

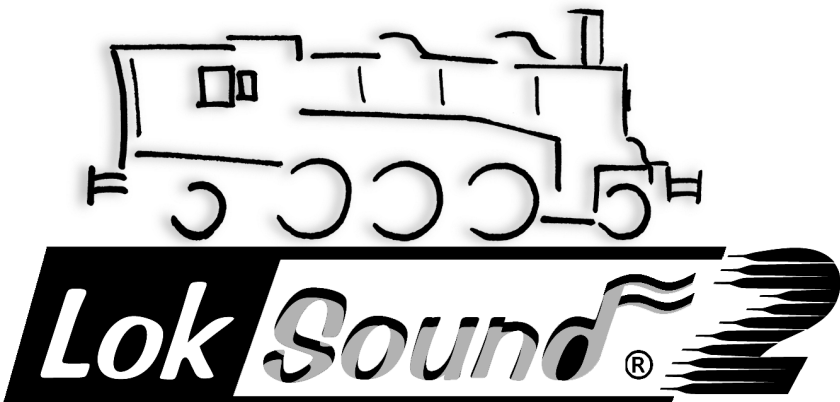


**Electronic Solutions Ulm**

# **User Manual**

## **LokSound2**

**Version 1.0**  
**January 2002**



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### 1. Introduction

Congratulations on your acquisition of a LokSound2 decoder. With LokSound2 your locomotives may finally sound like the prototype. You will soon notice that your LokSound2 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 LokSound2 decoders are very robust, incorrect connection may destroy the module!

#### **Important Warning:**

- LokSound2 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
- Don't remove the heat shrink sleeve on the decoder
- Never solder on the circuit board, extend cables if necessary
- 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 LokSound2 decoder.

This manual has several chapters. Chapter 2 is an overview of the characteristics of LokSound2 decoder. Chapter 3 is about installing and connecting. Chapter 4 deals with operational functions of the LokSound2 decoder. This chapter provides information how programming parameters must be modified in order to get certain functions. The fifth 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 LokSound2 decoder

The LokSound2 decoder is a universal electronic module for installation in model locomotives of gauges TT, H0 and 0. LokSound2 is the improved version of LokSound and combines two components that had to be acquired separately in the past:

- A full-feature digital decoder with outstanding characteristics:

*Multi-protocol operation:* LokSound2 decoder understand both, the common Märklin® / Motorola® - format and the format of NMRA/DCC-system. Thus LokSound2 may be used with almost all presently available modern digital systems. LokSound2 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 motors (e.g. Bühler, Mabuchi)
- Coreless motors (e.g. Faulhaber, Maxxon)
- Alternating current 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 LokSound2 decoder without problem.

*Motor regulation:* LokSound2 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.

*Three function outputs:* In addition to the two lighting outputs, another function output is 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! With blinking light effects and individually dimmable lamps your trains look real and give you a lot of enjoyment.

*Brake tracks:* LokSound2 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.

Please make sure that you adhere to the maximum permitted current for the function outputs and avoid short circuits between the outputs: the LokSound2 is protected. In case of overload the outputs will be destroyed.

*Analogue operation:* LokSound2 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:* LokSound2 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 LokSound2

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 LokSound2 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 LokSound2 decoder has 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.

The decoder gets very warm during operation. Never pack the LokSound2 decoder in foam material. This impedes air circulation and causes overheating.

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.

### 3.2 Locomotives with NEM interface

The LokSound2 decoder comes with a NEM650/652 (NMRA S9.1/9.2) digital connector (see fig. 1). The installation is therefore particularly easy:

- Remove the body shell. Follow the instructions in the locomotive manual!
- Remove the connector plate or directional relay that is supplied with the locomotive. Please keep the plug / relay for future use.
- Insert the connector plug with pin 1 (the side with the red/orange wire) into the side of the connector which is usually marked with \*, +, • or 1. Take care not to bend any pins. Do not rely on the assumption that the wires have to lead in a certain direction the marking is the only valid reference.
- Place the decoder in a suitable location within the locomotive and fasten it with double sided tape or a drop of glue.
- Now fix the speaker in a suitable place. See chapter 3.4 for details

### 3.3 Locomotives without DCC Interface

Not every locomotive has a digital connector and the wiring becomes more elaborate:

Disconnect existing wires within the locomotive and any connection to the chassis. Both motor contacts must be isolated, make sure there isn't any connection to the chassis, the wheels or the pantographs. This may easily be overlooked particularly in Fleischmann models.

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

How to proceed depends very much on how the light and special functions are wired in the locomotive.

- If directional headlights and functions are isolated from the locomotive body proceed as per figure 2.
- Directional headlights and functions may be connected with their common to the track voltage (e.g. almost all Märklin® -locomotives and older Fleischmann or ROCO locomotives) as per figure 3.

Don't get confused by the fact that both figure 2 and 3 show how to wire a DC or a coreless motor.

Figure 5 shows the connection of a Märklin® motor.

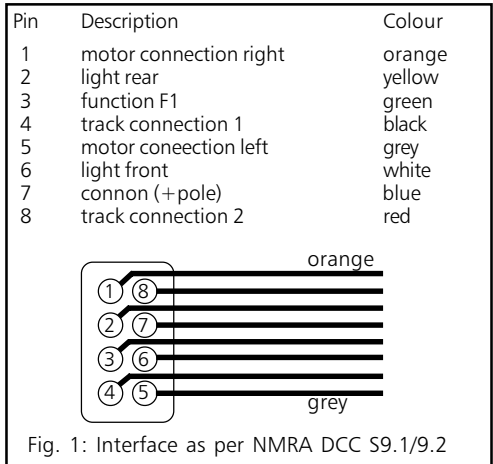


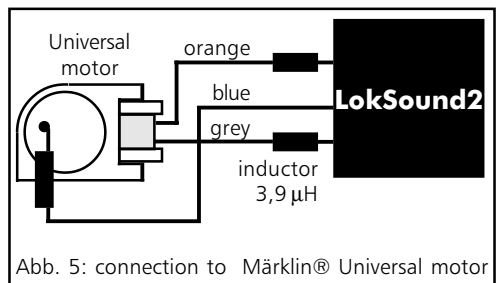
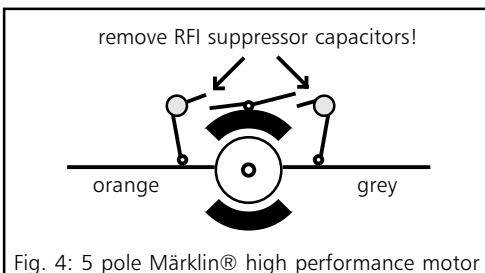
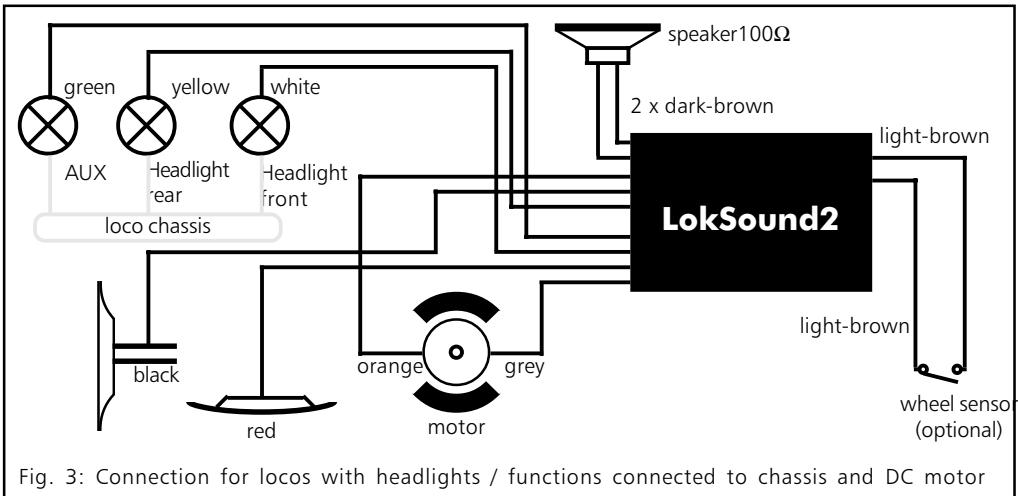
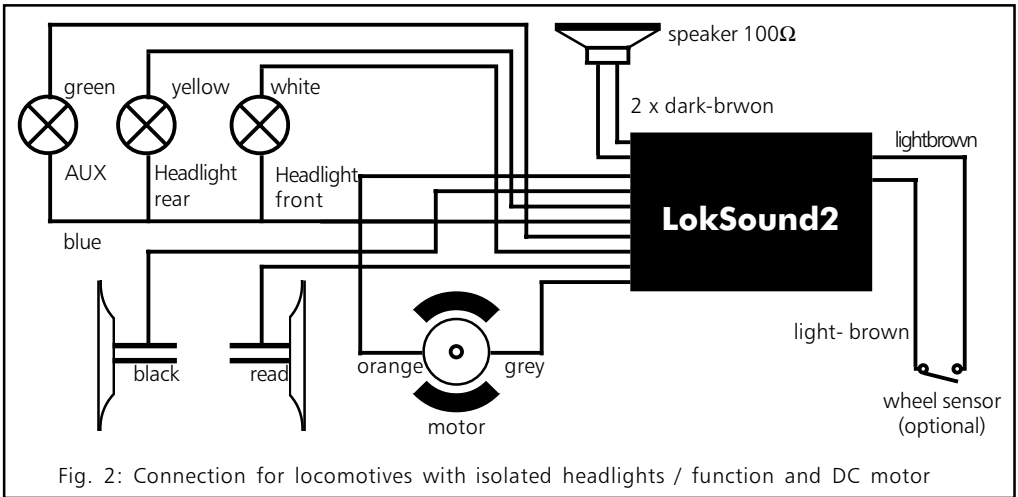
Fig. 1: Interface as per NMRA DCC S9.1/9.2

- Connect the red wire to the right rail pickup (or center pick up in AC models)
- the black wire to the left rail pickup (common rails in AC models).
- Solder the rear headlights to the yellow wire, the front headlights to the white wire.
- Connect the green wire to the function output AUX. Allocate the function key later.
- Solder the speaker to the two dark-brown wires.
- The wheel sensor for synchronizing the steam chuff sounds may be connected to the light-brown wire. Important: the other contact must be connected to the other light-brown wire.
- If directional headlights and functions are isolated from the chassis (see figure 2) connect all commons to the blue wire. Make sure the blue wire has no contact to the locomotive chassis.

#### 3.3.1 Connecting DC motors

- Connect the orange wire with the motor terminal, which was originally wired to the right wheel pick up (center pick up slip in AC models).
- The grey wire goes to the terminal, which was originally connected to the left rail (common rails for AC models).
- Exchanging both wires changes direction of travel.
- Some Locomotives with the Märklin® 5-pole high performance drive may have 3 RFI suppressors directly soldered to the motor.

## Connection diagrams



The two suppressors that connect the motor terminals with the motor chassis must be removed (see figure 4).

### 3.3.2 Connecting a universal motor

Figure 5 shows how a universal motor (e.g. AC motor by Märklin®) is connected to the LokSound2 decoder:

- Connect the orange wire with the motor terminal that was originally connected with the center pick up.
- Connect the grey wire to the motor terminal that was originally connected to the common / wheel pick up.
- Exchanging both wires will change direction of travel.
- Solder 2 inductivities with at least  $3,9 \mu\text{H}$  to the motor terminals. You may order these as spare parts from Märklin® under article number 516520.
- The RFI suppression inductor remains attached to the collector terminal of the motor and has to be soldered to the blue wire.

For optimal operation the motor PWM frequency has to be reduced from 22kHz to 87Hz. To achieve this set CV 9 to value 204 (see chapter 5).

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.

### 3.4 Connecting the speaker

The LokSound 2 decoder may only be used with the speakers offered by ESU electronic solutions ulm GmbH. They have an impedance of 100 Ohm. The use of speakers by others may cause considerable distortion and in extreme cases even destroy the LokSound2 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.

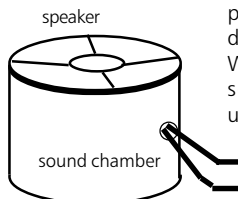
Connect the speaker to the 2 dark brown wires of the LokSound module. Make sure that you use a small soldering iron (max. 20 W) and only heat the marked spot as shown in the figure (close to the edge of the small contact plate). Polarity is not important.



An optimal sound effect is achieved by putting the speaker into a sound chamber.

A sound chamber is supplied with each 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.



### 3.5 Connecting the auxiliary functions

Any load may be connected to the light and function outputs as long as it doesn't exceed the maximum current (see technical data in the appendix of this manual). Note that the overload protection of the decoder reacts quickly and will switch off all functions immediately in case of an overload or short circuit.

Therefore use only 16 V bulbs or higher and a maximum nominal current of 50mA: Incandescent lamps have a high starting current and this may activate the overload protection of the decoder when bulbs are switched on.

Use only digital smoke generators (e.g. Seuthe No. 11) for locomotives whose light and function outputs are connected as shown in figure 2. All other smoke generators require too much current. There are smoke generators with more than 250mA nominal current.

Locomotives that are connected as shown in figure 3 needs an analogue smoke generator e.g. Seuthe No. 10.

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 LokSound2 decoders are protected high voltage on the terminals or a short circuit may cause damage.

### 3.6 Connecting a wheel sensor

To synchronize the steam chuff an external sensor may (but does not have to be) used. The sensor input is the light brown wire on the LokSound2 decoder.

The LokSound2 decoder supports reed switches or mechanical contacts.

If a reed switch 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 switch 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.

All double pole (mechanical) contacts that are isolated (not connected to the chassis) may be used.

Before the wheel sensor can function various CVs have to be programmed. See chapter 5.2.4 on page ??.

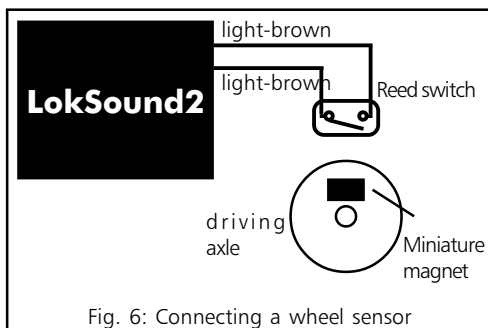


Fig. 6: Connecting a wheel sensor

### 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 LokSound2 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 LokSound2 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?

If the LokSound2 decoder was built into a locomotive with DCC interface: check if the DCC connector is plugged in correctly.



### 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 LokSound2 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 LokSound2 decoder may be used with all Märklin® products or compatible systems.

The functions F1 to F4 only 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.

LokSound2 may be operated with any DCC compatible system. However, the DCC protocol has some drawbacks, one of which happens so frequently that we want to mention it right here:

#### Lights do not work with DCC systems

DCC locomotives may be set for 14, 28 or 128 speed steps. LokSound 2 provides all 3 alternatives, but the decoder "needs to know" which number of speed steps has been set in the DCC controller for this particular address.

The DCC command center too has to manage the desired mode. Not all command stations implement all speed modes: The Intellibox e.g. offers all 3 variants, whereas Lenz Digital plus V2.x only manages 14 or 28 speed steps. As from Lenz Digital plus V3.0 all 3 variants are available.

The LokSound2 decoder is pre-set to 14 speed step mode.

Thus the DCC command station must be set to 14 speed steps. Some command stations may be set to operate every locomotive with 28 (e.g. ZIMO) or with 128 (e.g. Intellibox) speed steps. In other words: the settings between LokSound2 and command station may not match. This leads to the following difficulties:

- Lights cannot be switched via F0
- Lights turn on and off, and on and off again (depending on the speed step).

This can easily be fixed: Simply set the speed steps of the decoders and the command station to the same value. There are two ways to do this:

a) Make sure the command station knows that the locomotive is operated with 14 speed steps. With Intellibox e.g. you first call up the locomotive with one of the controllers (press "Locomotive"-key, enter address, press "Enter") and then press the "Locomotive" and "Menu" keys. Now press and hold the "arrow down" key until the display show "DCC 14 speed steps". After pressing the "enter" key the locomotive will be operated with 14 speed steps and the lights work as desired.

For other DCC systems please consult the user manual for information on how to adjust the speed steps.

b) Set the LokSound2 decoder to the desired mode. Owners of ZIMO command stations may desire to operate the LokSound2 decoder with 28 speed steps like all other locomotives. In that case you have to change a register (CV29) in the LokSound2 decoder (see chapter 5).

### 5. Adjusting decoder parameters

Chapter 5 provides information on how to change the settings of LokSound2 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 LokSound2 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 LokSound2 decoders

LokSound2 decoders are compatible with the NRMA / DCC standard. That means, that all parameters which change the properties of LokSound2 decoders, are stored in so called CVs (Configuration Variables). LokSound2 decoders support 121 variables. This large number of CVs shows the multitude of possibilities available with LokSound2 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 LokSound2

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 LokSound2 decoder.

##### 5.2.1 Back EMF control (load control)

The LokSound2 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  $16 \text{ V} * 75 \% = 12 \text{ V}$ , 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 ( $12 \text{ V} * 10$ ) 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 LokSound2 decoder will find a value, from track voltage and an assumed efficiency, which is acceptable for ROCO, Brawa, Mehano, Liliput and Kato Locomotives

The internal PI-control of LokSound2 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.

LokSound2 decoders are factory pre-set for the use with ROCO-, Brawa- or Kato motors.

- 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 LokSound2 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. 80. 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 Fleischmann motors

Locomotives with the traditional Fleischmann motor should be programmed as follows:

CV 57 = ca. 80 - 120  
CV 58 = 20

### Parameter for Märklin® High performance motor

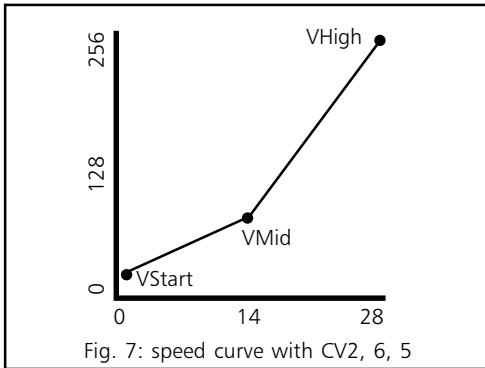
The 5-pole high performance motor from Märklin® (series 37xxx) is best suited for the LokSound2 decoder when programmed as follows:

CV 57 = ca 80 - 110  
CV 58 = 38

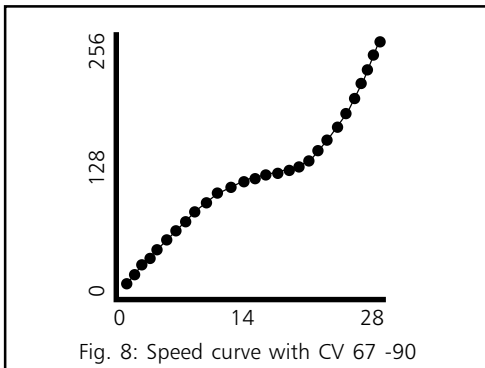
### 5.2.2 Speed Curve

LokSound2 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 7). 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).



You may also define an individual speed curve: store the speed curve values in CVs 67 to 94 (as per figure 8). Those 28 values will determine the 256 speed steps. This method permits to optimize the driving performance. This mode is also activated via CV 29. We recommend the use of the ESU LokProgrammer with software for easy calculation and programming.



### 5.2.3 Function outputs

LokSound2 decoder has 3 physical function outputs, two for directional lighting, one for an auxiliary load.

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

In addition the functions "sound module on / off" and "acceleration on / off" are available. The latter function

turns off the acceleration- and deceleration rate 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 9 shows the different possible combinations and also the ex-factory setting.

Please note:

- Some function keys are linked to direction of travel.
- Possibly not all function keys are available on your DCC command station.
- Each of the 3 function outputs must be turned on or off separately.

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:

- *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).

There is a CV (CV 113, 114, 115) for each output, in which the desired mode may be stored. Please note that you may deactivate each output with "0" if not needed.

The light outputs are factory pre-set to "on". This is also true for the AUX output for steam locomotives, which may be controlled with the light key.

### Dimming of lamps

With LokSound2 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, 114, 115) 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 AUX and F5.

Let's assume you want to control a smoke generator with function key F5 that should be connected to output AUX. Please refer to the installation instructions in chapter 2.5. The output AUX 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 AUX (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 AUX: see figure 9: 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 9, locate the intersection of the row for F5 and column AUX and find the number (in this case 1). Once we enter this value in CV 39 the F5key controls the output AUX.

#### • Example 2: blinking light at AUX and F6.

We want to connect a "blinking light" to AUX and control it via the F6 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 in paragraph 5.2.3.3.

First we have to activate output AUX and set it to "blinking". We achieve this by entering 32 (for blinking) + 5 (= 6/15 of maximum brightness) = 37 in CV 115.

Next we assign output AUX to the F6 key. We enter the functions to be controlled via F6 into CV 40. Again we consult the table in figure 9, find the intersection between row F6 and column AUX and enter the number from the table in CV 40 (in this case 1). Now the F6 key controls the output AUX.

#### • 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 9)

We recommend a PC and LokProgrammer for programming function outputs: the Loksound2 decoder offers so many possible combinations that it is difficult to manage these without a computer.

### 5.2.4 Sound adaptation

LokSound2 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.

Function key	Description	Control-CV	Output "light forward"	Output "light rear"	Output "AUX" (green)		Soundslot 1	Soundslot 2	Soundslot 3	Soundslot 4	Soundslot 5	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		

### 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. LokSound2 is factory pre-set to speed step depend adjustment.

### Using the wheel sensor

The wheel sensor must be connected as described in chapter 3.6. Then two more settings have to be done: set CV 52 to value 255 and enter a value  $\geq 1$  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 LokSound2 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 LokSound2 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 LokSound2 decoder responds to the two most commonly used brake generators, which are:

- Lenz-brake generator in DCC operation
- Märklin® brake track

As soon as the LokSound2 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).

This feature is activated in CV 49.

### Lenz brake generator LG100

No settings are required. The Lenz brake generator LG 100 uses the mechanisms recommended by the NMRA standards. It is always supported by LokSound2 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).

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 LokSound2 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 10.

### 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 LokSound2 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 LokSound2 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 LokSound2

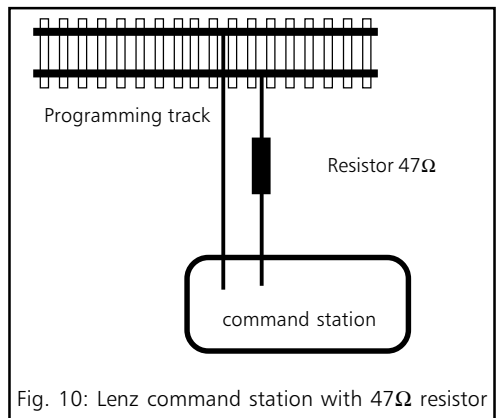


Fig. 10: Lenz command station with 47Ω resistor

#### 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 LokSound2 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 11 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 11 and then modify it.

Many CVs have three digit values, however, the 6021 only allows a two digit input. The LokSound2 decoder overcomes this problem by multiplying the entered value with a factor. The result will be memorized internally. See figure 11 for the appropriate multiplier.

That means that not all functions of the LokSound2 decoder may be adjusted with Märklin® command stations.

**Abb.11: register values for 6021**

Register	CV	description	multiplier
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	

### 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:

Verschieden lange und hohe Töne zeigen die verschiedenen Modi des LokSound2-Decoders an:

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 Loksound2 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.
- The LokSound2 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 LokSound2 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 LokSound2 decoder.
- The motor may not be isolated from the chassis. In this case remove the motor but do not disconnect it and test the LokSound2 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)

„The locomotive runs perfectly, but there are no sound.“

- 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.

„The locomotive runs perfectly, but the light does not work or switches on - off - on with each speed step.“

- Check if the plug was inserted correctly when operating a locomotive with NMRA interface (see chapter 3.2).
- If you are using DCC, refer to chapter 4.2.2 for problem solving.

„I would like to reset the LokSound2 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.

A decoder-reset is easily possible with a PC and the LokProgrammer software.

„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 LokSound2 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 LokSound2 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) PWM frequency = 87 Hz (for universal motors)	0 204			
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			0
			reversed direction			1
		1	speed steps (only for DCC operation)			
			14 speed steps			0
			28 or 128 speed steps			2
		2	analogue operation			
			analogue operation switched off			0
			analogue operation permitted			4
		4	selection of speed curve			
			speed curve through CV 2,5, 6			0
			speed curve through CV 67 - 96			16
		5	selection of locoaddress (only for DCC operation)			
			short addresses (CV 1) in DCC operation	0		
			long addresses (CV 17 + 18) in DCC operation	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 AUX	4	
		4	acceleration / deceleration off	16	
		5	sound on / off	32	
		6	sound slot 1	64	
		7	sound slot 2	128	
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 AUX	4	
		4	acceleration / deceleration off	16	
		5	sound on / off	32	
		6	sound slot 1	64	
		7	sound slot 2	128	
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 AUX	4	
		4	acceleration / deceleration off	16	
		5	sound on / off	32	
		6	sound slot 1	64	
		7	sound slot 2	128	

### List of all supported CVs

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		
		0	light output forward		
		1	light output rear		
		2	function output AUX		
		4	acceleration / deceleration off		
		5	sound on / off		
		6	sound slot 1		
		7	sound slot 2		
37	Function assignment F3	Assignment of function outputs, which are activated with function key F3		0 - 255	32
		Bit	description		
		0	function output AUX		
		2	acceleration / deceleration off		
		3	sound on / off		
		4	sound slot 1		
		5	sound slot 2		
		6	sound slot 3		
		7	sound slot 4		
38	Function assignment F4	Assignment of function outputs, which are activated with function key F4		0 - 255	64
		Bit	description		
		0	function output AUX		
		2	acceleration / deceleration off		
		3	sound on / off		
		4	sound slot 1		
		5	sound slot 2		
		6	sound slot 3		
		7	sound slot 4		

### 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 AUX	1	
		2	acceleration / deceleration off	4	
		3	sound on / off	8	
		4	sound slot 1	16	
		5	sound slot 2	32	
		6	sound slot 3	64	
		7	sound slot 4	128	
40	Function assignment F6	Assignment of function outputs, which are activated with function key F6		0 - 255	0
		Bit	description	value	
		0	function output AUX	1	
		2	acceleration / deceleration off	4	
		3	sound on / off	8	
		4	sound slot 1	16	
		5	sound slot 2	32	
		6	sound slot 3	64	
		7	sound slot 4	128	
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	sound slot 3	4	
		3	sound slot 4	8	
		4	sound slot 5	16	
		5	sound slot 6	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		
		0	sound slot 1		
		1	sound slot 2		
		2	sound slot 3		
		3	sound slot 4		
		4	sound slot 5		
		5	sound slot 6		
		6	sound slot 7		
		7	sound slot 8		
43	Function assignment F9(f)	Assignment of function outputs, which are activated with function key F9 when driving forward		0 - 255	0
		Bit	description		
		0	sound slot 1		
		1	sound slot 2		
		2	sound slot 3		
		3	sound slot 4		
		4	sound slot 5		
		5	sound slot 6		
		6	sound slot 7		
		7	sound slot 8		
44	Function assignment F10(f)	Assignment of function outputs, which are activated with function key F10		0 - 255	0
		Bit	description		
		0	sound slot 1		
		1	sound slot 2		
		2	sound slot 3		
		3	sound slot 4		
		4	sound slot 5		
		5	sound slot 6		
		6	sound slot 7		
		7	sound slot 8		



### 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		
		0	sound slot 1		
		1	sound slot 2		
		2	sound slot 3		
		3	sound slot 4		
		4	sound slot 5		
		5	sound slot 6		
		6	sound slot 7		
		7	sound slot 8		
46	Function assignment F12	Assignment of function outputs, which are activated with function key F12		0 - 255	0
		Bit	description		
		0	sound slot 1		
		1	sound slot 2		
		2	sound slot 3		
		3	sound slot 4		
		4	sound slot 5		
		5	sound slot 6		
		6	sound slot 7		
		7	sound slot 8		
47	Function assignment F9(r)	Assignment of function outputs, which are activated with function key F9 when driving backwards		0 - 255	0
		Bit	description		
		0	sound slot 1		
		1	sound slot 2		
		2	sound slot 3		
		3	sound slot 4		
		4	sound slot 5		
		5	sound slot 6		
		6	sound slot 7		
		7	sound slot 8		

## List of all supported CVs

CV	name	description	range	default
48	Function assignment F10(r)	Assignment of function outputs, which are activated with function key F9 when driving backwards	0 - 255	0
		Bit description		
		0 sound slot 1		
		1 sound slot 2		
		2 sound slot 3		
		3 sound slot 4		
		4 sound slot 5		
		5 sound slot 6		
		6 sound slot 7		
		7 sound slot 8		
49	Extended configuration	Activate support for brake track sections or switch off Back EMF control		5
		Bit description		
		0 load control activated		
		1 Märklin brake track activated		
50	Sound Min	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	0 - 255	128
51	Sound Max	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	0 - 255	128
52	Sound mode 1	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	0 - 255	steam: 90 diesel: 0 electric: 0
53	Sound mode 2	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.	0 - 255	steam: 200 diesel: 0 electric: 0

### 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	0
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	80
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	63
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

CV	name	description			range	default																																																																																																																																																																																																
64	Märklin® address	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			0 - 255	12																																																																																																																																																																																																
		<table><tr><td>address</td><td>value</td><td>address</td><td>value</td><td>address</td><td>value</td></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><tr><td colspan="3">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></tr><tr><td>66</td><td>Forward trim</td><td colspan="3">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 colspan="3">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 colspan="3">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>					address	value	address	value	address	value	1	3	28	195	55	67	2	1	29	193	56	65	3	12	30	204	57	76	4	15	31	207	58	79	5	13	32	205	59	77	6	4	33	196	60	68	7	7	34	199	61	71	8	5	35	197	62	69	9	48	36	240	63	112	10	51	37	243	64	115	11	49	38	241	65	113	12	60	39	252	66	124	13	63	40	255	67	127	14	61	41	253	68	125	15	52	42	244	69	116	16	55	43	247	70	119	17	53	44	245	71	117	18	16	45	208	72	80	19	19	46	211	73	83	20	17	47	209	74	81	21	28	48	220	75	92	22	31	49	223	76	95	23	29	50	221	77	93	24	20	51	212	78	84	25	23	52	215	79	87	26	21	53	213	80	85	27	192	54	64			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.			66	Forward trim	Divided by 128 is the factor used to multiply the motor voltage when driving forward.  Value 0 deactivates the trim			0 - 255	0	67-94	Speed Table	Defines motor voltage for speed steps. The values "in between" will be interpolated.			0 - 255	---	95	Reverse trim	Divided by 128 is the factor used to multiply the motor voltage when driving backwards.  Value 0 deactivates the trim			0 - 255	0
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## List of all supported CVs

CV	name	description		range	default	
105 106	User ID	Available to the user for any data		0 - 255	0	
112	Brake sound threshold	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.		0 - 255	0 / 12	
113	Output configuration forward light	Specifies function of output forward light		0 - 255	31	
		Bit	function			value
		-	Output switched off			0
		-	Output as dimmer (normal)			Vol + 16
		-	Output as blinking light			Vol + 32
		-	Output is blinking light reversed			Vol + 48
		Add values of brightness (= Vol) to the values above. Permitted values are 0 (very dark) to 15 (very bright)				
114	Output configuration rear light	Specifies function of output rear light		0 - 255	31	
		Bit	function			value
		-	Output switched off			0
		-	Output as dimmer (normal)			Vol + 16
		-	Output as blinking light			Vol + 32
		-	Output is blinking light reversed			Vol + 48
		Add values of brightness (= Vol) to the values above. Permitted values are 0 (very dark) to 15 (very bright)				
115	Output configuration AUX	Specifies function of output AUX		0 - 255	31	
		Bit	function			value
		-	Output switched off			0
		-	Output as dimmer (normal)			Vol + 16
		-	Output as blinking light			Vol + 32
		-	Output is blinking light reversed			Vol + 48
		Add values of brightness (= Vol) to the values above. Permitted values are 0 (very dark) to 15 (very bright)				
121	Blinking light	Specifies the duration of the "bright period" and the on/off ratio of outputs, which are set to blinking		0 - 255	0	
		Bit	function			value
		0-3	On / Off ratio			0 - 15
		4-7	PWM period time			16 - 240
		The PWM period time is a multiple of 0.18432 seconds.				

## 7.2 Technical data

Dimensions:	43mm x 19,5mm x 6,5mm
Layout:	4 Layer multi-layer-PCB, double sided SMD-technology. DCC Interface
Operating voltage:	5 to 25 V / pulse for change of direction 32 Volts
Supported protocols:	DCC / NMRA-standard with 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 1.1A Suitable for DC-, AC- and coreless motors (auto detect feature) 22 kHz PWM frequency - quiet, smooth motor control overload protection of motor output, Back EMF control (may be switched off)
Function outputs:	3 Outputs, 2 of which may be used for light functions 140 mA load per output, common overload protection Total current of function and motor outputs 1.2A
Sound part:	two independent channels High performance amplifier, ~ 1,6 Watt Sound data can be modified because of flash memory
speaker:	specially designed speakers in different sizes with 100 Ohms impedance.

## 8. Service-Support and assistance

Your model train or hobby shop is your competent partner for all your questions regarding LokSound2 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.

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by Fax :	++49 (0)7043 - 90 75 36
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