the "CV-programming byte-wise" mode.

Lenz digital plus

There are various software versions available of the Lenz digital plus command station. You need firmware version 2.3 or higher in order to program LokSoundXL decoders. Contact Lenz for more details regarding upgrades of older versions.

> Use "paged CV" mode for programming. Depending on the firmware version the "CV mode" might cause problems.

Older command stations such as "Digital plus", "Lenz compact" and "Arnold Digital" create another phenomenon:

- Programming is not possible. The Lenz command station displays "err02", the Arnold command station "short circuit":

This is caused by the overload protection of the digital system, which is very sensitive. The LokSoundXL decoder with the built in audio amplifier uses a higher current than other decoders and thus activates the overload protection of the systems. To rectify this, solder a resistor with 47 ohm (0,5 Watt) in one of the two wires, connecting the digital command station with the programming track. See figure 13.

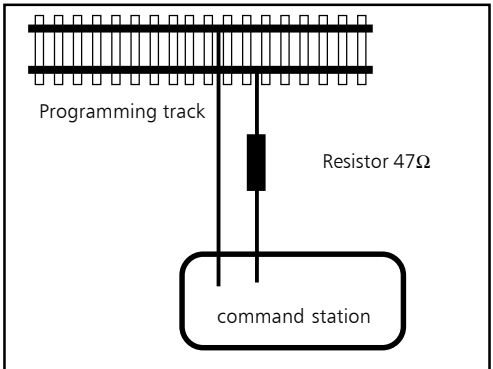


Fig. 14: Lenz command station with 47Ω resistor

5.3.3 Using Märklin® 6021

With the Märklin® command station you cannot modify standard CVs as it does not comply with the NMRA DCC standards. However, the most important CVs of LokSoundXL decoders may be changed with a specific programming mode, described as follows:

You cannot program the 6021 with the CV concept because only values from 01 to 80 may be entered with this command station. That's why we call values, which may be modified with the 6021 "registers". Each of the 64 registers responds to a DCC standard CV. Figure 14 shows a list of the register numbers and their CV numbers.

If you want to change a certain CV you have to look up the register number first in figure 14 and then modify it.
Many CVs have three digit values, however, the 6021 only allows a two digit input. The LokSoundXL decoder overcomes this problem by multiplying the entered value with a factor. The result will be memorized internally. See figure 14for the appropriate multiplier.

That means that not all functions of the LokSoundXL decoder may be adjusted with Märklin® command stations.

Programming mode of 6021

Set decoder into programming mode before entering any changes with the 6021. Only then may the register be selected and the new value entered and confirmed. Once you have modified all parameters you want to change, exit the programming mode with register "80".

Peep sounds, varying in pitch and length, indicate which mode you are currently using. That keeps you in control:

Peep sounds, varying in pitch and length, indicate the various modes of LokSoundXL decoder:

a) Register input mode (01 to 64 or 80)

• • • (short, low tones, long intervals)

b) value input mode (01 to 80)

— • • — • • — • • (combination from long / short tones, high frequency)

c) Confirmation

——— (long, high tone)

Make sure that not only the track- and motor connections are installed properly but also the speaker, since the speaker provides the acoustic signals.

- The regulator must be set to 0.
- Take all other locomotives off the track.
- Listen to the sound signals of the locomotive.

To get into programming mode:

- Press the "stop" and "go" keys simultaneously on 6021 to activate a reset (or pull the plug of the power pack).
- To switch off the track voltage, press the "stop" key.
- Enter the current decoder address (alternative "80").
- Activate the change of direction feature (turn the control knob far left until you hear a "click"), hold the knob in position and press the "go"-key.
- The LoksoundXL decoder is now in *register input mode*.
- Enter the register number you want to change. Make sure you always enter a two digit number (e.g. "01" and not "1")
- To confirm any entry turn the knob far left (change of direction feature). The decoder is now in *value input mode*.
- Now enter a new value for the register as a two digit number. Bear in mind that this value is multiplied with the factor given for each register in figure 11.

> Note that you may only enter values 01 to 80 with the 6021. Value "0" is missing, enter instead "80".

- Turn the knob far left to confirm. You hear a long, high tone.

Fig.14 register values for 6021

Register	CV	description	multiplicator
01	64	Märklin Address	1
02	2	VStart	1
03	6	VMid	4
04	5	VHigh	4
05	3	Acceleration rate	1
06	4	Deceleration rate	1
07	61	Acceleration rate signal section	1
08	62	Deceleration rate signal section	1
09	57	Load control parameter K	4
10	58	Load control parameter I	4
11	50	Sound Speed Min	4
12	51	Sound Speed Max	4
13	52	Sound Steam 1 (chuff)	4
14	53	Sound Steam 2 (chuff)	4
15	**63**	**Volume (Speaker)**	**1**
16	9	Motor PWM	1
17	56	Regulation reference	4
18	11	Packet Time-Out	4
19	60	Analogue VStart	1
20	13	Analogue Function status 1	1
21	14	Analogue Function status 2	1
22	29	Configuration data	1
23	49	Control data	1
24	33	Output location FL(f)	1
25	34	Output location FL(r)	1
26	35	Output location F1	1
27	36	Output location F2	1
28	37	Output location F3	1
29	38	Output location F4	1
30	66	Forward trim	1
31	95	Reverse trim	1
60	112	Braking sound Level	1
61	121	Flash light	1
62 - 64	113-115	Output Config Light - AUX	1
80		End of programming mode	

- The LokSoundXL decoder changes again to *register input mode*. Enter further CVs you want to modify.
- Exit the programming mode by selecting register "80" or switch the track voltage off and on (press "stop"-key and then "go"-key on 6021).

6. Frequently asked questions (FAQ)

There could be many reasons if the LokSoundXL decoder does not work properly after installation. Frequently there is no defect, only the various settings do not correspond with the respective locomotive. We list some symptoms and how to solve them:

„Lighting / sound / read and write CVs works, but the locomotive does not move."

- A short circuit in the motor or a high current draw has released the overload protection of LokSoundXL decoder.
- The motor may not be isolated from the chassis. In this case remove the motor but do not disconnect it and test the LokSoundXL decoder.
- Set the motor takt frequency from 22 kHz to 87 Hz when using universal motors (see CV 9).

„The locomotive jerks and does not run smoothly at low speed when Back EMF control is activated."

- Check if the symptoms persist when you deactivate Back EMF control (see chapter 5.2.1). If so, adjust the motor control parameters (see 5.2.1)
- Possibly the motor has not been isolated against the chassis. To eliminate this particular problem first remove the motor and then test it. If it works you have identified the cause of the problem.

  Make sure there is no electrical contact between the motor and chassis when you reinstall the motor. This is particularly important with older motors from Märklin® (ie: class 78).

„The locomotive runs, but there are no sounds."

- Check the wiring to the speaker.
- The F1 key works only with the new Motorola format when using Märklin® 6021 (see chapter 4.2.1). If this is ok, there may be damage to the speaker.

„I would like to reset the LokSoundXL decoder to factory settings. How does it work?"

- This is not an easy task because the factory settings vary depending on the purchased sound version. However, for most CV's, a default value is given in the table found in chapter 7.1
- A decoder-reset is easily possible with a PC and the LokProgrammer software.

„After installing the LokSoundXL decoder the locomotive moves in one direction at max speed while it remains stationary in the opposite direction!?"

- This is caused by an incorrect motor connection. Please refer to Fig. 2 and 4. Has the motor been connected to the right terminals? They are not located adjacent to each other, there may be inputs or outputs in between.

I have installed LokSoundXL decoders in my LGB locomotives. Why do functions F2 and higher not respond when activated with the LGB-Lokhandy?

- This problem is typical for the LGB command station and is not related to our decoder. If you press F5 for instance, then the Lokhandy transmits five times F1 on, F1 off, F1 on, etc. The LGB decoders count these pulses and subsequently switch the required function output.
- LokSoundXL decoders can „count" these pulses, but you need to enable this function first. See section 4.2.2 for further details.

„I have studied the manual, but there are still problems. What can I do?"

- If you have further questions don't hesitate to contact our service department. Contact details are listed in chapter 8, on the last page of this manual.
- If you have studied this manual but feel you don't want to proceed with the installation, esu electronic solutions ulm GmbH can offer professional help:

  Enquire at your local hobby store for the LokSound service pack: we install the decoder for you. (available in Germany only)

7. Appendix

7.1 List of all supported CVs

On the following pages you will find tables with all existing CVs.

Read about the CV concept in chapter 5.1.

> Change CVs only if you have a clear understanding of the implications. Wrong settings may damage the LokSoundXL decoder

List of all supported CVs

CV	name	description	range	default
1	Locomotive address	Address of locomotive	1 - 119	3
2	Start voltage	Sets the minimum speed of the locomotive	0 - 255	3
3	Acceleration	This value multiplied by 0.869 is the time from stop to maximum speed	0 - 63	4
4	Deceleration	This value multiplied by 0.869 is the time from maximum speed to stop	0 - 63	3
5	Maximum speed	Maximum speed of locomotive	0 - 255	63
6	Vmid	Medium speed of locomotive	0 - 255	25
7	Version number	Internal software version of LokSoundXL decoder	-	-
8	Manufacturer's ID	Manufacturer's version number (ID) of ESU	-	151
9	PWM period	Duration of PWM signal for motor control	0, 204	0
		function: value PWM frequency = 22000 Hz (recommended): 0 PWM frequency = 87 Hz (for universal motors): 204		
11	Paket timeout time	This value multiplied by 0.36864 is the time after which the locomotive stops if no DCC packet is received. Switch off with value 0.	0 - 255	0
13	Analogue mode F1-F8	Status of functions F1 to F8 in analogue mode.	0-255	0
		Bit: Function: 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		
14	Analogue mode FL, F9-F12	Status of functions FL, F9 bis F12 in analogue mode.	0-255	3
		Bit: Function: Value 0: Function FL(f): 1 1: Function FL(r): 2 2: Function F9(f): 4 3: Function F10(f): 8 4: Function F11: 16 5: Function F12: 32 6: Function F9(r): 64 7: Function F10(r): 128		

List of all supported CVs

CV	name	description	range	default
17 18	Extended locomotive address	long address of locomotive CV 17 contains byte with higher value (Bit 6 and Bit 7 must always be active), CV18 contains byte with lower value. Only active when function in CV 29 is switched on. (see below)	128 - 9999	0
19	Consist address	Additional address for consist value 0 means: consist address deactivated	0 - 127	0
23	Acceleration adaptation	Additional period of acceleration which is added to or deducted from the base value (CV 3) values from 0 - 127 are added to the base value, values > 128 are deducted. Mathematical: bit 0-6 represents the value, bit 7 indicates plus (0) or minus (1) (see DCC Standards)	0 - 255	0
24	Deceleration adaptation	Additional period of deceleration, which is added to or deducted from the base value (CV 4) values from 0 - 127 are added to the base value, values > 128 are deducted. Mathematical: bit 0-6 represents the value, bit 7 indicates plus (0) or minus (1) (see DCC Standards)	0 - 255	0
29	Configuration register	The most complex CV within the DCC standards. This register contains important information, which is only relevant in DCC operation.	-	4

Bit	function	value
0	Reverse direction of travel (forward becomes reverse)	
	normal direction reversed direction	0 1
1	speed steps (only for DCC operation)	
	14 speed steps 28 or 128 speed steps	0 2
2	analogue operation	
	analogue operation switched off analogue operation permitted	0 4
4	selection of speed curve	
	speed curve through CV 2,5, 6 speed curve through CV 67 - 96	0 16
5	selection of locoaddress (only for DCC operation)	
	short addresses (CV 1) in DCC operation long addresses (CV 17 + 18) in DCC operation	0 32

List of all supported CVs

CV	name	description	range	default
33	Function-assignmentFL(f)	Assignment of function outputs, which are activated with the "light" function (f) when driving forward	0 - 255	1

Bit	description	value
0	light output forward	1
1	light output rear	2
2	function output AUX1	4
3	function output AUX2	8
4	acceleration / deceleration off	16
5	sound on / off	32
6	sound slot 1	64
7	sound slot 2	128

CV	name	description	range	default
34	Function-assignmentFL(r)	Assignment of function outputs which are activated with the "light" function (f) when driving backwards	0 - 255	2

Bit	description	value
0	light output forward	1
1	light output rear	2
2	function output AUX1	4
3	function output AUX2	8
4	acceleration / deceleration off	16
5	sound on / off	32
6	sound slot 1	64
7	sound slot 2	128

CV	name	description	range	default
35	Function assignmentF1	Assignment of function outputs, which are activated with function key F1	0 - 255	32

Bit	description	value
0	light output forward	1
1	light output rear	2
2	function output AUX1	4
33	function output AUX2	8
4	acceleration / deceleration off	16
5	sound on / off	32
6	sound slot 1	64
7	sound slot 2	128

CV	name	description	range	default
36	Function assignment F2	Assignment of function outputs, which are activated with function key F2	0 - 255	64

Bit	description	value
0	light output forward	1
1	light output rear	2
2	function output AUX1	4
3	function output AUX2	8
4	acceleration / deceleration off	16
5	sound on / off	32
6	sound slot 1	64
7	function output AUX4 / sound slot 2	128

CV	name	description	range	default
37	Function assignment F3	Assignment of function outputs, which are activated with function key F3	0 - 255	32

Bit	description	value
0	function output AUX1	1
1	function output AUX2	2
2	acceleration / deceleration off	4
3	sound on / off	8
4	sound slot 1	16
5	sound slot 2	32
6	function output AUX3 / sound slot 3	64
7	function output AUX4 / sound slot 4	128

CV	name	description	range	default
38	Function assignment F4	Assignment of function outputs, which are activated with function key F4	0 - 255	64

Bit	description	value
0	function output AUX1	1
1	function output AUX2	2
2	acceleration / deceleration off	4
3	sound on / off	8
4	sound slot 1	16
5	sound slot 2	32
6	function output AUX3 / sound slot 3	64
7	function output AUX4 / sound slot 4	128

List of all supported CVs

CV	name	description	range	default
39	Function assignment F5	Assignment of function outputs, which are activated with function key F5	0 - 255	0

Bit	description	value
0	function output AUX1	1
1	function output AUX2	2
2	acceleration / deceleration off	4
3	sound on / off	8
4	sound slot 1	16
5	sound slot 2	32
6	function output AUX3 / sound slot 3	64
7	function output AUX4 / sound slot 4	128

CV	name	description	range	default
40	Function assignment F6	Assignment of function outputs, which are activated with function key F6	0 - 255	0

Bit	description	value
0	function output AUX1	1
1	function output AUX2	2
2	acceleration / deceleration off	4
3	sound on / off	8
4	sound slot 1	16
5	sound slot 2	32
6	function output AUX3 / sound slot 3	64
7	function output AUX4 / sound slot 4	128

CV	name	description	range	default
41	Function assignment F7	Assignment of function outputs, which are activated with function key F7	0 - 255	0

Bit	description	value
0	sound slot 1	1
1	sound slot 2	2
2	function output AUX3 / sound slot 3	4
3	function output AUX4 / sound slot 4	8
4	function output AUX5	16
5	function output AUX6	32
6	sound slot 7	64
7	sound slot 8	128

List of all supported CVs

CV	name	description	range	default
42	Function assignment F8	Assignment of function outputs, which are activated with function key F8	0 - 255	0

Bit	description	value
0	sound slot 1	1
1	sound slot 2	2
2	function output AUX3 / sound slot 3	4
3	function output AUX4 / sound slot 4	8
4	function output AUX5	16
5	function output AUX6	32
6	sound slot 7	64
7	sound slot 8	128

CV	name	description	range	default
43	Function assignment F9(f)	Assignment of function outputs, which are activated with function key F9 when driving forward	0 - 255	0

Bit	description	value
0	sound slot 1	1
1	sound slot 2	2
2	function output AUX3 / sound slot 3	4
3	function output AUX4 / sound slot 4	8
4	function output AUX5	16
5	function output AUX6	32
6	sound slot 7	64
7	sound slot 8	128

CV	name	description	range	default
44	Function assignment F10(f)	Assignment of function outputs, which are activated with function key F10	0 - 255	0

Bit	description	value
0	sound slot 1	1
1	sound slot 2	2
2	function output AUX3 / sound slot 3	4
3	function output AUX4 / sound slot 4	8
4	function output AUX5	16
5	function output AUX6	32
6	sound slot 7	64
7	sound slot 8	128

List of all supported CVs

CV	name	description	range	default
45	Function assignment F11	Assignment of function outputs, which are activated with function key F11	0 - 255	0

Bit	description	value
0	sound slot 1	1
1	sound slot 2	2
2	function output AUX3 / sound slot 3	4
3	function output AUX4 / sound slot 4	8
4	function output AUX5	16
5	function output AUX6	32
6	sound slot 7	64
7	sound slot 8	128

CV	name	description	range	default
46	Function assignment F12	Assignment of function outputs, which are activated with function key F12	0 - 255	0

Bit	description	value
0	sound slot 1	1
1	sound slot 2	2
2	function output AUX3 / sound slot 3	4
3	function output AUX4 / sound slot 4	8
4	function output AUX5	16
5	function output AUX6	32
6	sound slot 7	64
7	sound slot 8	128

CV	name	description	range	default
47	Function assignment F9(r)	Assignment of function outputs, which are activated with function key F9 when driving backwards	0 - 255	0

Bit	description	value
0	sound slot 1	1
1	sound slot 2	2
2	function output AUX3 / sound slot 3	4
3	function output AUX4 / sound slot 4	8
4	function output AUX5	16
5	function output AUX6	32
6	sound slot 7	64
7	sound slot 8	128

List of all supported CVs

<table>
<tr><th>CV</th><th>name</th><th>description</th><th>range</th><th>default</th></tr>
<tr><td>48</td><td>Function assignment F10(r)</td><td>Assignment of function outputs, which are activated with function key F9 when driving backwards
<table>
<tr><th>Bit</th><th>description</th><th>value</th></tr>
<tr><td>0</td><td>sound slot 1</td><td>1</td></tr>
<tr><td>1</td><td>sound slot 2</td><td>2</td></tr>
<tr><td>2</td><td>function output AUX3 / sound slot 3</td><td>4</td></tr>
<tr><td>3</td><td>function output AUX4 / sound slot 4</td><td>8</td></tr>
<tr><td>4</td><td>function output AUX5</td><td>16</td></tr>
<tr><td>5</td><td>function output AUX6</td><td>32</td></tr>
<tr><td>6</td><td>sound slot 7</td><td>64</td></tr>
<tr><td>7</td><td>sound slot 8</td><td>128</td></tr>
</table></td><td>0 - 255</td><td>0</td></tr>
<tr><td>49</td><td>Extended configuration</td><td>Activate support for brake track sections or switch off Back EMF control
<table>
<tr><th>Bit</th><th>description</th><th>value</th></tr>
<tr><td>0</td><td>load control activated</td><td>1</td></tr>
<tr><td>1</td><td>Märklin brake track activated</td><td>2</td></tr>
<tr><td>3</td><td>DCC Automatic Speed Step Detection activated</td><td>32</td></tr>
<tr><td>4</td><td>function key interpretation according to LGB MTS System</td><td>64</td></tr>
</table></td><td></td><td>5</td></tr>
<tr><td>50</td><td>Sound Min</td><td>Divided by 128 this will yield the factor for reproducing the sound at the slowest speed step.
values < 128 are slower, values > 128 are faster than original speed</td><td>0 - 255</td><td>128</td></tr>
<tr><td>51</td><td>Sound Max</td><td>Divided by 128 this will yield the factor for reproducing the sound at the fastest speed step.
values < 128 are slower, values > 128 are faster than original speed</td><td>0 - 255</td><td>128</td></tr>
<tr><td>52</td><td>Sound mode 1</td><td>Multiplied by 0,04608 is the time in seconds between two chuff sounds at speed step 1
value 0 deactivates steam sound and changes to diesel sound
value 255 indicates that period between chuffs is controlled by a wheel sensor</td><td>0 - 255</td><td>steam: 90
diesel: 0
electric: 0</td></tr>
<tr><td>53</td><td>Sound mode 2</td><td>Value defines the gradual decrease of intervals of chuffs with increasing speed. A higher value indicates a more rapid decrease, a lower value a slower decrease.
in diesel mode (CV 52 = 0): CV 53 = 0
If a wheel sensor is used (CV 52 = 255), then this value specifies the number of pulses needed to trigger on chuff.</td><td>0 - 255</td><td>steam: 200
diesel: 0
electric: 0</td></tr>
</table>

List of all supported CVs

CV	name	description	range	default
54	Random sound min	Multiplied by 0,18432 is the time in seconds for the shortest random sound interval. These values represent the interval between random sounds.	0 - 255	20
55	Random sound max	Multiplied by 0,18432 is the time in seconds for the longest interval between random sounds. These values represent the interval between random sounds. Playing of random sounds is deactivated when CV 53 and CV 54 = 0	0 - 255	60
56	Motor control reference	Defines the Back EMF voltage, which the motor should generate at maximum speed. The higher the efficiency, the higher this value may be set. If the locomotive does not reach maximum speed, reduce this parameter. If CV 56 is set to = 0 ist, the decoder measures the track voltage and takes a fraction of this value for the reference.	0 - 255	145
57	Load control K-segment	„K"-segment of internal PI-controller Defines the effect of load control. The higher the value, the stronger the effect of Back EMF control	0 - 255	30
58	Load control I-Segment	„I"-segment of internal PI-controller Defines momentum of motor. The higher the momentum of the motor (large flywheel or bigger diameter motor) the lower this value has to be set (see chapter 5.2.1)	0 - 255	120
60	Analogue start voltage	Start voltage of motor in analogue operation	0 - 255	25
61	Acceleration signal track	Value multiplied by 0.869 is the time from stop to maximum speed	0 - 64	8
62	Deceleration signal track	Value multiplied by 0.869 is the time from maximum speed to stop	0 - 64	4
63	sound volume	0 = low, 1 = medium, 2 = loud	0,1, 2	2

List of all supported CVs

<table>
<tr><th>CV</th><th>name</th><th>description</th><th>range</th><th>default</th></tr>
<tr><td>64</td><td>Märklin® address</td><td>Address of decoder in Motorola® operation.
The address is interpreted according to the Motorola® format. The following table shows the values, that have to be entered in CV64 to get the corresponding Märklin® address
<table>
<tr><th>address</th><th>value</th><th>address</th><th>value</th><th>address</th><th>value</th></tr>
<tr><td>1</td><td>3</td><td>28</td><td>195</td><td>55</td><td>67</td></tr>
<tr><td>2</td><td>1</td><td>29</td><td>193</td><td>56</td><td>65</td></tr>
<tr><td>3</td><td>12</td><td>30</td><td>204</td><td>57</td><td>76</td></tr>
<tr><td>4</td><td>15</td><td>31</td><td>207</td><td>58</td><td>79</td></tr>
<tr><td>5</td><td>13</td><td>32</td><td>205</td><td>59</td><td>77</td></tr>
<tr><td>6</td><td>4</td><td>33</td><td>196</td><td>60</td><td>68</td></tr>
<tr><td>7</td><td>7</td><td>34</td><td>199</td><td>61</td><td>71</td></tr>
<tr><td>8</td><td>5</td><td>35</td><td>197</td><td>62</td><td>69</td></tr>
<tr><td>9</td><td>48</td><td>36</td><td>240</td><td>63</td><td>112</td></tr>
<tr><td>10</td><td>51</td><td>37</td><td>243</td><td>64</td><td>115</td></tr>
<tr><td>11</td><td>49</td><td>38</td><td>241</td><td>65</td><td>113</td></tr>
<tr><td>12</td><td>60</td><td>39</td><td>252</td><td>66</td><td>124</td></tr>
<tr><td>13</td><td>63</td><td>40</td><td>255</td><td>67</td><td>127</td></tr>
<tr><td>14</td><td>61</td><td>41</td><td>253</td><td>68</td><td>125</td></tr>
<tr><td>15</td><td>52</td><td>42</td><td>244</td><td>69</td><td>116</td></tr>
<tr><td>16</td><td>55</td><td>43</td><td>247</td><td>70</td><td>119</td></tr>
<tr><td>17</td><td>53</td><td>44</td><td>245</td><td>71</td><td>117</td></tr>
<tr><td>18</td><td>16</td><td>45</td><td>208</td><td>72</td><td>80</td></tr>
<tr><td>19</td><td>19</td><td>46</td><td>211</td><td>73</td><td>83</td></tr>
<tr><td>20</td><td>17</td><td>47</td><td>209</td><td>74</td><td>81</td></tr>
<tr><td>21</td><td>28</td><td>48</td><td>220</td><td>75</td><td>92</td></tr>
<tr><td>22</td><td>31</td><td>49</td><td>223</td><td>76</td><td>95</td></tr>
<tr><td>23</td><td>29</td><td>50</td><td>221</td><td>77</td><td>93</td></tr>
<tr><td>24</td><td>20</td><td>51</td><td>212</td><td>78</td><td>84</td></tr>
<tr><td>25</td><td>23</td><td>52</td><td>215</td><td>79</td><td>87</td></tr>
<tr><td>26</td><td>21</td><td>53</td><td>213</td><td>80</td><td>85</td></tr>
<tr><td>27</td><td>192</td><td>54</td><td>64</td><td></td><td></td></tr>
</table>
You don't need above table if you want to change the address with Märklin® 6021 (see 5.3.3):
Enter desired address directly and the decoder will do the rest.</td><td>0 - 255</td><td>12</td></tr>
<tr><td>66</td><td>Forward trim</td><td>Divided by 128 is the factor used to multiply the motor voltage when driving forward.

Value 0 deactivates the trim</td><td>0 - 255</td><td>0</td></tr>
<tr><td>67-94</td><td>Speed Table</td><td>Defines motor voltage for speed steps.
The values "in between" will be interpolated.</td><td>0 - 255</td><td>---</td></tr>
<tr><td>95</td><td>Reverse trim</td><td>Divided by 128 is the factor used to multiply the motor voltage when driving backwards.

Value 0 deactivates the trim</td><td>0 - 255</td><td>0</td></tr>
</table>

List of all supported CVs

<table>
<tr><th>CV</th><th>name</th><th>description</th><th>range</th><th>default</th></tr>
<tr><td>105
106</td><td>User ID</td><td>Available to the user for any data</td><td>0 - 255</td><td>0</td></tr>
<tr><td>112</td><td>Brake sound threshold</td><td>Specifies when the decoder starts the braking noises. The higher the value, the sooner it will start.

If CV 112 = 0, the sound is only played once the locomotive has stopped.</td><td>0 - 255</td><td>0 / 12</td></tr>
<tr><td>113</td><td>Output configuration forward light</td><td>Specifies function of output forward light
<table><tr><th>Bit</th><th>function</th><th>value</th></tr><tr><td>-</td><td>Output switched off</td><td>0</td></tr><tr><td>-</td><td>Output as dimmer (normal)</td><td>Vol + 16</td></tr><tr><td>-</td><td>Output as blinking light</td><td>Vol + 32</td></tr><tr><td>-</td><td>Output is blinking light reversed</td><td>Vol + 48</td></tr></table>Add values of brightness (= Vol) to the values above. Permitted values are 0 (very dark) to 15 (very bright)</td><td>0 - 255</td><td>31</td></tr>
<tr><td>114</td><td>Output configuration rear light</td><td>Specifies function of output rear light
<table><tr><th>Bit</th><th>function</th><th>value</th></tr><tr><td>-</td><td>Output switched off</td><td>0</td></tr><tr><td>-</td><td>Output as dimmer (normal)</td><td>Vol + 16</td></tr><tr><td>-</td><td>Output as blinking light</td><td>Vol + 32</td></tr><tr><td>-</td><td>Output is blinking light reversed</td><td>Vol + 48</td></tr></table>Add values of brightness (= Vol) to the values above. Permitted values are 0 (very dark) to 15 (very bright)</td><td>0 - 255</td><td>31</td></tr>
<tr><td>115</td><td>Output configuration AUX1</td><td>Specifies function of output AUX1
<table><tr><th>Bit</th><th>function</th><th>value</th></tr><tr><td>-</td><td>Output switched off</td><td>0</td></tr><tr><td>-</td><td>Output as dimmer (normal)</td><td>Vol + 16</td></tr><tr><td>-</td><td>Output as blinking light</td><td>Vol + 32</td></tr><tr><td>-</td><td>Output is blinking light reversed</td><td>Vol + 48</td></tr></table>Add values of brightness (= Vol) to the values above. Permitted values are 0 (very dark) to 15 (very bright)</td><td>0 - 255</td><td>31</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table>

List of all supported CVs

CV	name	description	range	default
116	Output configuration AUX2	Specifies function of output AUX2 Bit: - function: Output switched off — value: 0 Bit: - function: Output as dimmer (normal) — value: Vol + 16 Bit: - function: Output as blinking light — value: Vol + 32 Bit: - function: Output is blinking light reversed — value: Vol + 48 Add values of brightness (= Vol) to the values above. Permitted values are 0 (very dark) to 15 (very bright)	0 - 255	31
117	Output configuration AUX3	Specifies function of output AUX3 Bit: - function: Output switched off — value: 0 Bit: - function: Output as dimmer (normal) — value: Vol + 16 Bit: - function: Output as blinking light — value: Vol + 32 Bit: - function: Output is blinking light reversed — value: Vol + 48 Add values of brightness (= Vol) to the values above. Permitted values are 0 (very dark) to 15 (very bright)	0 - 255	31
118	Output configuration AUX4	Specifies function of output AUX4 Bit: - function: Output switched off — value: 0 Bit: - function: Output as dimmer (normal) — value: Vol + 16 Bit: - function: Output as blinking light — value: Vol + 32 Bit: - function: Output is blinking light reversed — value: Vol + 48 Add values of brightness (= Vol) to the values above. Permitted values are 0 (very dark) to 15 (very bright)	0 - 255	31
119	Output configuration AUX5	Specifies function of output AUX5 Bit: - function: Output switched off — value: 0 Bit: - function: Output as dimmer (normal) — value: Vol + 16 Bit: - function: Output as blinking light — value: Vol + 32 Bit: - function: Output is blinking light reversed — value: Vol + 48 Add values of brightness (= Vol) to the values above. Permitted values are 0 (very dark) to 15 (very bright)	0 - 255	31

List of all supported CVs

<table>
<tr><th>CV</th><th>name</th><th>description</th><th>range</th><th>default</th></tr>
<tr><td>120</td><td>Output configuration AUX2</td><td>Specifies function of output AUX6
<table><tr><td>Bit</td><td>function</td><td>value</td></tr><tr><td>-</td><td>Output switched off</td><td>0</td></tr><tr><td>-</td><td>Output as dimmer (normal)</td><td>Vol + 16</td></tr><tr><td>-</td><td>Output as blinking light</td><td>Vol + 32</td></tr><tr><td>-</td><td>Output is blinking light reversed</td><td>Vol + 48</td></tr></table>Add values of brightness (= Vol) to the values above.
Permitted values are 0 (very dark) to 15 (very bright)</td><td>0 - 255</td><td>31</td></tr>
<tr><td>121</td><td>Blinking light</td><td>Specifies the duration of the "bright period" and the on/off ratio of outputs, which are set to blinking
<table><tr><td>Bit</td><td>function</td><td>value</td></tr><tr><td>0-3</td><td>On / Off ratio</td><td>0 - 15</td></tr><tr><td>4-7</td><td>PWM period time</td><td>16 - 240</td></tr></table>The PWM period time is a multiple of 0.18432 seconds.</td><td>0 - 255</td><td>0</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td></tr>
</table>

7.2 Technical data

Dimensions:	44 mm x 40 mm x 6,5mm
Layout:	Double-sided PCB with SMD-technology. Connection of all functions with screw terminals
Operating voltage:	5 to 25 V / pulse for change of direction 32 Volts
Supported protocols:	DCC / NMRA-standard wth 14, 28, 128 speed steps Märklin® / Motorola® (old and new) 2- and 4-digit addresses Märklin® and Lenz LG100 braking modules Analogue DC and AC operation possible Operations Mode Programming, F1 to F12
Motor control:	max load 3.0 A Suitable for DC-, AC- and coreless motors (auto detect feature) 22 kHz PWM frequency - quiet, smooth motor control overload protoection of motor output, Back EMF control (may be switched off)
Function outputs:	8 Outputs, 2 of which may be used for light functions 600 mA load per output. Total current of 2 Amp. for all function output. Overload protection for all function outputs
Sound part:	two independent channels High performance amplifier, ~ 3 Watts Sound data can be modified in flash memory

8. Service-Support and assistance

Your model train or hobby shop is your competent partner for all your questions regarding LokSoundXL decoders.

You may also contact us directly. For enquiries please use either email or fax (don't forget to provide your own fax-no.) 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 you may encounter delays. Also check our website for more information. You will find many hints regarding FAQ and even feed back from other users.

by phone:	++49 (0)700 - LOKSOUND
	++49 (0)700 - 56576863
	Tue from 10am to 12am Wed from 10am to 12am
by Fax :	++49 (0)7043 - 90 75 36
by email:	**support@loksound.de**
by mail:	ESU electronic solutions ulm GmbH - technischer Support - Am Tiefen See 5 **D-75433 Maulbronn**
Internet:	**www.loksound.de**

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