# LokPilot Nano

## Instruction Manual

1. Edition, November 2016

LokPilot Nano Standard
LokPilot Fx Nano

### Important Notes – Please read this chapter first

We congratulate you to your purchase of an ESU LokPilot Nano Standard or LokPilot Fx Nano decoder. This manual will guide you step by step through the features of your LokPilot decoder.

Please read this manual carefully. Although the LokPilot has been design as a robust device an incorrect connection may lead to faults or even to the destruction of the device. Avoid any "costly" experiments.

- Do not expose to wet and humid conditions and Avoid mechanical force or pressure on the decoder
- Any wiring has to be carried out while power is disconnected.
- Adhere to the wiring principles as outlined in this manual for wiring any external components. Other circuitry may cause damage to the decoder.
- Make sure that neither the decoder nor any blank wire ends may come into contact with the engine chassis (risk of short circuit).
- Never wrap the decoder in insulation tape, since this may cause overheating.
- Any power supply must be protected by a fuse or circuit breaker to avoid any potential hazards such as burning cables in case of a short circuit. Only use transformers specifically designed for model trains that bear the VDE/EN marks.
- Never operate the LokPilot unattended. It is not a (children›s) toy.

### Declaration of Conformity

We, ESU electronic solutions ulm GmbH & Co. KG, Edisonallee 29, D-89231 Neu-Ulm, declare in sole responsibility that the product

**Product description: LokPilot Nano Standard, LokPilot Fx Nano**
**Part Number: 53661, 53664, 53665, 53620**

acomplies with all relevant regulations of the Directive for Electromagnetic Compatibility (2004/108/EG). The following harmonised standards have been applied:

EN 55014-1:2006 + A1:2009: Electromagnetic Compatibility - requirements for household appliances, electric tools, and similar apparatus - Part 1: Emission - Product

EN 55014-2:1997 + A1:2001 + A2:2008: Electromagnetic Compatibility - Requirements for household appliances, electric tools, and similar apparatus - Part 2: Immunity - Product family standard.

### General Properties

The LokPilot Nano Standard is our smallest decoder based on only 8.0mm x 7.0mm. It is only 2.4 mm high and thus is shallow enough to fit into very small locomotives, even in TT and N scale. Despite its very compact size we have not made any shortcuts with regard to quality and robustness.

The LokPilot Nano Standard supports the DCC protocol including RailComPlus and is available with either a 6-pin or 8-pin plug (with and without wire harness) and can control up to 4 function outputs.

The LokPilot Fx Nano is a multi-protocol decoder that supports DCC with RailComPlus and Motorola for vehicles without a motor and can control up to 6 functions.The decoder is supplied with a wire harness and an 8-pole plug as per NEM-652.

| Specifications | | | | | | |
|---|---|---|---|---|---|---|
| | LokPilot Nano Standard | | | LokPilot Fx Nano | | |
| Operating Voltage | 5V bis 18V | | | 5V bis 18V | | |
| DCC-Operation | Ok | | | Ok | | |
| Motorola®-Operation | - | | | Ok | | |
| M4-Operation (mfx® compatible) | - | | | - | | |
| Selectrix®-operation | - | | | - | | |
| Analogue DC operation | Ok | | | Ok | | |
| Analogue AC operation | - | | | - | | |
| DCC-Pprogramming mode | Ok | | | Ok | | |
| programming with 6021, Mobile/ Central Station® | - | | | Ok | | |
| RailComPlus® | Ok | | | Ok | | |
| ABC brake mode | - | | | - | | |
| Continuous motor current | 0,5A | | | - | | |
| Function output current | 4/100 mA | | | 6/100mA | | |
| Optional connection for Power-Pack buffer capacitor | - | | | - | | |
| Connection type | 8-pin harness | 6-pin harness | 6-pin Direct | 8-pin harness | | |
| Item Number | 53661 | 53664 | 53665 | 53620 | | |

**Requirements for Installation**

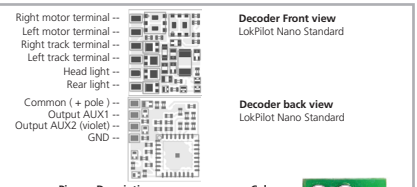
The locomotive must be in perfect operating condition prior to the conversion: Only a locomotive with faultless mechanical properties and smooth running characteristics in analogue mode is worth converting to digital. Check and replace all wear and tear parts such as motor brushes, wheel contacts, light bulbs etc., if necessary.

## Installing the Decoder

**LokPilot Nano Standard with 8-pin NEM652 interface**

Some LokPilot Nano decoders are supplied with an 8-pin interface as per NEM 652 (refer to Fig 1). Remove the dummy plug from the socket and keep it for future use.

Insert the plug of the decoder in such a way that pin 1 of the plug (this is the side with the red / orange wires) sits next to the corner of the socket that is usually marked with *, +, •. Please make sure that the pins are straight and do not tilt when inserting the plug.



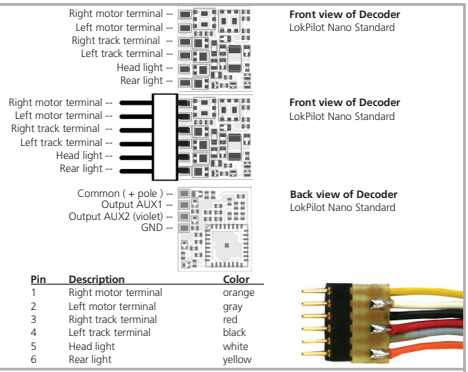

| Pin | Description | Color |
|---|---|---|
| 1 | Right motor terminal | orange |
| 2 | Rear light | yellow |
| 3 | Output AUX1 | green |
| 4 | Left track terminal | black |
| 5 | Left motor terminal | gray |
| 6 | Head light | white |
| 7 | Common (+ pole ) | blue |
| 8 | Right Track terminal | red |

**Fig. 1: LokPilot Nano with 8-pin NEM652 Interface**

**LokPilot Nano Standard with 6-pin NEM651 interface**

Some LokPilot Nano decoders are supplied with an 6-pin interface as per NEM 651 (refer to Fig 3). Remove the dummy plug from the socket and keep it for future use.

Insert the plug of the decoder in such a way that pin 1 of the plug (this is the side with the red / orange wires) sits next to the corner of the socket that is usually marked with *, +, •. Please make sure that the pins are straight and do not tilt when inserting the plug.




| Pin | Description | Color |
|---|---|---|
| 1 | Right motor terminal | orange |
| 2 | Left motor terminal | gray |
| 3 | Right track terminal | red |
| 4 | Left track terminal | black |
| 5 | Head light | white |
| 6 | Rear light | yellow |

**Fig. 3: LokPilot Nano with 6-pin NEM651 interface**

**LokPilot Nano Standard for locomotives without interface**

Firstly, please cut all wires installed in the locomotive. Take special care to remove any connections to the chassis (ground): the motor leads must be positively potential-free, in other words they may not have any contact to the chassis or body or the wheels and wheel contacts. Figure 2 shows all connections. Connect the common of the function outputs to the blue wire. As an alternative, you may wire (some) function outputs against the chassis of the locomotive.

**Function outputs**

You can wire all kind of load to the function outputs.

Please make sure that the load does not exceed the permitted maximum current and there are no short circuits. Due to size restictions. the outputs of the LokPilot Nano have NO short circuit protection on the function outputs. A wiring mistake may suffer damage or destruction of the output or decoder.

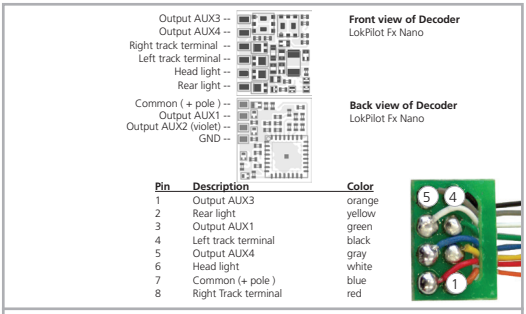
Only install bulbs rated 16V or higher and with a nominal current draw, that does not exceed 50 mA or use suitable smoke units such as Seuthe No. 11. LEDs need a resistor with a rating between 470 Ohms and 2.2 kOhms need to be wired in series. Running the LED without resistor will lead to their immediate destruction!

**LokPilot Fx Nano for non motorized vehicles**

Only LokPilot Fx Nano Standard decoders support the outputs AUX3 and AUX4. You can access these outputs via the orange resp. the gray wire.

A LokPilot Fx Nano can not control a traction motor!

The pin connections do not follow the NEM standard. The connections are shown in Fig. 4.




| Pin | Description | Color |
|---|---|---|
| 1 | Output AUX3 | orange |
| 2 | Rear light | yellow |
| 3 | Output AUX1 | green |
| 4 | Left track terminal | black |
| 5 | Output AUX4 | gray |
| 6 | Head light | white |
| 7 | Common (+ pole ) | blue |
| 8 | Right Track terminal | red |

**Fig. 4: LokPilot Fx Nano with 8-pin NEM652 interface**

## DCC Operation

The LokPilot Nano works with any DCC system.Remove any capacitors that are wired into the track feeders (e.g. ROCO® feeder track). This could impair the functionality of the decoder.

The address is set to 03 with 28 speed steps.

F1 switches output AUX1
F2 switches output AUX2
F3 switches the switching mode on and off
F4 switches the acceleration an deceleration on /off
F5 switches output AUX3 (if applicable)
F6 switches output AUX4 (if applicable)

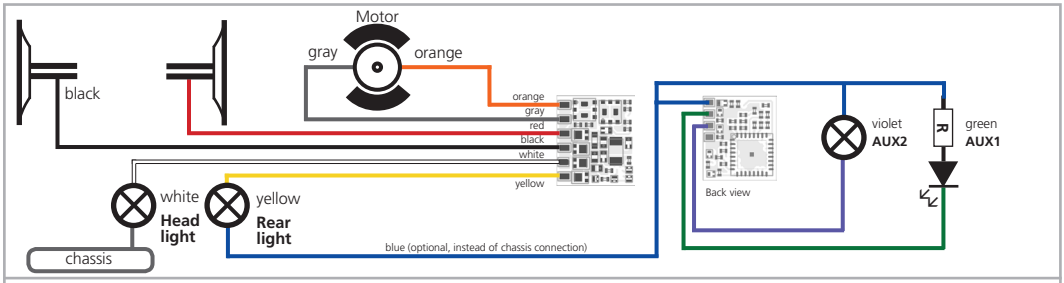



**Fig. 2: Wiring diagram for LokPilot Nano Standard (wiring example)**

## Motorola® Operation

Only the LokPilot Fx Nano supports also the Motorola®-protocol. Therefore it can also be used on Märklin®-operated layouts. However, only the function buttons F0 and F1 to F4 are available.

## Analogue DC operation

The LokPilot Nano Standard work on conventional DC layouts also. DC operation is detected automatically.

⚠ Please check the maximum output voltage of your transformer. The usage of a Märklin® AC transformer will will definitely lead to the destruction of the decoder

## Decoder settings (Programming)

A list of all CV parameters ist given later. These can be changes using any DCC command station. LokPilot decoders support all NMRA programming modes as there are the programming track modes and the mode for the main. With RailCom® you can read CV values on the main

**Programming using Märklin® 6021 (LokPilot Fx Nano only)**

The Märklin® central unit 6021 works differently: Since it does not comply with the NMRA DCC standards, LokPilot decoders 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.

**Entering Programming mode using 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 arrestor 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".

**The 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).

**The 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 – 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" ).

## RailComPlus®

Using RailComPlus®, the decoder will be automaitcelly recognized by a compatible command station.

You can disable this by deleting Bit 7 of CV 28.

## Function Outputs

Each function output can be set to a certain effect. For each physical output one CV (CV113 - CV118) is provided to define both their beha-

| CV | Function | Head Light | Rear Light | AUX 1 | AUX 2 | AUX 3 | AUX 4 | Shunting Mode | Acceleration/ Deceleration | CV | Grade Crossing | Dimmer | Dynamic Brake | Virtual Sound | n.a. | n.a. | n.a. | n.a. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 33 | F0 Forward | **1** | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 139 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 34 | F0 Reverse | 1 | **2** | 4 | 8 | 16 | 32 | 64 | 128 | 140 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 35 | F1 Forward | 1 | 2 | **4** | 8 | 16 | 32 | 64 | 128 | 141 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 36 | F2 | 1 | 2 | 4 | **8** | 16 | 32 | 64 | 128 | 142 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 37 | F3 | 1 | 2 | 4 | 8 | 16 | 32 | **64** | 128 | 143 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 38 | F4 Forward | 1 | 2 | 4 | 8 | 16 | 32 | 64 | **128** | 144 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 39 | F5 Forward | 1 | 2 | 4 | 8 | **16** | 32 | 64 | 128 | 145 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 40 | F6 Forward | 1 | 2 | 4 | 8 | 16 | **32** | 64 | 128 | 146 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 41 | F7 Forward | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 147 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 42 | F8 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 148 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 43 | F9 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 149 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 44 | F10 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 150 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 45 | F11 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 151 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 46 | F12 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 152 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 47 | F1 Reverse | 1 | 2 | **4** | 8 | 16 | 32 | 64 | 128 | 153 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 129 | F13 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 154 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 130 | F14 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 155 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 131 | F15 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 156 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 132 | F16 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 157 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 133 | F17 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 158 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 134 | F18 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 159 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 135 | F4 Reverse | 1 | 2 | 4 | 8 | 16 | 32 | 64 | **128** | 160 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 136 | F5 Reverse | 1 | 2 | 4 | 8 | **16** | 32 | 64 | 128 | 161 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 137 | F6 Reverse | 1 | 2 | 4 | 8 | 16 | **32** | 64 | 128 | 162 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |
| 138 | F7 Reverse | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 | 163 | 1 | 2 | 4 | 8 | 16 | 32 | 64 | 128 |

**AUX3: LokPilot Fx Nano only**
**AUX4: LokPilot Fx Nano only**

**Fig. 5: Function Mapping Table LokPilot Nano Standard, LokPilot Fx Nano**

viour (Mode) and the brightness. Please write the following values into the corresponding CVs to enable the following effects:

| Name | Description | Brightness | Mode |
|---|---|---|---|
| Dimmer | Normal light | 0 - 15 | + 0 |
| Blinking light Phase I | Output is blinking with defined frequency | 0 - 15 | + 16 |
| Blinking light Phase II | like above, but the light is blinking alternating. | 0 - 15 | + 32 |
| Strobe | Strobe light | 0 - 15 | + 48 |
| Firebox | Flickering light of a fire box or braking lights | 0 - 15 | + 80 |
| Zoom | Light that fades in / out | 0 - 15 | + 112 |
| Marslight | Mars light | 0 - 15 | + 128 |
| Gyralight | Gyra light | 0 - 15 | + 144 |
| Ditch light | Ditch light Phase I | 0 - 15 | + 208 |
| Ditch light | Ditch light Phase II | 0 - 15 | + 224 |

**Flash rate for blinking lights**

You can also set the flash rate for the lighting effects Blinking Light, Strobe or Marslight. All effects will flash or strobe at the same rate. The desired value should be stored in CV 112.

**Function Mapping**

All function outputs may be assigned to the available function buttons. Each function button (F0 to F18) is linked to two CVs: For example, for F0 forward is linked to CV 33 and CV 139, for F0 reverse you will find CV34/140 and so on. The number you enter defines the behaviour of the output.

Example: Writing the value 8 into CV36 defines that output AUX2 will listen to Function Button F2.

The table shown in Fig.5 shows the values that have to be entered into these CVs. Refering to the table, locate the intersection of

- The row of the desired function button and
- The column for the desired function output.

There you can find the value that you have to enter into the appropriate CV. factory settings are printed in bold. If one function button has to control more outputs, simply add the numbers and write the result into the CV

**Virtual Sound**

If desired, the LokPilot Nano Standard is able to delay the start of the loco: the loco will just start driving when the time set in CV 128 has run out. This serves the synchronisation of locos equipped with LokSound decoders and run with advanced consisting. Just map this fuction to a key of your choice to switch the sound (and thus the delay) virtually on and off.

**Grade Crossing**

Map this function to any function button to enable the «Grade crossing» function: If active, all outputs that are set to «Ditch light» will blink as long as this function button is pressed.

**Decoder Reset**

You can reset the decoder to the default settings at any time.

Enter the value 08 into CV 08.

| CV | Name | Description | Range | Value |
|---|---|---|---|---|
| 1 | Locomotive address | Adress of engine | 1 - 127 | 3 |
| 2 | Start voltage | Sets the minimum speed of the engine | 1 - 64 | 3 |
| 3 | Accceleration | This value multiplied by 0.25 is the time from stop to maximum speed | 0 - 255 | 16 |
| 4 | Deceleration | This value multiplied by 0.25 is the time from maximum speed to stop | 0 - 255 | 12 |
| 5 | Maximum speed | Maximum speed of the engine | 0 - 64 | 64 |
| 6 | Medium speed | Medium speed of the engine | 0 - 64 | 22 |
| 8 | Manufacturer ID | Manufacturer´s ID ESU - Writing value 8 in this CV triggers a reset | 151 | - |
| 17/18 | Extended address | Long address of the engine | 128- 9999 | 192 |
| 19 | Consist Address | Additional address for consist operation. Value 0 or 128 disables the consist address<br>1 – 127 Consist address, normal direction<br>129 – 255 Consist address, reverse direction | 0-255 | 0 |
| 27 | Brake mode | Allowed brake modes<br>Bit / Function / Value<br>3 / Brake on DC, if polarity against driving direction / 8<br>4 / Brake on DC, if polarity like driving direction / 16 | | 24 |
| 28 | RailCom® Configuration | Settings for RailCom® (Set value to 0 to disable an option)<br>Bit / Function / Value<br>0 / Channel 1 Broadcast enabled / 1<br>1 / Data transmission allowed on channel 2 / 2<br>7 / RailComPlus® automatic loco recognition enabled / 128 | | 131 |
| 29 | Configuration register | This CV contains important information to setup your decoder<br>Bit / Function / Value<br>0 / Reverse Direction of travel / 1<br>1 / 28 or 128 speed steps instead of 14 speed steps / 2<br>2 / Enable analogue operation / 4<br>3 / Enable RailCom® / 8<br>4 / Speed curve through CV 67 - 94 (instead of CV 2,5,6) / 16<br>5 / Long addresses (CV 17+18) instead basic address (CV 1) / 32 | | 12 |
| 33-47 | Function mapping | Assignment of function outputs to the function buttons. Part #1 | 0 - 255 | - |
| 49 | Extended Configuration | Further settings of the decoder (set value to 0 to disable an option)<br>Bit / Function / Value<br>0 / Enable B-EMF function / 1<br>4 / Enable automatic DCC speed step detection / 16 | 0 - 255 | 17 |
| 53 | Control Reference voltage | Defines the Back EMF voltage, which the motor should generate at maximum speed. If the engine does not reach maximum speed, reduce this parameter. | 0 - 255 | 140 |
| 54 | Load control parameter «K» | «K»-component of the internal PI-controller. Defines the effect of load control. The higher the value, the stronger the effect of Back EMF control. | 0 - 255 | 50 |
| 55 | Load control parameter «I» | «I»-component of the internal PI-controller. Defines the momentum (inertia) of the motor. The higher the momentum of the motor (large flywheel or bigger motor diameter), the higher this value has to be set. | 0 - 255 | 100 |
| 67-94 | Speed table | Defines motor voltage for speed steps. | 0 - 255 | - |
| 112 | Blinking frequency | Blinking frequency for light effects. A multiple of 0.065536 Seconds. | 1 - 255 | 16 |
| 113 | Head light configuration | Defines brightness and mode of output Head light | 0 - 255 | 15 |
| 114 | Rear light configuration | Defines brightness and mode of output Rear light | 0 - 255 | 15 |
| 115 | AUX1 configuration | Defines brightness and mode of output AUX1 | 0 - 255 | 15 |
| 116 | AUX2 configuration | Defines brightness and mode of output AUX2 | 0 - 255 | 15 |
| 117 | AUX3 configuration | Defines brightness and mode of output AUX3 (LokPilot Fx Nano only) | 0 - 255 | 15 |
| 118 | AUX4 configuration | Defines brightness and mode of output AUX4 (LokPilot Fx Nano only) | 0 - 255 | 15 |
| 128 | Virtual Sound | Defines the start delay when function is active. A multiple of 0.065536 seconds. | | |
| 129-163 | Function mapping | Assignment of function outputs to the function buttons. Part #2 | 0 - 255 | - |