ESU

Electronic Solutions Ulm

User Manual

LokPilot V2.0
LokPilotDCC V2.0
LokPilot micro

4th edition, August 2005

Lok Pilot®

content

General Features:

LokPilot V2.0 is the successor of the popular LokPilot decoder. It enhances the already outstanding properties with more features with the objective to improve running characteristics even more as well as to increase reliability and flexibility.

LokPilot V2.0 is available in three types:

LokPilot V2.0 is a multi-protocol-decoder. It supports Märklin® / Motorola® as well as the widely used DCC system. It can also be used in analogue layouts with AC or DC supply. Thus it is the ideal decoder even for layouts with combined Motorola® / DCC controls.

LokPilotDCC V2.0 is a „thoroughbred" DCC Decoder. It provides all functions of LokPilot V2.0, except for the Motorola®-protocol and can also be used in analogue mode (DC only).

The LokPilot micro is an extremly small decoder for the use in N-scale models.

All decoders are thepremier choice for the demanding model train enthusiasts who insist on excellent load control – particularly at low speeds – and maximum flexibility in terms of adapting the decoder to the model engine. LokPilot V2.0 detects the operating mode automatically and can control DC motors, coreless motors (e.g.: Faulhaber) or universal motors converted to DC motors using HAMO-magnets.Due to its unique features LokPilot V2.0 offers great flexibility and reliability, as you have come to expect it from a top quality decoder. Even future updates are no problem for LokPilot V2.0: Due to its flash memory technology it can be updated to the latest version at any time.

Properties of LokPilotDCC V2.0:

• Fully operational on analogue DC layouts
• Fully automatic change of operating mode (auto-detect)
• 4th generation load control: to be adapted to motor characteristics with three CVs
• 40 kHz pulse frequency for smooth and silent motor control
• Supports Lenz® Brake sections

• 14, 28 and 128 speed steps in DCC-mode
• Automatic detection of speed step setting in most DCC-systems
• 2- or 4-digit address
• Fully compatible with NMRA-standards
• Shunting speed
• Acceleration and deceleration can be switched off
• Advanced Consisting
• Freely selectable speed curve
• Improved function mapping: All outputs can be assigned to any function button
• Lighting effects: Strobe, Double Strobe, Mars and Gyro light, Firebox, Blinker, Flash.
• 2 directional outputs for headlights for up to 180 mA each
• 2 auxiliary outputs (F1 und F2), for up to 180 mA each
• Maximum total current of all 4 outputs: 350 mA
• Adjustable acceleration and maximum speed even in analogue mode
• Motor output: maximum 1.1 A, short circuit protection
• Total maximum load of decoder: 1.2 A
• Dimensions: 23 x 15.5 x 6.5 mm
• Designed for the future - possible firmware upgrade with flash-memory

Additional features of LokPilot V2.0:

• Suitable for analogue AC layouts
• Supports Motorola®-format (old and new)
• Programming mode for Märklin® 6021 (for the most important functions)

Additional features of LokPilot micro:

• Supports Motorola®-format (old and new)
• Supports Selectrix® system (For normal Operation only, for Programming DCC programming mode has to be used)
• Programming mode for Märklin® 6021 (for all important functions)

green | purpel | yellow | white
F1 | F2 | Rear light | Head light
blue

black | red | orange | gray
enginr
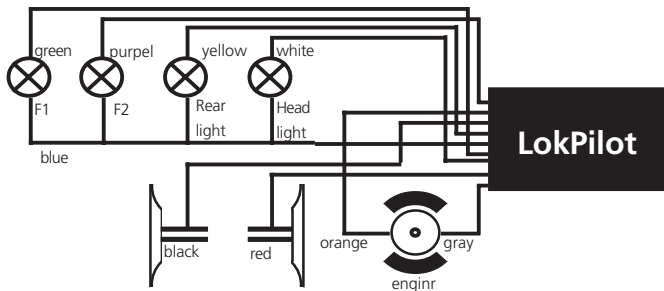
figure 2: Wiring of engines with DC motor and isulated functions

green | purple | yellow | white
F1 | F2 | Rear light | Head light
chassis

black | red | orange | gray
engine
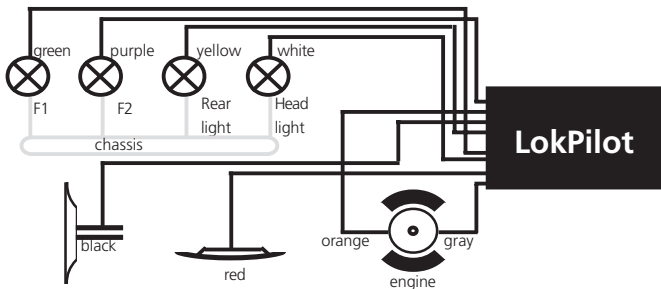
figure 3a: Wiring of engines wtih DC motors and functions with the common pole connected to the chassis

engine
black | red | gray | orange

LokPilot micro

yellow | white
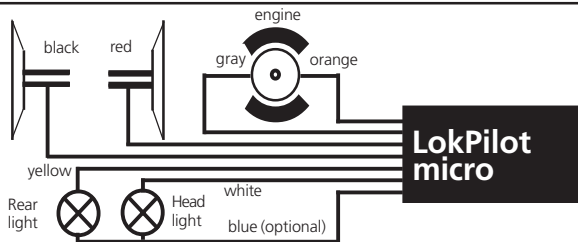Rear light | Head light | blue (optional)

figure 3b: Wiring LokPilot micro (with blue common ploe)

Important note:

- The LokPilot V2.0 and LokPilotDCC 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
- Do not remove the heat shrink sleeve around 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 no blank wire ends come into contact with any metal parts of the locomotive
- Make sure that no wires are squeezed or cut by the model's transmission parts when reassembling the locomotive.

Prior to installation

The locomotive must be in perfect technical condition prior to installation. Only a locomotive with a trouble-free mechanism and smooth running properties in analogue mode should be converted for digital mode. Wear and tear parts, such as motor brushes, wheel contacts, light bulbs, etc. must be inspected and cleaned or replaced if necessary.

All work has to be carried out with the locomotive placed on a suitable base (not the track) and definitely un-powered. Make sure there can never be any electrical power applied to the loco during the conversion – even inadvertently.

Locomotives with DCC Interface

The LokPilotDCC is equipped with an interface as per NMRA (See fig. 1a & 1b). Installation in locomotives with interface is therefore particularly easy:

- Remove the body from the chassis. Please refer to the instructions provided with your locomotive!
- Remove the plug from the DCC socket. Please keep it for later use.
- Insert the plug in such a way that pin 1 of the plug(near the red / orange wires) is located next to the point marked *, +, . or 1. Please take care to avoid bending the pins. Do not rely on the assumption that the wires have to lead from the socket in a certain direction: only the position of pin 1 determines which way the plug has to be inserted.
- Locate the decoder at a suitable position within the locomotive. Most modern models have sufficient space for a decoder. Use double sided adhesive tape or a small amount of hot glue.

Pin	Description	Color
1	motor terminal right	orange
2	back-up light	yellow
3	function F1	green
4	current pick-up 1	black
5	motor terminal left	gray
6	headlight	white
7	common (+pole)	blue
8	current pick-up 2	red
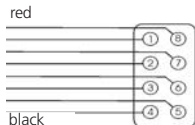
Figure 1a: NEM652 interface

Pin	Description	Color
1	motor terminal right	orange
2	motor terminal left	gray
3	track connection right	red
4	track connection left	black
5	head light	withe
6	rear light	yellow

Figure 1b: NEM651 interface

Locomotives without interface

First separate all wires in the locomotive and make sure there is no hidden connection from one of the motor terminals to the chassis or the wheel contacts. The motor terminals definitely must be insulated. Fleischmann® models often have such a connection, which can easily be overlooked. Check all connections using an Ohmmeter and make sure there are no short circuits between the motor terminals and the wheel contacts.

How to proceed depends on how the headlights and other functions are wired:

a) If directional headlights and functions are insulated from the locomotive body proceed as per figure 2.

b) Directional headlights and functions may be connected with their common to the track voltage (e.g. almost all Maerklin® -locomotives and older Fleischmann® or ROCO® locomotives are wired like that) as per figure 3.

- Connect the red wire to the right rail pick up (or centerpick up in AC models),
- and the black wire to the left rail pick up (chassis groung in AC models).
- Connect the orange wire with the motor terminal, which was originally wired to the right wheel pick up (center pick up „Schleifer" in AC models).
- The gray wire goes to the terminal, which was originally connected to the left rail (chassis ground for AC models).
- Solder the rear lights to the yellow wire, the front headlights to the white wire.
- Connect the green wire to the function output which you want to switch with function button F1.
- Connect the purple wire with the function output which you want to switch with the function button F2.

If your locomotive is wired as per b) above then wiring is completed.

In the case as per fig. 2 you have to connect the second pole of all light bulbs or other loads to the blue wire. The blue wire must not be connected to the chassis!

Connecting Auxiliary Functions

Any load may be connected to the light and function outputs as long as it doesn't exceed the maximum current. Please note that the overload protection of the decoder responds very quickly and will switch off all functions immediately in case of overload or short circuit.

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

Only use 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 may draw too much current. Some commercially available smoke generators have a nominal current above 250 mA!

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

> Make sure that the total current for all function outputs does not exceed the permitted current rating and avoid short circuits between outputs. Although outputs of LokPilotDCC decoders are protected, high voltage on the terminals or a short circuit may damage the decoder!

Set-up and initial operation

Before replacing the body and reconnecting the engine it is recommended to carry out a function test.

The factory pre-set address is 03.

- Does the locomotive move in either direction?
- Turn the lights on: are they operating correctly? If the LokPilotDCC V2.0 decoder is used in a locomotive with NMRA interface: check if the NMRA connector is plugged in correctly.

DCC-Mode

Remove capacitors that may be connected to the track section (e.g. in ROCO® connecting track). They may impede normal operation of the decoder and even destroy it. LokPilotDCC may be operated with any DCC compatible system. The automatic speed step detection was tested with the following devices: ROCO® Lokmaus2, Uhlenbrock Intellibox, Lenz® Digital plus V2.3, ZIMO® MX1.

When using Lenz® digital plus V3.0 the auto-detect feature does not operate in 14-speed step mode. Change to 28/128 speed steps.

LokPilotDCC attempts to detect the speed step setting every time the system is powered up and the lights are turned on. In order to accomplish this, you have to switch on the lights and vary the speed setting until the lights burn consistently.

If you want to change the speed step setting during operation, you have to disconnect the circuit/track/ locomotive to activate the auto-detect feature

The auto-detect feature can be turned off with CV 49 Bit 4 (refer to the table on page 8).

Motorola®-mode (not for LokPilotDCC V2.0)

The LokPilot V2.0 can be used with all Märklin® devices or compatible systems previously sold or currently on the market. The functions F1 to F4 can only be activated with the so-called „new Motorola®-format". To activate this, the DIP switch 2 on the 6021 has to be set to the upper position („On").

Selectrix®-operation (LokPilot micro only).

You can use the LokPilot micro with any Selectrix® compatible command station. All normal commands for speed and function are available. However, to change the decoders settings (CVs), you need to use the DCC programming mode of your command station.

Adjusting decoder parameters

The LokPilot V2.0 supports many parameters. A detailed list is provided at the end of this manual. All adjustable parameters are stored in so called CVs (configuration variables). They can be adjusted individually, depending on the type of command station. Please refer to the relevant chapters in the manual of your digital system (e.g.: programming of DCC decoders). The LokPilot V2.0 supports all programming methods as per NMRA.

Programming Märklin® 6020 / 6021

Märklin® central units 6020 and 6021 have to be dealt with differently. Only parameters up to number 80 are available, provided the desired number is also below 80. Proceed as follow to adjust these CVs (not for LokPilotDCC V2.0):

The throttle must be set to 0. No other engines may be on the layout. Take note of the blinking lights of the engine!

- Press the „Stop"- and „Go"-buttons of the 6021 simultaneously until a reset is triggered. (alternatively pull the mains plug and re-plug afterwards)
- Press the „Stop"-button in order to turn off the track voltage
- Enter the current decoder address (alternative: „80")
- Activate change of direction with the throttle (turn the knob left over the „Stop"-position until you hear a click, hold the knob there and press the „Go"-button
- The LokPilot V2.0 is now in programming mode (headlights are blinking)
- Enter the number of the parameter (CV) you want to change (two digits).
- Confirm by pressing „change of direction" (now the headlights blink in double mode)
- Enter the new value for the CV (two digits)
- Confirm by pressing „change of direction" (headlights are on for 1 second and then start blinking)
- Now you can change other registers in the same manner
- You exit the programming mode by selecting register „80" or by turning off the track voltage for a moment (press „Stop"-button on 6021, then „Go"-button)

- The value „0" can not be entered with 6021. Instead you have to enter „80".
- Only CVs from 01 to 80 can be changed.
- For adjusting CVs higher than 80 you have to use a DCC-compatible command station.
- For easy and comfortable programming of ESU decoders we recommend the LokProgrammer order no.: 53451 With its assistance you can comfortably program your LokPilot V2.0 on your PC. More information regarding the LokProgrammer can be found on our website.

Tips & Tricks

Adjusting Load control

The load control of the LokPilot V2.0 can be adapted to different types of motors. The standard settings match most motors very well but may have to be adjusted for other models. This is particularly true for coreless motors (Faulhaber, Maxxon) where we recommend to set the K-value (CV 54) to a lower value.

Parameters for Fleischmann®

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

    CV 54 = 14 - 18

    CV 55 = 20

Parameters for Märklin® high performance motors

The 5-pole high performance motor by Maerklin® (series 37xxx) is best suited for the LokPilotDCC when programmed as follows:

    CV 54 = approx. 20 - 25

    CV 55 = 38

Parameters for coreless motors

    CV 54 = approx. 4 - 10

    CV 55 = approx. 3 - 8

Decoder-Reset

> **You can easily reset the decoder by writing the value 08 in CV 08 at any time.**

Function mapping

The outputs can be assigned to any function button. ESU utilizes the so-called Enhanced Mapping with the advantage that each function can be assigned to any function button.

Furthermore the assignment can vary subject to direction of travel. It is also possible to trigger several functions with one button simultaneously. Each function button are assigned two CVs per direction (so-called control CVs A, B,) to determine the desired behavior of each button.

Function Mapping index on page 13 shows the possible combinations.

Generally it can be said:

- All function buttons are directional. If you change the assignment of any function button, please do so for both directions.
- Your digital system may not support all function buttons.
- Each physical output must be assigned to a function button and also has to be „switched on" initially.

Later on we will show some examples to provide a better understanding. Before we have to explain two more properties of function outputs.

Activating on function outputs

Prior to use each function output can / must first be activatedon. Furthermore each output offers the possibility to set one of 10 different lighting effects:

- Dimmer: normal, continuous output
- Blinking: output blinks with adjustable frequency.
- Inverse blinking: Output blinks as before, but with opposite timing. Thus alternate blinking lights can be set.
- Strobe
- Double Strobe
- Random, firebox
- Smoke, adjusting the intensity of the smoke generator

- Zoom, high beam and dimmed lights
- Mars light
- Gyra light

There is one CV for each output (CV 113 - 116), in which the desired mode can be saved. Please note that you can deactivate each output by setting it to 0 if you son't want to use it. The lighting outputs are pre-set to „on". In steam engines this is also true for AUX1 output which is assigned to the headlight button.

Adjust lamp brightness

The LokPilot V2.0 offers the feature to adjust the brightness of lamps in 15 steps in order to adapt the light intensity optimally to the specific model. The lamps are supplied with pulses, i.e. they are switched on and off very frequently. The desired brightness (0 – 15) must be set in the appropriate control CV (113 – 116) by adding it to the value corresponding with the type of function.

Blinking frequency and duration of cycle

CV 112 determines the blinking frequency (subject to the duration of the cycle) as well as the „on/off" ration for all outputs set to blinking.

The cycle can be set in 33 different steps. The cycle is always a multiple of 65.5 ms. The „on/off" ratio can be set in 16 steps (from 1/16 to 16/16). At a ratio of 8/16 the „on" and „off" period is equally long. The value to be entered in control CVs 113 – 116 can be calculated as follows:

Cycle (value: 0-15) + 16 + On / Off ratios.

Examples:

- **Example 1:**

smoke generator on AUX 1 and F5.

Let's assume you want to operate a smoke generator with function button F5 and output AUX 1.

Output AUX 1 must be activated and the F5-button has to be assigned:

First you activate the output; in this case we want a continuous output (dimming setting at 100% brightness). CV 115 is responsible for this output. The value to be entered in CV 115 has to be calculated as follows: 15 for maximum brightness.

Now the function button has to be assigned to output AUX 1: Have a look at figure 4: Control CV 171 is responsible for button F5 in forward mode (third column). You have to enter in CV 171 which functions should be triggered with F5. If you follow the row for F5 in the table in figure 4 to the right until it meets the column for function AUX 1 you will find a number in the heading of this column. In our example it is a „4". This value has to be written into CV 171. Then the F5 button controls AUX 1. Thus the function is switched in forward mode. In order to also switch this function in back up mode you have to enter the same value in CV 174.

- **Example 2:**
Blinking light on AUX2 and F6.

A blinking light should be wired to AUX 2 and assigned to the F6-button. The brightness is to be set to 6/15 of maximum brightness. The blinking cycle and on/ off ration are to be set as described above. First we need to activate output AUX 2 and set it to blinking mode. CV 116 is responsible for this. In our example we enter 16 (for blinking mode) + 5 (corresponds to 6/15 of maximum brightness) = 21.

Now we have to assign AUX 2 to button F6. The control CV 177 is responsible for F6. We enter in this CV which functions should be switched with the F6 button. If you follow the row for „F6 forward" in the table in figure 4 to the right until it meets the column for AUX 2 you find the number „8" at the top of the column. This value has to be entered into CV 177. Now the F6 button switches AUX 2 in forward mode. To also set the F6 button for back up mode, enter value 8 in CV 180.

• Example 3:

Braking time On / Off with F5.

Acceleration / deceleration should be controlled with F5. Since acceleration / deceleration does not represent a physical output but rather a logical output, this function does not have to be configured. Only the button F5 has to be assigned to acceleration / deceleration. This is done with CV 172 where you enter the value „1". If this function should also work in back up mode, value „1" has to be entered in CV 175. For configuring function outputs we recommend using your PC and the LokProgrammer.

The LokPilot V2.0 decoder offers many possibilities and combinations of functions and therefore a PC and the LokProgrammer (order no.: 53451) are extremely useful for programming.

Settings for analogue mode

With the aid of CVs 125 and 126 you can adjust the starting and maximum speed for analogue DC operation. In analogue AC operation CVs 127 and 128 are responsible (not for LokPilotDCC V2.0, LokPilot micro). Thus you can adjust the various speed settings even in analogue operation.

LGB®-control

When using LGB®-command stations or the Roco® Lokmaus I the LokPilot V2.0 can be set to pulse control. Set bit 5 in CV 49 for this purpose. Subsequently the decoder counts the number of times the F1 button is pressed in sequence in order to be activated the desired function. Thus you can trigger all available functions by pressing the F1 button the appropriate number of times.

Brake sections

The LokPilot V2.0 decoder supports the most commonly used brake systems:

• Lenz®-Brake generator in DCC-mode

• Märklin® Brake section (not LokPilotDCC V2.0)

As soon as a brake command is recognized the LokPilot V2.0 decoder slows down the engine with the deceleration set in CV 4. After the enforced stop the engine accelerates as per the setting in CV 3. In order to active this feature certain settings have to be entered in CV 51.

Lenz® Brake generator

The Lenz® LG100 works in compliance with the mechanisms described by the NMRA and is fully supported by the LokPilot V2.0 decoder. Write value 8 in CV 51.

Märklin®-Brake section

In principle the Märklin®-Bake section applies DC to the track instead of the digital signals. In order to activate this mode the value 1 has to be written in CV 51. The Märklin®-Brake section and the analogue DC operation should never be active at the same time, because the DC supply of the Märklin® Brake section could be interpreted as analogue DC-mode. Turn off the analogue mode in CV 29 and CV 50 to avoid this. The Märklin® Brake section is not available for the LokPilotDCC V2.0.

Support and Assistance

Your first port of call with any questions is the dealer where you purchased the LokPilot V2.0 decoder. He is your competent partner for all your questions related to the model train hobby.

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 and you may encounter delays. Also check our website for more information. You will find many hints under „Support / FAQ" and even feed back from other users.

Of course we will be pleased to assist you. You can contact us at:

Hotline

Phone: **+49 (0) 700 - 37872537**

          Tuesday and Thursday

          10AM - 12PM (CT)

Fax: **+49 (0) 700 - 37872537**

Email: **support@loksound.de**

Mail: **ESU GMBH & CO. KG**
          -Warranty department-
          Industriestrasse 5
          D - 89081 Ulm

www.loksound.de

LokPilot V2.0

Operating modes
NMRA / DCC with 14, 28 and 128 speed steps
2-digit and 4-digit addresses
Märklin® Motorola® system (14 speed steps)
Conventional AC & DC operation
Autodetection of operating mode
Autodetection of DCC speed step setting
Supports brake mode by Lenz® LG100 or Märklin®

Motor control
1.1A continuous load,
Suitable for AC, DC and coreless motors
(AC Motors with HAMO conversion only)
Silent motor control with 40kHz
PWM frequency Motor output protected against overload
4th generation load control (can be switched off)
Dynamic drive control

Function outputs
4 outputs, 2 for headlights, 180mA per output
Total maximum current of all outputs is 0.35A
Function mapping, F1 to F12 possible
Outputs are short circuit protected
Various lighting effects, user adjustable brightness

LokPilotDCC V2.0

Operating modes
NMRA / DCC with 14, 28 and 128 speed steps
2-digit and 4-digit addresses
Conventional DC operation
Autodetection of operating mode
Autodetection of DCC speed step setting
Supports brake mode by Lenz® LG100

Motor control
1.1A continuous load,
Suitable for AC, DC and coreless motors
(AC Motors with HAMO conversion only)
Silent motor control with 40kHz
PWM frequency Motor Output
protected against overload
4th generation load control
(can be switched off)
Dynamic drive control

Function outputs
4 outputs, 2 for headlights, 180mA per output

Total maximum current of all outputs is 0.35A
Function mapping, F1 to F12 possible
Outputs are short circuit protected
Various lighting effects, user adjustable brightness

LokPilot micro

Operating modes
NMRA / DCC with 14, 28 and 128 speed steps
2-digit and 4-digit addresses
Motorola® system (14 speed steps)
Selectrix system
Conventional DC operation
Autodetection of operating mode
Autodetection of DCC speed step setting
Supports brake mode by Lenz® LG100

Motor control
0.5A continuous load
Suitable for DC and coreless motors
Silent motor control with 40kHz
PWM frequency Motor output
protected against overload
4th generation load control (can be switched off)
Dynamic drive control

Function outputs
2 for headlights, 140mA per output
Total maximum current of all outputs is 0.28A
Function mapping, F1 to F12 possible
Outputs are short circuit protected
Various lighting effects, user adjustable brightness

List of all supported CVs

The following pages provide a list of all CVs of LokPilot decoders. Please refer to the remarks regarding the concept of CVs in Chapter 5.1.

Change CVs only if you have a clear understanding of the implications. Incorrect settings may lead to malfunctioning decoders.

Function button	Description	Control CV A	Headlight	Back-up lights	AUX 1	AUX 2	Control CV B	Acceleration on / off	Shunting mode on / off
	value	value	1	2	4	8	value	1	2
	stand forward	129					130		
	stand backward	132					133		
	drive forward	135					136		
	drive backward	138					139		
F0	light forward	141	1				142		
F0	light backward	144		2			145		
F1	key F1 forward	147					148		
F1	key F1 backward	150					151		
F2	key F2 forward	153			4		154		
F2	key F2 backward	156			4		157		
F3	key F3 forward	159				8	160		2
F3	key F3 backward	162				8	163		2
F4	key F4 forward	165					166	1	
F4	key F4 backward	168					169	1	
F5	key F5 forward	171					172		
F5	key F5 backward	174					175		
F6	key F6 forward	177					178		
F6	key F6 backward	180					181		
F7	key F7 forward	183					184		
F7	key F7 backward	186					187		
F8	key F8 forward	189					190		
F8	key F8 backward	192					193		
F9	key F9 forward	195					196		
F9	key F9 backward	198					199		
F10	key F10 forward	201					202		
F10	key F10 backward	204					205		
F11	key F11 forward	207					208		
F11	key F11 backward	210					211		
F12	key F12 forward	213					214		
F12	key F12 backward	216					217		

List of all supported CDs

CV	Name	Description		Range	Value
1	Address	address of locomotive		1 – 127	3
2	Starting voltage	determines the starting speed		1 – 75	3
3	Acceleration	This value multiplied by 0.869 gives the time from stop to maximum speed		0 – 64	8
4	Deceleration	This value multiplied by 0.869 gives the time from maximum speed to stop		0 – 64	6
5	Maximum speed	maximum speed of locomotive		0 - 64	64
6	Medium speed	Speed of locomotive at medium speed step		0 - 64	22
7	Version number	Internal software version of LokPilotDCC (read only)		-	-
8	Manufacturer's ID	Manufacturer's identity (ID) of ESU Writing value 8 triggers a reset of all CVs to factory values			151
13	Analogue mode F1-F8	Setting of functions F1 to F8 in analogue mode		0-255	1
		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	Setting of functions FL, F9 to 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	
17 18	Extended locomotive address	Long address of locomotive CV 17 contains the higher value Byte (Bit 6 and Bit 7 must always be active), CV 18 contains the Lower value Byte. Only active, if feature is switched on in CV 29 (see below)		128 - 9999	192
19	Consist address	Additional address for consist operation Value 0 or 128 means: Consist address inactive 1 – 127 consist address for normal direction of travel 129 – 255 consist address for reversed direction of travel		0 – 255	0

CV	Name	Description		Range	Value
29	Configuration register	The most complex CV within the DCC standards. - This register contains important information, most of which is only available in DCC mode.			4
		Bit	**Function**	**Value**		
		0	Reverse direction of travel (forward becomes reverse) normal direction of travel- reversed directional properties	0 1		
		1	speed step system (DCC-mode only) 14 speed steps 28 or 128 speed steps	0 2		
		2	Analogue mode Analogue mode off Analogue mode 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 address (DCC-mode only) short addresses (CV 1) in DCC-mode Long addresses (CV 17+18) in DCC-mode	0 32		
49	Expanded Configuration	Here you can active support for Brake sections or turn off load control			19
		Bit	**Description**	**Value**		
		0	Load control active Load control off	1 0		
		1	DC Motor PWM frequency 20 kHz Tact frequency on 40 kHz Tact frequency on	0 2		
		2	Märklin® Delta Mode Delta Mode off Delta Mode on	0 4		
		3	Märklin® 2. address Märklin® 2. address off Märklin® 2. address on	0 8		
		4	Automatic speed step detection speed step detection in DCC mode off speed step detection DCC mode on	0 16		
		5	LGB® Function button mode LGB® Mode off LGB® Mode on	0 32		
		6	ZIMO® Manual function ZIMO® Manual function off ZIMO® Manual function on	0 64		

CV	Name	Description			Range	Value
50	Analogue mode	Determines which analogue modes are permitted			0-3	3
		Bit	Function	Value		
		0	AC Analogue mode AC Analogue mode off AC Analogue mode on	 0 1		
		1	DC Analogue mode DC Analogue mode off DC Analogue mode on	 0 2		
51	Brake mode	Determines which brake modes are permitted				3
		Bit	Function	Value		
		0	Märklin® Brake mode Märklin® Brake mode off Märklin® Brake mode on	 0 1		
		1	ZIMO® Brake mode ZIMO® Brake mode off ZIMO® Brake mode on	 0 2		
		2	not used			
		3	Lenz® DCC Brake mode Lenz® Brake mode off Lenz® Brake mode on	 0 8		
53	Control reference	Determines the back EMF that the motor should supply at maximum speed. The more efficient the motor, the higher this value may be. Reduce this value if the engine does not reach its designed . maximum speed			0 - 80	56
54	Load control parameter K	„K"-component of the internal PI-controller. Determines how strongly load control effects. The higher the value, the stronger the impact on the motor.			0 - 80	32
55	Load control parameter I	„I"-component of the internal PI-controller. Determines the momentum of the motor. Motors with large flywheels of large diameter require a smaller value.			0 - 80	24
56	Load control influence	0 – 100 % Determines up to how many % of the speed load control is active. At a value of 32 load control will be switched off , half the maximum speed is reached.			0 - 64	64
66	Forward trim	Divided by 128 results in the factor, with which the motor voltage is multiplied in forward mode. The value 0 deactivates the trim.			0 - 255	0
67-94	Speed table	Assigns a motor voltage to the speed steps. Values in between will be interpolated.			0 – 255	—
95	Back up trim	Divided by 128 results in the factor, with which the motor voltage is multiplied in forward mode. The value 0 deactivates the trim.			0 - 255	0
112	Blinking frequency	Frequency of Strobe effects. always a multiple of 65,536 ms			4 - 64	33

CV	Name	Description		Range	Value
113	Output configuration Headlights (forward)	Function of output Headlights (forward)		0 – 255	15
		Description	Value		
		Continous output (dimmer)	Vol		
		Blinking output (Phase 1)	Vol + 16		
		Blinking output (Phase 2)	Vol + 32		
		Strobe	Vol + 48		
		Double Strobe	Vol + 64		
		Firebox	Vol + 80		
		Smoke generator	Vol + 96		
		Headlights (high beam / low beam	Vol + 112		
		Mars light	Vol + 128		
		Gyro light	Vol + 144		
		Vol = brightness. Range 0 (dark) - 15 (maximum)			
114	Output configuration Back up lights	Function of output Back up lights (reverse)		0 - 255	15
		Description	Value		
		Continous output (dimmer)	Vol		
		Blinking output (Phase 1)	Vol + 16		
		Blinking output (Phase 2)	Vol + 32		
		Strobe	Vol + 48		
		Double Strobe	Vol + 64		
		Firebox	Vol + 80		
		Smoke generator	Vol + 96		
		Headlights (high beam / low beam	Vol + 112		
		Mars light	Vol + 128		
		Gyro light	Vol + 144		
		Vol = brightness. Range 0 (dark) - 15 (maximum)			
115	Output configuration AUX 1	Function of output AUX 1		0 - 255	15
		Description	Value		
		Continuous output (dimmer)	Vol		
		Blinking output (Phase 1)	Vol + 16		
		Blinking output (Phase 2)	Vol + 32		
		Strobe	Vol + 48		
		Double Strobe	Vol + 64		
		Firebox	Vol + 80		
		Smoke generator	Vol + 96		
		Headlights (high beam / low beam	Vol + 112		
		Mars light	Vol + 128		
		Gyro light	Vol + 144		
		Vol = brightness. Range 0 (dark) - 15 (maximum)			

CV	Name	Description		Range	Value
116	Output configuration AUX 2	Function of output AUX 2		0 - 255	15
		Description	Value		
		Continous output (dimmer)	Vol		
		Blinking output (Phase 1)	Vol + 16		
		Blinking output (Phase 2)	Vol + 32		
		Strobe	Vol + 48		
		Double Strobe	Vol + 64		
		Firebox	Vol + 80		
		Smoke generator	Vol + 96		
		Headlights (high beam / low beam	Vol + 112		
		Mars light	Vol + 128		
		Gyro light	Vol + 144		
		Vol = brightness. Range 0 (dark) - 15 (maximum)			
124	Data memory	Determines, which data are to be saved and used after an interruption of the power supply.		0 - 15	7
		Bit Function	Value		
		0 Saves the direction of travel	1		
		1 Saves the status of function buttons	2		
		2 Saves the current speed setting	4		
		3 Accelerates after a reset with the programmed acceleration	8		
125		Analogue DC starting voltage		0-127	110
126		Analogue DC maximum speed		0-127	127
127		Analogue AC starting voltage		0-127	50
128		Analogue AC maximum speed		0-127	127
129	Assignment of function buttons Standstill – forward A	Assignment of function outputs to be active in status standstill - forward		0 – 255	0
		Bit Description	Value		
		0 Headlights (forward)	1		
		1 Back up lights (reverse)	2		
		2 Auxiliary function AUX 1	4		
		3 Auxiliary function AUX 2	8		
130	Assignment of function buttons Standstill – forward B	Assignment of function outputs to be active in status standstill - forward		0 – 255	0
		Bit Description	Value		
		0 Acceleration on / off	1		
		1 Shunting speed on / off	2		

CV	Name	Description			Range	Value
132	Assignment of function buttons	Assignment of function outputs to be active in status standstill – back up			0 - 255	0
	Standstill – back up A	Bit	Description	Value		
		0	Headlight (forward)	1		
		1	Back up light	2		
		2	Auxiliary function AUX 1	4		
		3	Auxiliary function AUX 2	8		
133	Assignment of function buttons	Assignment of function outputs to be active in status standstill – back up			0 - 255	0
	Standstill – back up B	Bit	Description	Value		
		0	Acceleration on / off	1		
		1	Shunting speed on / off	2		
135	Assignment of function buttons	Assignment of function outputs to be active in forward mode			0 - 255	0
	Forward A	Bit	Description	Value		
		0	Headlight (forward)	1		
		1	Back up light	2		
		2	Auxiliary function AUX 1	4		
		3	Auxiliary function AUX 2	8		
136	Assignment of function buttons	Assignment of function outputs to be active in forward mode			0 - 255	0
	Forward B	Bit	Description	Value		
		0	Acceleration on / off	1		
		1	Shunting speed on / off	2		
138	Assignment of function buttons	Assignment of function outputs to be active in back up mode			0 - 255	0
	Back up A	Bit	Description	Value		
		0	Headlight (forward)	1		
		1	Back up light	2		
		2	Auxiliary function AUX 1	4		
		3	Auxiliary function AUX 2	8		
139	Assignment of function buttons	Assignment of function outputs to be active in back up mode			0 - 255	0
	Back up B	Bit	Description	Value		
		0	Acceleration on / off	1		
		1	Shunting speed on / off	2		

CV	Name	Description			Range	Value
141	Assignment of headlight button Forward A	Assignment of function outputs to headlights to be active in forward mode			0 - 255	1
		Bit	Description	Value		
		0	Headlight (forward)	1		
		1	Back up light	2		
		2	Auxiliary function AUX 1	4		
		3	Auxiliary function AUX 2	8		
142	Assignment of headlight button Forward B	Assignment of function outputs to headlights to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	Acceleration on / off	1		
		1	Shunting speed on / off	2		
144	Assignment of headlight button Back up A	Assignment of function outputs to headlights to be active in back up mode			0 - 255	2
		Bit	Description	Value		
		0	Headlight (forward)	1		
		1	Back up light	2		
		2	Auxiliary function AUX 1	4		
		3	Auxiliary function AUX 2	8		
145	Assignment of headlight button Back up B	Assignment of function outputs to headlights to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	Acceleration on / off	1		
		1	Shunting speed on / off	2		
147	Assignment of function button F1 Forward A	Assignment of function outputs to F1 to be active in forward mode			0 - 255	4
		Bit	Description	Value		
		0	Headlight (forward)	1		
		1	Back up light	2		
		2	Auxiliary function AUX 1	4		
		3	Auxiliary function AUX 2	8		
148	Assignment of function button F1 Forward B	Assignment of function outputs to F1 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	Acceleration on / off	1		
		1	Shunting speed on / off	2		

CV	Name	Description			Range	Value
150	Assignment of function button F1 Back up A	Assignment of function output to F1 to be active in back up mode			0 - 255	4
		Bit	Description	Value		
		0	Headlight (forward)	1		
		1	Back up light	2		
		2	Auxiliary function AUX 1	4		
		3	Auxiliary function AUX 2	8		
151	Assignment of function button F1 Back up B	Assignment of function outputs to F1 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	Acceleration on / off	1		
		1	Shunting speed on / off	2		
153	Assignment of function button F2 Forward A	Assignment of function outputs to F2 to be active in forward mode			0 - 255	8
		Bit	Description	Value		
		0	refer to CV 147			
154	Assignment of function button F2 Forward B	Assignment of function outputs to F2 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 148			
156	Assignment of function button F2 Back up A	Assignment of function outputs to F2 to be active in back up mode			0 - 255	8
		Bit	Description	Value		
		0	refer to CV 150			
157	Assignment of function button F2 Back up B	Assignment of function outputs to F2 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 151			
159	Assignment of function button F3 Forward A	Assignment of function outputs to F3 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 147			
160	Assignment of function button F3 Forward B	Assignment of function outputs to F3 to be active in forward mode			0 - 255	2
		Bit	Description	Value		
		0	refer to CV 148			

CV	Name	Description			Range	Value
162	Assignment of function button F3 Back up A	Assignment of function outputs to F3 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 150			
163	Assignment of function button F3 Back up B	Assignment of function outputs to F3 to be active in back up mode			0 - 255	2
		Bit	Description	Value		
		0	refer to CV 151			
165	Assignment of function button F4 Forward A	Assignment of function outputs to F4 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 147			
166	Assignment of function button F4 Forward B	Assignment of function outputs to F4 to be active in forward mode			0 - 255	1
		Bit	Description	Value		
		0	refer to CV 148			
168	Assignment of function button F4 Back up A	Assignment of function outputs to F4 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 150			
169	Assignment of function button F4 Back up B	Assignment of function outputs to F4 to be active in back up mode			0 - 255	1
		Bit	Description	Value		
		0	refer to CV 151			
171	Assignment of function button F5 Forward A	Assignment of function outputs to F5 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 147			
172	Assignment of function button g F5 Forward B	Assignment of function outputs to F5 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 148			
174	Assignment of function button F5 Back up A	Assignment of function outputs to F5 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 150			

CV	Name	Description			Range	Value
175	Assignment of function button F5 Back up B	Assignment of function outputs to F5 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 151			
177	Assignment of function button F6 Forward A	Assignment of function outputs to F6 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 147			
178	Assignment of function button F6 Forward B	Assignment of function outputs to F6 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 148			
180	Assignment of function button F6 Back up A	Assignment of function outputs to F6 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 150			
181	Assignment of function button F6 Back up B	Assignment of function outputs er to F6 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 151			
183	Assignment of function button F7 Forward A	Assignment of function outputs m to F7 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 147			
184	Assignment of function button F7 Forward B	Assignment of function outputs to F7 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 148			
186	Assignment of function button F7 Back up A	Assignment of function outputs to F7 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 150			
187	Assignment of function button F7 Back up B	Assignment of function outputs to F7 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 151			

CV	Name	Description			Range	Value
189	Assignment of function button F8 Forward A	Assignment of function outputs to F8 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 147			
190	Assignment of function button F8 Forward B	Assignment of function outputs to F8 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 148			
192	Assignment of function button F8 Back up A	Assignment of function outputs to F8 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 150			
193	Assignment of function button F8 Back up B	Assignment of function outputs to F8 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 151			
195	Assignment of function button F9 Forward A	Assignment of function outputs to F9 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 147			
196	Assignment of function button F9 Forward B	Assignment of function outputs to F9 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 148			
198	Assignment of function button F9 Back up A	Assignment of function outputs to F9 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 150			
199	Assignment of function button g F9 Back up B	Assignment of function outputs to F9 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 151			
201	Assignment of function button F10 Forward A	Assignment of function outputs to F10 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 147			

CV	Name	Description			Range	Value
202	Assignment of function button F10 Forward B	Assignment of function outputs to F10 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 148			
204	Assignment of function button F10 Back up A	Assignment of function outputs to F10 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 150			
205	Assignment of function button F10 Back up B	Assignment of function outputs to F10 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 151			
207	Assignment of function button F11 Forward A	Assignment of function outputs to F11 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 147			
208	Assignment of function button F11 Forward B	Assignment of function outputs to F11 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 148			
210	Assignment of function button F11 Back up A	Assignment of function outputs to F11 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 150			
211	Assignment of function button F11 Back up B	Assignment of function outputs to F11 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to e CV 151			
213	Assignment of function button F12 Forward s A	Assignment of function outputs to F12 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 147			
214	Assignment of function button F12 Forward B	Assignment of function outputs to F12 to be active in forward mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 148			

CV	Name	Description			Range	Value
216	Assignment of function button F12 Back up A	Assignment of function outputs to F12 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 150			
217	Assignment of function button F12 Back up B	Assignment of function outputs to F12 to be active in back up mode			0 - 255	0
		Bit	Description	Value		
		0	refer to CV 151			

Electronic Solutions Ulm

Trouble Shooting Sheet

1. Personal Information

Name:	
Address:	
Address:	
State:	
Phone:	
Email:	

2. Product Details and System Environment

Order number	Description / Sound	Date of Purchase	Address (Märklin)

Operating Mode: ☐ DC ☐ DCC ☐ DC Analog ☐ AC digital

Command Station Used: ☐ Märklin 6021 ☐ Roco Digital ☐ LGB MZS
☐ Intellibox ☐ Lenz Digital ☐ Digitrax
☐ others _____

3. Error Description

☐ Headlight Output   ☐ Front   ☐ Rear

☐ Motor Putput

☐ Short Circuit

☐ Sound   ☐ No Sound   ☐ Wrong Sound

☐ Programming

☐ AUX-Outputs Fail

☐ Change Direction Problems

☐ Wire Harness

4. Additional information

Installed by: _____

Comments: _____
_____
_____
_____

5. Proof of Purchase
Please enclose with the claimed decoder!

6. Dealer Information

Company, Shop or Dealer Address