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Instruction manual

Loco-1 / Loco-2

Art.-No. 10600 / 10601

Rail Com

Table of Content

1   Declaration of conformity

This product was developed in accordance with the harmonized
European standards EN 55014-1 and EN 61000-6-3 and meets the
requirements of EU directive 2014/30 / EU on electromagnetic
compatibility and EU directive 2011/65 / EU to restrict the use of
certain hazardous substances in electrical and electronic equipment.
It bears the CE mark for compliance.

2   Safety advices

**Before you start using this product or its installation read these
instructions carefully.**

This product is not a toy. Not suitable for children under 14 years!
Keep these instructions for future reference!

This module is intended to be integrated into a model railway system
for driving a locomotive model within the limits indicated in Chapter 3
- "Technical specifications".

Any other use is considered improper. The manufacturer is not liable
for any damage resulting from improper use. The risk lies entirely
with the user.

All connection work must be performed only when the operating
voltage is shut off!

The power supply must be protected so that it cannot result in a cable
fire in the event of a short circuit. Use only commercially available
and VDE / EN model railroad transformers!

Use the device only in closed, clean and dry environment. Avoid ambient humidity, moisture and water spray.

When making electrical connections pay attention to sufficient wire cross section.

After the formation of condensate on the parts wait for at least two hours for drying off before you switch power on.

Danger of burns! Some components on the decoder can achieve a high operating temperature!

Warning: risk of burns! Please note during installation that the soldering experiences high temperatures. Use safety glasses when soldering if possible! There may be solder squirts that can get on your skin or in your eyes.

Warning: risk of fire! Please note that in case of use of a soldering iron fire hazard exists! Do not leave the switched-on soldering iron unattended! There is a fire hazard if the soldering iron is in contact with flammable materials!

Only use lead-free solder for the installation of the decoder!

3   Introduction

Thank you for choosing the Loco-1/Loco-2 decoder. This guide is meant to take the decoder into operation and help you to make the various settings.

This manual applies starting from firmware version 16 for Loco-1 and firmware version 11 for Loco-2. Any firmware updates may include other new features that are not included in this manual. An updated manual is supplied as a PDF file with the new firmware, if needed.

4   Technical specifications

Data format	Märklin®/Motorola or DCC (Loco-1 with RailCom® support)
Motor type	DC- or AC(Märklin®)-Motor
max. current rating of the motor driver	1A
Number of function outputs	4
max. current rating of AUX drivers (single / sum of all)	0,5 A / 0,5 A
max. current rating of decoder	1,5 A
Operating voltage	12 … 24 V

Ambient temperature range:
    - operation
    - storage
	0…40°C
	-20…70°C

Dimensions	ca. 16 x 19 x 3 mm

5 Mounting

Open the locomotive housing according to the manufacturer's instructions. Determine the location where you want to install the decoder. First disconnect the connections of the motor and the consumers from the rail collectors or, for locomotives with electronic or electro-mechanical switch, the connections of the switch to the motor and to the rail collectors. The changeover switch is no longer needed and should be removed.

Note: When installing the decoder, the already existing wiring in the loco can be reused in most cases. The existing wires have to be unsoldered or separated at the appropriate places and have to be soldered to the corresponding solder points of the decoder.

Please inform yourself in advance about the problems that can be expected or are possible when installing the decoder, especially with older locomotives!

If you have any doubts about correct installation or if the following description is unclear, please contact us before commissioning!

Important: The decoder is not protected against all possible short circuits or types of short circuits!

5.1 Solder pads connection overview

Pad	Function
Rail	Connections to the current collectors / grinder
MOT	Motor connection (DC and AC motor)
+	common connection for AUX outputs and motor shield with AC (Märklin®) motor
AUX1 – AUX4	Function outputs for lighting, smoke generator, Telex couplers, etc.
C+ / C-	backup capacitor (see page 9)

The picture below shows the connections:
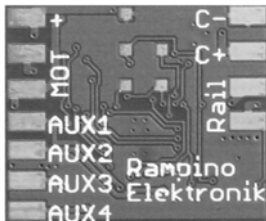
5.2   **Connection of the rail collector**

In a two- rail-loco connect the lines of the two current collectors with either of the two solder points with the label 'Rail'.
In a three-rail-loco, connect the locomotive ground with one of the two solder pads called 'Rail'. Connect the grinder with the remaining solder pad.
Note: The polarity of the digital signal is automatically detected by the decoder.

5.3   **Connecting the motor**

Check before installation of the decoder, if the maximum current of the locomotive motor under load is below the maximum permissible value of 1.000 mA. If the value is above 1.000 mA, this decoder is not suitable for installation in the locomotive. The decoder has an over-current shutdown, which is activated, if the maximum permissible motor current is exceeded. Please note that if the motor is worn or defective or if there is no or inadequate interference suppression, overvoltage can occur on the motor, which can destroy the decoder! It may be necessary to replace defective motor components, e.g. if there is a short circuit in the armature!

Interference suppression: The interference suppression devices that are attached to the motor or in the supply line from the motor to the decoder must not be removed! Only remove any capacitors that may be present that lead from the motor connections to the locomotive ground or to the chassis. If there is no interference suppression at all, please retrofit it. Significant electrical disturbances can occur in the entire system if interference suppression components are removed or missing. Check in advance whether the interference suppression components used are intact.

Important: In addition to the usual interference suppression devices, please be sure to fit a bidirectional TVS diode (suppressor diode 24 - 27V, e.g. P6KE27CA). This is imperative to avoid defects.

Connecting a DC motor:
Connect the two terminals of the motor (chokes) each to one of the two solder points labeled 'MOT'. Mount the TVS diode in parallel with the motor (capacitor), directly on the motor.

Connection of an all-current (or AC) motor (Märklin®):
Connect the leads of the two field coils to one of the two solder points labeled 'MOT'. Connect the motor shield connection (choke) to the solder point '+'. Attach the TVS diode to the "C+" and "C-" decoder connections.

5.4 **Connection of consumers/loads**

Check before mounting the decoder whether the current consumption of the loads to be connected (e.g. lighting, smoke generator) is not exceeded. The maximum value of all consumer connection is 500mA. The decoder also has an overcurrent shutdown.

Consumers are connected to one of the solder points AUX 1 - AUX 4. By default setting, the headlights have to be connected to AUX1 (forward direction) or AUX2 (reverse direction). The assignment of the function outputs can be changed using the corresponding CV.

If possible and applicable, the consumer should be decoupled from the chassis of the locomotive, for example in order to avoid flickering of a possibly connected light. The consumer has to be connected via the '+' terminal of the decoder in this case.

Connection of LEDs as a consumer
The function outputs (AUX1 to AUX 4) are switched towards the
decoder ground. Therefor the cathode (-) of the LEDs have to be
connected to the output of the function outputs (AUX).
The anodes of the LEDs, have to be connected to the decoder
connection with the designation '+'.

Attention:
If you are using LEDs, you must always operate them via a series re-
sistor. The series resistors are different depending on the rail power
and the characteristics of the LEDs. Determine the correct value for
the corresponding LED. You can connect several LEDs in parallel to
each output. In this case, each LED must have its own resistor. If you
connect several LEDs to one output in series, only one series resistor
is needed.

Connection of a backup capacitor
A backup capacitor (e.g. electrolytic capacitor 100 µF / 35V) must be
connected to solder points "C -" and "C +". Pay attention to the
polarity of the capacitor! The plus pole is connected to "C +", the
minus pole to "C -". Capacitors larger than 220 µF may only be
connected via an additional charging circuit.

5.5   Mounting/fastening the locomotive decoder

After completing of all connections to the decoder it should be
fastened. This can be done e.g. with double-sided tape. Please note
that the decoder heats up and the applied adhesive tape can possibly
be solved by heating. Take care that the decoder has no contact with
the conductive enclosure or chassis parts of the locomotive when
mounting. When closing the locomotive housing, also make sure that
no cables are squeezed or that the cable insulation is not damaged.

6 Decoder functions

Digital operation

The decoder is a multi-protocol decoder. It automatically detects whether it is driven in DCC format or the Märklin® / Motorola format. The automatic detection can be disabled.
The address range depends on the format in which the decoder is controlled:

Märklin®/Motorola-Format: 255 or 80 addresses (depending on the control center). In the Märklin ® / Motorola format the decoder can be used with 14 or 27 speed steps (depending on the control center).

DCC- Format: 127 base addresses or 10.239 extended addresses. The decoder can be controlled in DCC format with 14, 28 or 128 speed steps.

Internally the decoder scales the speed steps up to 128 speed steps. The decoder programming is accomplished via configuration variables for the DCC format (DCC compliant) and for the Motorola format via registers.

Analogue operation

The decoder can also be used in analogue operated model railway layouts. Operation is possible with either an AC or a DC speed controller. Make sure that the maximum possible output voltage of the speed controller used does not exceed the maximum permissible voltage of the decoder! The decoder recognizes the digital or analogue mode automatically when the corresponding voltage is set. Automatic analogue mode detection can be disabled.
The on- and off control of the function outputs is not possible in analogue operation. They can be programmed so that they are turned on or off in analogue mode either. The effects that are set for the outputs, are also active in analogue mode. Outputs which can be switched with F0 on or off in analogue mode are switched on according to the driving direction.

Motor control

The detection of the connected motor type is automatic. The automatic detection can be switched off and the motor type can be set manually.

Note: If the loco does not run in analogue mode or only approach at high driving voltages, switch off the automatic motor recognition and set the appropriate motor type correctly.

The decoder controls a DC motor with a PWM frequency of 32 kHz or 16 kHz (adjustable). The decoder is thus also suitable for coreless (Faulhaber) motors.

A universal (Märklin®) motor is controlled with a PWM frequency of 120 Hz (not adjustable).

Load regulation

When controlling a DC motor load control is possible. The load regulation affects the motor voltage so that the speed of the locomotive operating at a given speed level remains constant, regardless of additional loads (e.g. running a gradient, coupled wagons).

The load control can be turned on or off and can be set so that it is effective only up to a certain speed level. The load control parameters can also be adjusted via CV variables or registers to adjust the decoder to individual characteristics of the motor.

For load control, a PID controller is implemented. Not only the P-, I- and D-values can be set, but also the length of the off time for the back electromotive force measurement (BEMF) and the length of the PWM pulse width, so that an optimum adaptation to the various types of motor is possible.

Note: Please make sure that when operating with load control the drive mechanism, gears and the motor of the locomotive are cleaned well and are perfectly functional.

Acceleration and braking delay
The acceleration and braking delay can be individually programmed.

Emergency stop
With a change of direction while driving an emergency stop is executed automatically.

Speed characteristic
By setting the start, mid and top speed the decoder can be adjusted to the driving characteristics of the engine and the characteristic speeds of the locomotive type. The decoder generates a linear velocity curve from the start, mid and top speed.
If the speed mode is set to 28 speed steps, any motor voltage can be assigned to an alternative to the linear velocity characteristic of each of the 28 speed steps. This allows the creation of a form adapted to the individual driving characteristics of the engine speed characterristic. The set values are stored in the alternate speed table.

Shunting speed
With appropriate programming the loco can be switched via a function key to the shunting speed. In the shunting speed all speed levels are reduced by approximately 50% compared to the set speed.
Note: In speed step 1, the driving speed is not reduced further.

Braking section
The decoder supports the Märklin® braking section. The mode can be adjusted via the corresponding CV.
Only Loco-1: In addition, the decoder supports the simple ABC-(DCC) braking section. Both types can be combined.

Function outputs
The decoder has four function outputs to which consumers can be connected based onto needs (e.g. lighting, smoke generator, sound module, electrical coupling). The function outputs are switched in DCC format using the function keys F0 to F12. In Motorola format, the function outputs are switched with the function keys F0 to F4. The function keys F5 to F8 can be switched via the function keys F1 to F4, which are associated with a second Märklin® / Motorola address. The functions F9 to F12 are not available in the Motorola format.

The assignment of the function keys to the function outputs of the Decoder is selectable. It is also possible to assign multiple function keys to a function output.
With the CV51 - Decoder configuration, the extended function mapping can be activated. This means that the mapping can be programmed depending on the direction. For example, an additional direction dependent lighting can be connected.

Effects of the function outputs
For all function outputs the following effects can individually be set:

Dimming function
The voltage present at the output can be reduced by programming (PWM).
Example: The bulbs of older locos, provided for analogue operation, can be dimmed and thus do not have to be replaced after installation of the decoder.

Dimming characteristic
A characteristic can be adjusted, which provides speed dependent dimming by a specified value of the corresponding output. This allows, for example, one of the driving position corresponding to realize smoke or a switched or dimmed in-cab lighting while driving. There are 15 levels available (speed step 0 - 14), the speed steps are converted accordingly to 28 or 128 speed steps.

Flash function

A small flash sequence can be programmed by programming up to 2 on and 2 off times in the corresponding CVs. Thus, for example a flash or a blinking light can be set (individually or alternately). The flashing mode can be set to any of the 4 function outputs and using the F key on and off. For the flash function, it is necessary to allocate it accordingly to bit 6 of the mapping function.

TELEX® - coupling / Roco® - digital coupling

The decoder has a kick-function for electric couplings. The coupling is first activated for 250ms at full voltage, then the drive voltage is lowered by a PWM. A maximum activation time or continuous operation can be set.

Note: Please enable this feature before starting the locomotive operation because otherwise the electric coupling can be damaged by actuation with permanent full decoder voltage.

Gyro-/Marslight

These two effects are adjustable for prototypical operations of U.S. locomotives. These effects can be adapted to LED lighting.

Overtemperature / Overload

The decoder is protected against overtemperature and overload. The function outputs and the motor output switch off in case of overload or overtemperature. If this is the case, check all connections for shorts and whether the connected loads are suitable for the decoder. In DCC systems the maximum temperature reached, and the error reason can be read via the corresponding CV.

Feedback with RailCom® (*only Loco-1*)

RailCom® is a protocol for bidirectional communication in digital model railway layouts that are controlled in DCC format. It allows for example feedback of the decoder address, CV settings and other information from the decoder to the digital control central or special receivers (RailCom® detectors). The decoder must be configured to send the so called RailCom® data packets. In addition, the booster or the DCC central must produce a cutout signal (blanking), within which the data is transmitted. In pure Motorola mode, without DCC control, the use of RailCom® is not possible.

The Loco-1 continuously sends the basic, advanced or consist address to the detectors (RailCom® broadcast message, adjustable) and transmits one or more CV value as response to a corresponding RailCom® readout command.

Function Decoder

The decoder can also be operated as a pure function decoder. Adjustment is via CV51 - Decoder configuration. In this mode the MOT outputs are assigned in a manner similar to the AUX outputs used. The MOT outputs are permanently assigned to a direction of travel: MOT1 forward, backward MOT2. These outputs can be assigned a function and are dimmable. It is possible to join anti-parallel connected LEDs between these outputs.

7 Decoder configuration/programming

7.1 Programming with a DCC Station

From the control center, you can program the configuration variables (CV). Please refer to the relevant section in the user manual of your control center, in which the byte-wise programming of CV variables is described (Direct CV Addressing). The decoder allows programming via POM (Programming on the main track) and the programming on a programming track.

7.2 Programming with a Märklin® Station

Set the loco on a track, which is connected to the output of the control center. Make sure that no other loco is on the track, because otherwise the further present decoder may also be programmed. Please note: If you have a control center that sends both the DCC and Motorola format, the programming of the decoder in DCC format is recommended. You can control the decoder after programming in the Motorola format.

Perform a reset at the control center by pressing the "stop" and "go" buttons at the same time for a longer time, or by turning the control center off and on again. First select the current address or the address '80' (if the current address is unknown). Make sure all functions are switched off (function, f1 to f4 to "off"). Next, press the "stop" button on the control panel. Then operate the direction switch and hold it in this position while you turn on the control center via the "go" button again.

Once the lighting of the vehicle starts to flash (after about 2 seconds), the decoder is in the programming mode, and you can release the direction switch. After you start the programming mode, you can program the registers of the decoder as follows:

- Select a register to program by selecting the register number as Märklin®/Motorola locomotive address. Note that in some control centers you must enter a leading "0".
- Activate the direction switch shortly. The lights will flash several times with higher frequency (input of the content of a register expected).
- Enter the desired value of the register by entering the register value as Märklin®/Motorola locomotive address
- Activate the direction switch again shortly. The lights will flash with lower frequency (input of a register number expected).

Repeat the above steps for all registers that you want to program. In order to program select a register or enter a value to a register, you must always confirm the entered number like selecting a Motorola locomotive address. Note that the register bank must be switched at registers greater than 79 (see table chapter 8).

Because at many control centers no addresses greater than 79 can be set, at register with contents greater than 79 the two most significant bits must separately be set before the actual programming of the register itself. This is done through the register 7.

Example:

If you want to program the value of 197 (bit value 11000101) into the register 90, proceed as follows:

- Program a 3 into the register 7 to set the two most significant bits (binary = 11 decimal 3)
- Program a '1' into the register 8 to switch the register bank
- Program a 5 (decimal 5 = binary 000101) into the register 11 (= 90 - 79)

Do not forget before programming the next register, to set the two most significant bits in register 7 accordingly. The reset of the register bank is done automatically after writing a register (with index > 79).

The programming mode is terminated by switching off the digital voltage. To do so press the "Stop" button on the control central.

Note: With Märklin® Central the value '0 'needs to be entered as '80'.

Hint: If you use a multi-protocol center, we recommend that you at least perform the programming in DCC mode. The settings are independent of the programming method used.

7.3   Programming with a Märklin® Mobile/Central Station

With the Central Station and the Mobile Station from Märklin®, you can program the registers.
To do this, select the article no. 29750 (V100) from the locomotive database and program the decoder as described for this article no. in the instructions of the Central Station or the Mobile Station.
In general, the option of the register programming can be found in menu 'change locomotive' under the point 'Reg'.

Also note the information in chapter 7.2

Note: To reset the CV values to the factory settings the CV 255 (or corresponding register) has to be used.

7.4   Firmware Update

The decoder firmware can be updated. The update can take place with installed decoder. To update you will need a PC with a serial (COM) port, and a booster that is connected to the COM port of the PC. You can find a description of this in the firmware update package or on our website under the heading "Firmware".
The change to update mode takes place automatically. For older decoders, please note the description of CV 255 in the following CV table. As soon as the update takes place, the front lighting flashes alternately. In the event of an error, the lighting is permanently on.

All CV and register settings are retained after a firmware update. This applies even if new CV or register were added by the update. It may happen that some CVs may need to be adjusted, due to changes in firmware.

8 Configuration Variables (CV) / Register

CV / Register Name	CV	Register Loco -1 / -2	Range (default)	Note
Base address	1	1	1 … 255 (3)	address of loco DCC: 1 … 127 Märklin®: 1 … 80 or 1 … 255
Minimum speed	2	2	0 … 255 (20)	Voltage applied to the motor at speed step 1
Acceleration rate	3	3	0 … 255 (10)	
Break rate	4	4	0 … 255 (10)	
Maximum speed	5	5	0 … 255 (220)	Voltage applied to the motor at the highest speed step
Mid speed	6	6	0 … 255 (110)	Voltage applied to the motor at the middle speed step
Version / upper bits register value	7	7	0 … 255 (6)	Firmware-Version (readable only in DCC format) in MM-Mode Bit 6 and 7 for the register programming: Bit 0: Registerbit 6 Bit 1: Registerbit 7

CV / Register Name	CV	Register Loco -1 / -2	Range (default)	Note
Manufacturer / Registerbank	8	8	57	Manufacturer ID (readable only in DCC format) in MM mode register bank switching for register greater than 79 (0: <= 79 1: > 79)
Load control Vmax	10	98 / 97	0 … 126 (0)	0 = load regulation off 1 … 126 = Speed step up to which the load control is active (based on normalized value)
Data packets timeout	11	9	0 … 255 (0)	Value in seconds after in the absence of loco addressing, the locomotive is stopped. 0 = no timeout
Reserved	12	10	0 (0)	not used
Analogue mode F1 – F8	13	11	0 … 255 (0)	State of functions F1 – F8 in analogue operation Bit 0: F1 Bit 1: F2 Bit 2: F3 Bit 3: F4 Bit 4: F5 Bit 5: F6 Bit 6: F7 Bit 7: F8 0 - function deactivated 1 - function activated

CV / Register Name	CV	Register Loco -1 / -2	Range (default)	Note
Analogue mode F0, F9 – F12	14	12	0 … 63 (3)	State of functions FL and F9 – F12 in analogue operation Bit 0: F0 forward Bit 1: F0 backward Bit 2: F9 Bit 3: F10 Bit 4: F11 Bit 5: F12 0 - function deactivated 1 - function activated
Extended address high byte	17	13	192 ... 231 (0)	Only in DCC Format activation via CV29 When changed in POM mode, this CV is stored only after the programming of CV18.
Extended address low byte	18	14	0 … 255 (3)	Only in DCC Format activation via CV29
Consist address	19	15	0 … 127 (0)	Only in DCC Format: address for Multitraction 0 = Multitraction deactivated

CV / Register Name	CV	Register Loco -1 / -2	Range (default)	Note
F1 – F8 activation with active multi traction	21	16	0 … 255 (0)	State of functions F1 – F8 with multi-traction Bit 0: F1 Bit 1: F2 Bit 2: F3 Bit 3: F4 Bit 4: F5 Bit 5: F6 Bit 6: F7 Bit 7: F8 0 - function deactivated 1 - function activated
FL, F9 – F12 activation with active multi traction	22	17	0 … 255 (0)	State of functions FL and F9 – F12 with multi-traction Bit 0: F0 forward Bit 1: F0 backward Bit 2: F9 Bit 3: F10 Bit 4: F11 Bit 5: F12 0 - function deactivated 1 - function activated

CV / Register Name	CV	Register Loco -1 / -2	Range (default)	Note
Automatic stop configuration	27	18	0 ... 255 (0)	Bit 0: automatic stop with asymmetrical DCC signal right track (ABC-braking, *only Loco-1*) Bit 1: automatic stop with asymmetrical DCC signal left track (ABC-braking, *only Loco-1*) Bit 4: automatic stop at positive DC rail voltage (Märklin®-braking) Bit 5: automatic stop at negative DC rail voltage (Märklin®-braking) 0 - function deactivated 1 - function activated Bit 0 and 1: not used, always 0 (*only Loco-2*) Bit 2, 3, 6 and 7: not used, always 0
Decoder configuration for RailCom® (*only Loco-1*)	28	19 / -	0 … 3 (0)	only with activated RailCom® (CV29) Bit 0: send address-broadcast in channel 1 Bit 1: send data in channel 2 0 - function deactivated 1 - function activated Bit 2 – 7: not used, always 0

CV / Register Name	CV	Register Loco -1 / -2	Range (default)	Note
Decoder configuration	29	20 / 19	0 … 63 (6)	Bit 0 loco direction 0 – normal 1 – inverted Bit 1 14/28 speed steps 0 – 14 speed steps 1 – 28 speed steps Bit 2 – analogue mode detection 0 – off 1 – on Bit 3 RailCom® configuration (*only Loco-1*) 0 – RailCom® off 1 – RailCom® on Bit 4 speed curve selection 0 – speed via CV2 and CV5 1 – speed curve active (CV 67-94) Bit 5 extended adressing (only DCC) 0 – base addressing via CV 1 1 – extended addressing via CV 17/18 Bit 3 – not used, always 0 (*only Loco-2*) Bit 6, 7 – not used, always 0
CV Page Index high (*only Loco-1*)	31	100 / -	0 ... 255 (0)	Page Index (see CV32)

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CV / Register Name	CV	Register Loco -1 / -2	Range (default)	Note
CV Page Index low (*only Loco-1*)	32	101 / -	0 ... 255 (0)	Page Index – in connection with CV31 these CVs determine which range is addressed via CV 257-512 CV31 = 0, CV 32 = 0: mirror of CV1-CV256 CV31 = 0, CV 32 = 255: RailCom® Page
Function mapping F0 forward	33	21 / 20	0 ... 255 (1)	Bit 0: AUX1 Bit 1: AUX2 Bit 2: AUX3 Bit 3: AUX4 Bit 4: shunting speed Bit 5: acceleration-/braking-delay Bit 6: flash sequence Bit 7: MOT (only in function decoder mode) 0 – inactive 1 – active
Function mapping F0 backward	34	22 / 21	0 ... 255 (2)	assignment of bits see CV33
Function mapping F1… F12	35 … 46	23 / 22 … 34 / 33	0 ... 255 (4, 8, 16, 32;rest 0)	assignment of bits see CV33 (in extended mapping for forward direction)

CV / Register Name	CV	Register Loco -1 / -2	Range (default)	Note
Dimming value AUX1…AUX4	47 … 50	35 / 34 … 38 / 37	0 … 100 (100)	Value in % with which the output is dimmed
Decoder settings	51	39 / 38	0 … 255 (128)	Bit 0: Motor type 0 – DC motor 1 – AC (Marklin®) motor Bit 1: Motor PWM frequency for DC-motor 0 – 15,625kHz 1 – 31,25kHz Bit 2: function mapping 0 – normal 1 – extended Bit 3: Function decoder mode 0 – Loco decoder 1 – Function decoder Bit 4: Storage speed 0 – on 1 – off Bit 5: Storage function key 0 – on 1 – off Bit 7: automatic detection of motor type 0 – off 1 – on Bit 6: not used Attention: POM cannot be used with this CV

CV / Register Name	CV	Register Loco -1 / -2	Range (default)	Note
Decoder temperature	52	40 / 39	0 … 100	Maximum measured temperature of the decoder in °C. Can be reset by writing the value '0'.
2nd Motorola address	53	41 / 40	1 ... 255 (4)	2nd address to reach the functions F5 – F8 of the decoder F1 of second address corresponds to F5 F4 of second address corresponds to F8
Load control PWM on time	54	42 / 41	0 … 255 (6)	Length of the time interval [ms] for the PWM pulses, where-with the control frequency can be adjusted
Load control blanking interval	55	43 / 42	0 … 255 (3)	Length of the blanking interval for the back EMF measurement [ms]
Load control PID controller P	56	44 / 45	0 … 255 (0)	P component of the PID controller for load control A value of 0 disables the load control
Load control PID controller I	57	45 / 44	0 … 255 (0)	I component of the PID controller for load control

CV / Register Name	CV	Register Loco -1 / -2	Range (default)	Note
Load control EMF reference	58	46 / 45	50 … 255 (220)	adjusts the maximum reference value of the back EMF voltage
Load control PID controller D	59	47 / 46	0 … 255 (0)	D component of the PID controller for load control
Fault memory	60	91 / 90	0 ... 7 (0)	Bit 0: Motor 0 – no overload 1 – overload Bit 1: AUX 0 – no overload 1 – overload Bit 2: Temperature 0 – normal temperature 1 – overtemperature Bit 3 – Bit 7: not used The fault memory can be cleared by writing the value '0' to this CV

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CV / Register Name	CV	Register Loco -1 / -2	Range (default)	Note
Motor/Start-kick	65	99 / 98	0 … 127 (0)	The value set here is used as the speed step when starting and is foreseen for engines that require an increased breakaway torque for starting. The value "0" disables this feature. The values set here correspond to the decoder internal speed steps (normalized to 128 steps)
Alternative speed characteristic	67 ... 94	48 / 47 … 75 / 74	0 … 255 (0)	Only in 28 speed step mode activation via CV29
User ID 1 … 2	105 … 106	92 / 91 … 93 / 92	0 … 255 (0)	free selectable ID
Characteristic for dimming AUX Output	112 … 126	76 / 75 … 90 / 89	0 … 255 (0)	With this characteristic, an AUX output can be dimmed depending on the speed step. The CV 112 corresponds to speed step 0, CV 126 to speed step 14/28/126.
Flash sequence	130 … 133	94 / 93 … 97 / 96	0 ... 255 (0)	CV130: T1ON, CV131: T1OFF, CV132: T2ON, CV133: T2OFF, Time adjustable in 50ms steps (0 = 0ms)

CV / Register Name	CV	Register Loco -1 / -2	Range (default)	Note
Effect AUX1	134	102 / 99	0 ... 255 (0)	Setting of effect-type for AUX 1 (see table page 34)
Effect Parameter 1-6 AUX1	135 … 140	103 / 100 … 108 / 105	0 ... 255 (0)	Parameter for effect AUX 1 (see table page 34)
Effect AUX2	141	109 / 106	0 ... 255 (0)	Setting of effect-type for AUX 2 (see table page 34)
Effect Parameter 1-6 AUX2	142 … 147	110 / 107 … 115 / 112	0 ... 255 (0)	Parameter for effect AUX 2 (see table page 34)
Effect AUX3	148	116 / 113	0 ... 255 (0)	Setting of effect-type for AUX 3 (see table page 34)
Effect Parameter 1-6 AUX3	149 … 154	117 / 114 … 122 / 119	0 ... 255 (0)	Parameter for effect AUX 3 (see table page 34)
Effect AUX4	155	123 / 120	0 ... 255 (0)	Setting of effect-type for AUX 4 (see table page 34)

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CV / Register Name	CV	Register Loco -1 / -2	Range (default)	Note
Effect Parameter 1-6 AUX4	156 … 161	124 / 121 … 129 / 126	0 … 255 (0)	Parameter for effect AUX 4 (see table page 34)
Function mapping F1 … F12 rev	162 … 173	130 / 127 … 141 / 138	0 … 255 (0)	assignment of bits see CV33 (only in extended mapping for reverse direction)
Dimming value MOT 1 … 2	174 … 175	236 … 237	0 … 255 (0)	Value with which the output is dimmed (only in Functiondecoder mode; 255 = 100%)
Bootloader Version	254	- / -	0 … 255	Only readable; Firmware version of the bootloader
Firmware update / CV Reset	255	255	222 123 (0 / 1)	- after setting the value 123 all the CVs / registers of the decoder are reset to delivery condition. - after setting the value 222 the decoder is put to the firmware update state (since bootloader version 3 not needed anymore) The reading of this CV provides back the product ID (0) for Loco-1; (1) for Loco-2 Attention: POM cannot be used with this CV

CV / Register Name	CV	Register Loco -1 / -2	Range (default)	Note
Indexed Page (*only Loco-1*)	257 … 512	- / -		see CV31/CV32

Description of settings for effects (CV134/141/148/155)

Type of effect	Value	Parameter	Note
none	0	none	for normal control dimming values via CVs 47 - 50
Speed dependent dimming	1	none	setting of the dimming characteristic via CVs 112 - 126
Flashing	2	none	settings in CVs 130 - 133
inverted flashing	3	none	inverted output of the flashing effect
Gyrolight	4	none	Bit 7: LED adaption 0 = Bulb 1 = LED
Marslight	5	none	Bit 7: LED adaption 0 = Bulb 1 = LED
TELEX®-coupling	8	No. 1: duration of activation (0 = permanent activation) Time adjustable in 50ms steps	
Roco® - digital coupling	9	see parameter TELEX®-coupling	

9   Terms of warranty

We provide a two-year warranty on this product. The guarantee includes the correction of faults, which are provable, due to defective material used by us or manufacturing defects. The compliance with the technical specifications of the circuit is guaranteed in accordance with the instruction compliant installation, specialist application and prescribed commissioning and operation. Further claims are excluded.

We assume no further liable beyond that one of the legal requirements under German law for incidental or consequential damages in connection with this product. We reserve the right to carry out repairs, improvements, replacement deliveries or a refund of the purchase price.

In following cases the warranty voids:

- if for soldering unsuitable tools (wrong soldering iron, solder containing liquid acids or lead, soldering grease, acid containing flux, etc.) were used,
- damage caused by not following the instructions of the wiring diagram / connection plan,
- at changes or trying to repair of the component,
- at unauthorized change in the circuit,
- when in the construction not foreseen, improper removal of components or free wiring of components,
- at destruction of copper tracks or soldering pads,
- at damage due to overloading of the component (e.g. overvoltage, short circuit),
- at connecting to an incorrect voltage or current,
- in the event of damage caused by interference by third parties,
- at incorrect operation or damage by careless use or abuse,
- at damage by touching components before electrostatic discharge of hands/tools (ESD damage).

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Waste Disposal: Do not dispose of the appliance in the household waste, but hand it over at the appropriate collection points for electronic waste.

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