

# 50708, 50709 Digital Car-Interior lighting

## Warnings

- The LED interior lights are intended for installation in model railroad cars.
- All connection work should be carried out only with the power turned off.
- Adhere to the principles as outlined in this manual.
- Protect from moisture and humidity, as well as mechanical force or pressure. To avoid damage do not bend the lights unnecessarily.
- Be sure when assembling the vehicle that no cables are pinched or metal parts of the car are touched or short circuits will occur.
- It is easy to vary the color of the LEDs, and their brightness within the manufacturer's tolerances.

## Main Features

The ESU LED car interior lights provide you with 11 LEDs for uniform illumination in your cars. The integrated multi-protocol decoder can be used with DCC or Motorola® and works on analogue DC layouts. The operating mode is automatically recognized. The following characteristics distinguish the interior lights specifically:

- 11 warm white LEDs (50708).
- 11 yellow LEDs (50709).
- Built-in constant voltage source for uniformly bright light, regardless of the track voltage.
- Individually adjustable brightness.
- The lighting strip can be shortened at eight points.
- A built-in buffer capacitor that bridges small power interruptions.
- Optionally, 50706 energy storage (a „power pack,“) can be connected to bridge longer interruptions.
- The 11 LEDs are divided into five groups, each of which is individually switchable.
- Each interior lighting strip comes with a red rear light, which can be switched in relation to the direction of travel.
- Connection for a directional white front light (LED only, up to 20mA).
- Connection option for further external loads (up to 100mA).
- Different lighting effects such as soft dimming, neon effect, defects or neon lighting, battery light, can be assigned to each group individually.
- Delay and random lights can be selected individually.

## Installation of Car lighting

### LED - Groups

The 11 integrated LEDs as shown in Fig. 1 are divided in the 5 groups „A“ to „E“ and connected directly to an output of the integrated function decoder. Each group can be switched individually and provided with light effects.

### Shortening the Car lighting

The interior light strip should first be cut to the required length. The PCB can be shortened at one of the points marked in Fig. 1. Cut along the dotted line with a small hacksaw. The remaining pieces can be used elsewhere for your own purposes.

**IMPORTANT:** Be careful when cutting that you do not damage any components on the pads and PCB.

### Power supply

The pre-wired power cable may be cut to the required length. All connection points left and right are already connected in the circuit board. Therefore, one cable per side is sufficient. One side is connected to the left wheel (or with the car ground/mass for Märklin models), the other side to the right wheel of the car (or the Center rail for Märklin models). The polarity is irrelevant; each strip has an internal rectifier.

ESU offers SKU 50707 "wheel pickups" appropriate for almost all cars. For cars with current carrying couplers, the two supply lines alternatively connect with the coupling contacts.

The easiest way to attach the PCB under the car roof is double-sided tape. You can also look in the interior design for suitable anchor points.

### Connecting a buffer capacitor

An integrated Tantalium capacitor eliminates flickering illumination during short power interruptions. If there is a poor connection situation, an additional buffer capacitor of at least 35V and a capacity of 4700 uF maximum can be connected to the position shown in Fig. 2.

### Connecting a PowerPack

If you would you like to have the lights on (at red signals, for example), even during a prolonged power failure, a simple buffer capacitor is not sufficient. You can connect the high-energy storage available under the order number 50706. In Fig. 3 the corresponding connecting points are marked with „Power Pack +“ and „Power Pack -“.

Make sure the polarity is correct, otherwise both the Power Pack and the lighting strip may be destroyed!

### Included rear lights

Each lighting strip has red rear lights that are already soldered on. These work directionally in both digital and analog model. If the rear lights are not needed, you should remove them. The rear lights can be used at both ends.

Therefore, the wires can be re-soldered on the other end. When re-soldering pay attention to the correct polarity.

### Brightness Control

By means of the control shown in Fig. 4, the maximum brightness of all LEDs together can be adjusted as desired. The brightness can be further reduced individually by programming.

### Optional front light

For operation in Control/Cab car, as shown in Fig. 5, a white front light can be added. Only white or yellow LEDs with a maximum current consumption of 15mA may be used. A series resistor is already installed. The front light works like the rear light, directionally.

### External load (AUX1)

To switch external loads (eg toilet lighting, destination signs, etc.) a separate transistor output with a maximum current of 100mA is available. It is shown in Fig. 6, and is preferably connected to the voltage + U. A series resistor for LEDs is not installed. The U + voltage is not buffered by the power pack and the control to adjust for brightness has no effect.

## Operation

### Digital operation

The interior lighting works with any digital system that uses either the DCC or the Motorola® format. The decoder recognizes the protocol automatically

The default address is 03 with 28 speed steps (DCC).

F0 F0 turns on the red rear light (direction of travel)

F1 switches the external load (AUX1)

F2 switches all the LEDs together

F3 switches the LEDs 1-3 (group „A“)

F4 switches the LEDs 4-5 (group „B“)

F5 switches the LEDs 6-7 (group „C“)

F6 switches the LEDs 8-9 (group „D“)

F7 switches the LEDs 10-11 (group „E“)

### Analog operation

The interior lighting can also be used with analog DC power supplies. In this case, the factory setting is set so that all the LEDs light up (the red rear lights as well as any installed front light.) These respond to the direction of travel with DC power supplies.

### Customize decoder settings

All adjustable parameters of the interior lights are in so-called CVs („Configuration Variables „) arranged according to the NMRA DCC standards. These can be selectively modified with your control system.

### Programming with DCC systems

The interior lighting strip knows all programming methods of the NMRA. Use either the Programming track or the main track programming („Programming on Main“). Note the relevant section in the manual of your Command Station.

Connect to AUX1 a load of 60mA to 100mA, in order to read CVs!

### Programming with Märklin®6021

The Märklin® central unit 6021 works differently: Since it does not comply with the NMRA DCC standards, the interior lighting start a special, obligatory programming procedure. Reading of values is not permitted.

There are two modes:

- In the short mode parameters with a number below 80 can be set provided the desired value is also lower than 80.
- In the long mode, all parameters with values from 0 to 255 are adjustable. Since the display of the 6020 /6021 is limited to two-digit numbers, values must be split and entered in two separate steps.

### Changing the Programming Mode

Enter the programming mode with the 6020/6021:

The throttle must be set to „0“. No other locomotives may be on on the layout. Watch out for flashing signals of the locomotive!

- Press the „Stop“ and „Go“ buttons of the 6021 simultaneously until a reset has been triggered (alternately pull the mains plug of the transformer). Press the „Stop“ button in order to switch off the track voltage. Enter the current decoder address. If you do not know the current address, simply enter „80“.
- Activate the change-of-direction button (turn the throttle knob to the left beyond the arrester until you hear a click sound), hold it in this position and then press the „Go“ button

Please bear in mind that the 6020/6021 only permits you to enter values from 1 to 80. The value 0 is missing. Always enter „80“ instead of „0“.

### Short mode

The decoder is in the short mode (the headlights flash periodically in brief intervals).

- Now enter the number of the CV that you want to adjust e.g.: „01“. Always enter this number with two digits.
- For confirmation activate the change-of-direction routine (now the lights flash twice very quickly).
- Now enter the new value for the desired CV, e.g.: 15 (two digits).
- For confirmation activate the change-of-direction routine (now the lights light up for about one second).
- Then you can enter other CVs as desired.
- Selecting „80“ allows you to exit the programming mode. Alternately you can switch off the track voltage and then on again (press the „Stop“ button on the 6021, then the „Go“ button).

### Long mode

You access the long mode by entering the value 07 in CV 07 while in the short mode. The decoder confirms the change to the long mode by slowly flashing lights.

- Enter the hundred-digit and the ten-digit (decade) of the CV that you want to change. Example: If you want to adjust CV 124, you enter „12“.
- For confirmation activate the change-of-direction routine (now the lights flash periodically: long – short – long – short - etc.)
- Now enter the unit of the CV („04“ in this example).
- For confirmation activate the change-of-direction routine. Now the decoder expects the entry of the CV value. The lights flash periodically: long – short – short).
- Now enter the hundred-digit and the ten-digit (decade) of the new CV value (as a two-digit number). Example: You want to write the value 135. Therefore, you enter „13“.
- For confirmation activate the change-of-direction routine. Now the lights flash periodically: long – short – short).
- Now enter the unit of the new CV value as a two-digit number („05“ in this example).
- For confirmation activate the change-of-direction routine (now the lights light up for about one second).
- Now you can adjust more CVs in long mode.
- Exit the long mode by switching off the track voltage and then on again (press the „Stop“ button on the 6021, then „Go“).

### Programming with LokProgrammer

Using the separately offered ESU LokProgrammer 53451/53452, you can comfortably change your interior lighting CVs right on your computer screen with a mouse click. This will save you from a search for CV numbers and values.

## Setting parameters

### Function outputs

At each function output light effects and special effects can be set. For each output a CV is set up (CV113 - CV 120, see table), in which the desired brightness value and the code for the desired mode is stored.

# 50708, 50709 Digital Car-Interior lighting

Name	Description	Brightness	Mode	Dealy on	Random light
Dimmer	Fast light on and off	0 - 7	+ 0	+ 64	+ 128
Zoom	Slow dimming of lights off and on	0 - 7	+ 8	+ 64	+ 128
Neon light	Neon light simulation	0 - 7	+ 16	+ 64	+ 128
Defective neon light	Defective neon light, flickering	0 - 7	+ 24	+ 64	+ 128
Flashing light phase I	Output flashes with adjustable frequency	0 - 7	+ 32	+ 64	+ 128
Flashing light phase II	Output flashes with adjustable frequency	0 - 7	+ 40	+ 64	+ 128
Strobe	Flashing light with adjustable frequency	0 - 7	+ 48	+ 64	+ 128
Flickering light	Flickering light simulation	0 - 7	+ 56	+ 64	+ 128

For example, to simulate a flashing light with brightness 5 for the external load (AUX1). Write in the CV 115 the value  $5 + 32 = 37$  to get that.

## Switch-on-delay

If desired, you can determine for each of the 8 outputs, whether these switch on immediately or delayed. This requires as shown in the table above, the value 64 to be added to the previous value of the CV for the output. The exact time of the delay is randomly determined each time within the limits defined in CVs 59 and 60.

## Random light

If desired, you can determine for each of the 8 outputs, whether it after switching via a function key it later goes randomly off again and later back on. For this purpose, the value 128 must be added to the previous value of the CV for the output as shown in the table above. When and for how long the output is then turned off, respectively, is determined by CVs 61 and 62.

## Start blink number of neon light

In CV 63, you can determine how often a neon lamp flashes before it is permanently switched on.

## Period for flashing lights

If the function flashing light or strobe was selected for an output, the period (and thus the blink rate) is stored for all outputs relating it in CV 112.

## Function mapping

The outputs can be freely assigned to function keys. For each of the functions F0 to F20 of the digital system a decoder CV is responsible. For the function F0 forward, it is the CV33, for the function F0 backward it is the CV34 and so on up to CV136 for the F20 function. The value in this CV determines which function output reacts to which function.

Example: In CV 35 a value of 4 specifies that the function output AUX1 for forward travel corresponds to Function 1.

What values must be entered in order to assign the functions to function outputs, can be seen in the next table:

Search in the table the intersection between

- the desired function line and
- the column of the desired function output.

Shown is the number that should be entered in the relevant CV for the desired assignment. The factory settings are shown in bold. If a function button should switch more outputs, simply add the values of the desired functions.

CV	Function	Front light	Rear light	AUX1	LED Group „A“	LED Group „B“	LED Group „C“	LED Group „D“	LED Group „E“
33	F0 forward	<b>1</b>	2	4	8	16	32	64	128
34	F0 reverse	1	<b>2</b>	4	8	16	32	64	128
35	F1 forward	1	2	<b>4</b>	8	16	32	64	128
36	F2	1	2	4	<b>8</b>	<b>16</b>	<b>32</b>	<b>64</b>	<b>128</b>
37	F3	1	2	4	<b>8</b>	16	32	64	128
38	F4	1	2	4	8	<b>16</b>	32	64	128
39	F5	1	2	4	8	16	<b>32</b>	64	128
40	F6	1	2	4	8	16	32	<b>64</b>	128
41	F7	1	2	4	8	16	32	64	<b>128</b>
42	F8	1	2	4	8	16	32	64	128
43	F9	1	2	4	8	16	32	64	128
44	F10	1	2	4	8	16	32	64	128
45	F11	1	2	4	8	16	32	64	128
46	F12	1	2	4	8	16	32	64	128
47	F1 reverse	1	2	<b>4</b>	8	16	32	64	128
129	F13	1	2	4	8	16	32	64	128
130	F14	1	2	4	8	16	32	64	128
131	F15	1	2	4	8	16	32	64	128
132	F16	1	2	4	8	16	32	64	128
133	F17	1	2	4	8	16	32	64	128
134	F18	1	2	4	8	16	32	64	128
135	F19	1	2	4	8	16	32	64	128
136	F20	1	2	4	8	16	32	64	128

## Decoder reset

You can always reset the decoder to the factory settings.

Write a value of 08 to CV 08.

## Firmware update

The interior lighting strip software can be updated at any time, to correct bugs or retrofit new functions. For that you will need the ESU LokProgrammer 53451/53452 with the most recent PC software for it. During the writing of parameter the firmware will be updated when applicable.

## Technical data

Power supply	4-24V 0 / -
Modes	DCC with 14, 28 and 128 speed steps (automatic detection) Motorola® data format Analogue DC operation
Constant brightness	from 6V input voltage
Current consumption	50708: about 25mA 50709: about 35mA
Dimensions	255mm x 7mm (decoder range : 8.1mm)

## List of all supported CVs

CV	Name	Description	Range	Value	
1	Loco address	Address	1 - 127	3	
8	MakerID	Maker (ID) ESU – Writing 8 into CV8 will reset to factory values	151	151	
17	Long loco address	Long address CV 17 holds the higher Byte (Bit 6 and Bit 7 always set), CV18 holds the lower Byte. Only used when the function is activated in CV 29 (See there)	128 - 9999	192	
18					
19	Consist Address	Additional address for consist operation. Value 0 or 128 means consist is disabled	0-255	0	
29	Configuration register	The most complex CV within the DCC standards. This register contains important information, some of which are only relevant for DCC operation	Bit	Function	Value
			0	Normal direction	0
				Reversed direction	1
			1	14 speed steps in DCC operation	0
				28 or 128 speed steps in DCC	2
			2	Disable Analog operation	0
		Analog operation enabled	4		
	5	short addresses (CV 1) in DCC mode	0		
		long addresses (CV 17+CV18) in DCC	32		
49	Extended Configuration	Additional important settings for Decoders	0 - 255	19	
			Bit	Description	Value
			3	Marklin® 2. Address Disable	0
				Marklin® 2. Address Enable	8
			4	Auto Speed step detection DCC OFF	0
		Auto Speed step detection DCC ON	16		
59	Delay lower limit	Minimal value of switch-ON. Delay Multiple of 0.25 Sec.	0 - 64	0	
60	Delay upper limit	Maximal value of switch-ON. Delay Multiple of 0.25 Sec.	0 - 64	8	
61	Random time lower limit	Minimum time on for output, using random timing. Multiple of 0.25 Sec.	0 - 64	10	
62	Random time upper limit	Maximum time on for output, using random timing. Multiple of 0.25 Sec.	0 - 64	20	
63	Start flash number Neon simulation	Number of start flashes for Neon light simulation	0 - 15	020	
112	Blinking frequency	Blinking frequency of Strobe effects. Always a multiple of 65.536 milliseconds.	4 - 64	16	
113	Front light configuration	Output configuration „Front light“	0 - 255	15	
114	Rear light configuration	Output configuration „Rear light“	0 - 255	15	
115	AUX1 Output configuration	Output configuration „AUX1“	0 - 255	15	
116	Output configuration LED 1-3	Output configuration „LED 1-3 Group A“	0 - 255	15	
117	Output configuration LED 4-5	D Output configuration „LED 4-5 Group B“	0 - 255	15	
118	Output configuration LED 6-7	Output configuration „LED 6-7 Group C“	0 - 255	15	
119	Output configuration LED 8-9	Output configuration „LED 8-9 Group D“	0 - 255	15	
120	Output configuration LED 10-11	Output configuration „LED 10-11 Group E“	0 - 255	15	

