Manual

FD-LED

Function decoder

MM	DCC

tams elektronik

Contents

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The asterisks **

This manual mentions the following companies:

Gebr. MÄRKLIN & Cie. GmbH | Stuttgarter Str. 55-57 | DE-73033 Göppingen

Uhlenbrock Elektronik GmbH | Mercatorstrasse 6 | DE- 46244 Bottrop

1. Getting started

How to use this manual

This manual gives step-by-step instructions for safe and correct fitting and connecting of the decoder, and operation. Before you start, we advise you to read the whole manual, particularly the chapter on safety instructions and the checklist for trouble shooting. You will then know where to take care and how to prevent mistakes which take a lot of effort to correct.

Keep this manual safely so that you can solve problems in the future. If you pass the decoder on to another person, please pass on the manual with it.

Intended use

The function decoder FD-LED is designed to be operated according to the instructions in this manual in model building, especially in digital model railroad layouts. Any other use is inappropriate and invalidates any guarantees.

The function decoder FD-LED should not be mounted by children under the age of 14.

Reading, understanding and following the instructions in this manual are mandatory for the user.

Checking the package contents

Please make sure that your package contains:
- one or five function decoders, depending on the version
     without soldered connecting wires or
     with soldered connecting wires;
- a CD (containing the manual, Software "POM-Updater.exe" and further information).

Required materials

For mounting and connecting the decoder you need:

- an electronic soldering iron (max. 30 Watt) or a regulated soldering iron with a fine tip and a soldering iron stand,
- a tip-cleaning sponge,
- a heat-resistant mat,
- a small side cutter, a wire stripper and a pair of tweezers,
- electronic tin solder (0.5 mm diameter).

In order to connect decoders without soldered connecting wires you will need wire. Recommended cross sections $\geq$ 0.04 mm² for all connections.

2. Safety instructions

⚠ **Caution:**

Integrated circuits (ICs) are inserted on the decoder. They are sensitive to static electricity. Do not touch components without first discharging yourself. Touching a radiator or other grounded metal part will discharge you.

Mechanical hazards

Cut wires can have sharp ends and can cause serious injuries. Watch out for sharp edges when you pick up the PCB.

Visibly damaged parts can cause unpredictable danger. Do not use damaged parts: recycle and replace them with new ones.

Electrical hazards

- Touching powered, live components,
- touching conducting components which are live due to malfunction,
- short circuits and connecting the circuit to another voltage than specified,
- impermissibly high humidity and condensation build up

can cause serious injury due to electrical shock. Take the following precautions to prevent this danger:

- Never perform wiring on a powered module.
- Assembling and mounting the kit should only be done in closed, clean, dry rooms. Beware of humidity.
- Only use low power for this module as described in this manual and only use certified transformers.
- Connect transformers and soldering irons only in approved mains sockets installed by an authorised electrician.
- Observe cable diameter requirements.
- After condensation build up, allow a minimum of 2 hours for dispersion.
- Use only original spare parts if you have to repair the kit or the ready-built module.

Fire risk

Touching flammable material with a hot soldering iron can cause fire, which can result in injury or death through burns or suffocation. Connect your soldering iron or soldering station only when actually needed. Always keep the soldering iron away from inflammable materials. Use a suitable soldering iron stand. Never leave a hot soldering iron or station unattended.

Thermal danger

A hot soldering iron or liquid solder accidentally touching your skin can cause skin burns. As a precaution:

- use a heat-resistant mat during soldering,
- always put the hot soldering iron in the soldering iron stand,
- point the soldering iron tip carefully when soldering, and
- remove liquid solder with a thick wet rag or wet sponge from the soldering tip.

Dangerous environments

A working area that is too small or cramped is unsuitable and can cause accidents, fires and injury. Prevent this by working in a clean, dry room with enough freedom of movement.

Other dangers

Children can cause any of the accidents mentioned above because they are inattentive and not responsible enough. Children under the age of 14 should not be allowed to work with this kit or the ready-built module.

⚠ **Caution:** Little children can swallow small components with sharp edges, with fatal results! Do not allow components to reach small children.

In schools, training centres, clubs and workshops, assembly must be supervised by qualified personnel.

In industrial institutions, health and safety regulations applying to electronic work must be adhered to.

3. Safe and correct soldering

> **⚠ Caution:**
>
> Incorrect soldering can cause dangers through fires and heat. Avoid these dangers by reading and following the directions given in the chapter **Safety instructions**.

- Use a small soldering iron with max. 30 Watt. Keep the soldering tip clean so the heat of the soldering iron is applied to the solder point effectively.
- Only use electronic tin solder with flux.
- When soldering electronic circuits never use soldering-water or soldering grease. They contain acids that can corrode components and copper tracks.
- Solder quickly: holding the iron on the joints longer than necessary can destroy components and can damage copper tracks or soldering eyes.
- Apply the soldering tip to the soldering spot in such a way that the wire and the soldering eye are heated at the same time. Simultaneously add solder (not too much). As soon as the solder becomes liquid take it away. Hold the soldering tip at the spot for a few seconds so that the solder flows into the joint, then remove the soldering iron.
- The joint should be held still for about 5 seconds after soldering.
- To make a good soldering joint you should use a clean and unoxidised soldering tip. Clean the soldering tip with a damp piece of cloth, a damp sponge or a piece of silicon cloth.
- After soldering check (preferably with a magnifying glass) tracks for accidental solder bridges and short circuits. This would cause faulty operation or, in the worst case, permanent damage. You can remove excess solder by putting a clean soldering tip on the spot. The solder will become liquid again and flow from the soldering spot to the soldering tip.

4. Operation overview

4.1. Modes of operation

Digital operation

The function decoder FD-LED is a multiple protocol decoder, that can operate with and automatically recognise both DCC or Motorola formats.

The number of addresses is dependant on the format being used:

- Motorola-Format: 255 addresses,
- DCC-Format: 127 Basis-addresses or 10.239 extended addresses.

In the DCC format the decoder can be driven in all speed levels (14, 28 or 128).

Programming the decoders is done:

- in Motorola format by setting the registers,
- in DCC format by setting the configuration variables (direct programming, DCC conform) or by POM (programming on main = main track programming).

Analogue mode

The FD-LED is not suitable for operation in analogue layouts.

4.2. Function outputs

The decoder has three function outputs:

- two boosted outputs (max. 300 mA each) and
- one not boosted output (max. 10 mA) for the connection of 2 LEDs (e.g. as tail lamps).

The decoder has two different types of return conductors for the connection of the two boosted outputs. The voltage supplied at the outputs depends on the return conductor connected to the output:

- constant voltage of 11 volts for the connection of 12 – 14 Volt-LED stripes. When using LED stripes with a power drain of 4,8 Watt/m you can connect a LED stripe with a total length of 0,75 m to each output.
- digtial voltage for the connection of other loads (e.g. light bulbs or standard vehicle lighting modules).

Info: LED stripes

LED stripes are not suitable for the direct connection to the outputs of vehicle or stationary decoders. The decoder outputs normally supply the digital voltage (as a standard about 18 volts), but the LED stripes are designed for a supply with a constant direct voltage (depending on the version approx. 12 or 24 volts). When used in digital model railroad layouts, the LEDs would either lighten very bright and burn through very quickly or lighten weakly or not at all.

Effects of the function outputs

- Switching on and off depending on the direction of travel: When the function key F0 has been assigned to an output, it is switched depending on the direction of travel.
- Dimming: You can dim the two boosted outputs individually. This allows you for example to adapt the brightness of the LD stripes to your needs.
- Orientation light: In order to change over between standard and orientation light (e.g. for sleeping cars or parked carriages), you can connect all LED stripes or light modules simultaneously to the two boosted outputs which dimming intensity is set unequally. Then you assign different function keys to the outputs.

4.3. Releasing the functions

The function outputs can be released by pushing the function keys. The mapping of the outputs to the function keys and the switching inputs is arbitrary. It is possible to assign several function keys and switching inputs to one output.

Outputs	DCC format	MM format
AUX1 and AUX2	F0 to F28	F0 to F4
AUX3	(Switching on and off depending on the direction of travel with F0 only)	(Switching on and off depending on the direction of travel with F0 only)

4.4. POM-update

POM-update is a procedure allowing to update the decoder´s firmware (= specific decoder software) without dismounting the decoder or using a specific device. POM-update is based upon programming on main (POM) for the DCC format.

Preconditions for using the procedure are:

- Function decoder FD-LED from version 1.1.
- Digital central unit with PC interface providing the DCC format and POM. Hint: As nearly every manufacturer of central units uses his own procedure for programming on main, the POM-update can be performed with the following central units only (status 07/2018):

    MasterControl (Tams Elektronik)

    RedBox (Tams Elektronik)

    CS2 (Märklin**)

    The current list of central units allowing to perform the POM-update is available on our homepage.

- PC. The system software must support Java.
- Software "POM-Updater.exe": You will find it on the CD included in

delivery. It is also available on our homepage for free download.

You can download the current firmware version of the decoder free of charge from our homepage. If you want to get information on new firmware versions please subsribe to our newsletter on our hompage.

5. Technical specifications

Data format	DCC and MM
Supply voltage	12-24 V digital voltage
Current consumption (without connected loads) max.	20 mA
Max. total current	600 mA
Number of function outputs	3
Maximum current of the outputs AUX1 and AUX2 AUX3	300 mA each 10 mA
Maximum power drain of the AUX1 AUX1 and AUX2	3.6 Watt each
Connection for buffer capacitor Capacity Electric strength	1 100 to 470 µF $\geq$ 25 V
Protected to	IP 00
Ambient temperature in use	0 ... +60 °C
Ambient temperature in storage	-10 ... +80 °C
Comparative humidity allowed	max. 85 %
Dimensions	ca. 21,5 x 11,5 x 4,5 mm
Weight without connecting wires Weight with connecting wires	ca. 1,4 g ca. 2,1 g

6. Connections

> ⚠ **Note the following comment in order to protect the decoder from (maybe irreparable) damage!**
>
> Avoid all conducting connections between the decoder and accessories connected to the decoder´s common return conductor for all function outputs on the one hand and metal parts of the vehicle or the rails on the other hand. Connections result for example from badly isolated connecting wires (as well at the stripped ends of connecting wires not in use) or insufficient fixing and isolating the decoder or the accessory, for example. Risk of short circuit!
>
> Before connecting the lighting and other accessories to the outputs check if their current is below the maximum permissible value per output and the total current is below the safe load. Should the permissible current be exceeded, this normally results in damage to the decoder.
>
> You should under no circumstances connect the decoder´s return conductors to vehicle ground. Risk of short circuit!
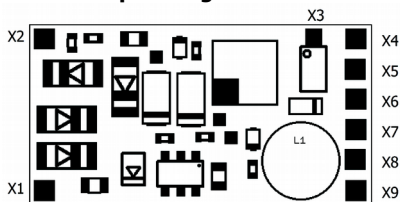
Connector pin assignment

Fig. 1:
Connector pin
assignment

	Colour of wire	Connection to (for use of settings in state of delivery)
X1 X2	black red	Current collector (left / right in direction of motion): X1= left current collector (or vehicle ground), X2= right current collector (or slider)
X3	white	AUX3 = not boosted output (max. 10 mA), switched with F0 / switched on at forward motion
X4	violet	AUX2 = boosted output (max. 300 mA), switched with function key F2
X5	brown	Return conductor for LEDs (-); Negative pole (-) of buffer capacitor
X6	green	AUX1 = boosted output (max. 300 mA), switched with function key F1
X7, X8	orange	Return conductor for LED stripes (+ 11 V)
X9	blue	Return conductor for other accessories (+); Positive pole (+) of buffer capacitor

Connection to the voltage supply

When connecting the vehicle´s current collectors check the right assignment (left / right). When interchanging the connections, the outputs switched depending on the direction of motion will be switched incorrectly in regard to the direction of travel.

Connecting LED stripes to the boosted function outputs

You can connect to each of the two boosted outputs LED stripes (for 12 to 14 V voltage) with a power drain of a maximum of 3,6 watts.

Before connecting the LED stripes you should check their power drain on the basis of the manufacturer´s data. Depending on the layout it can be 3.6 watts per m as well as more than 10 watts per m. For that reason the total length of LED stripes you can connect to an output can be very variable.

⚠ Attention: When exceeding the permissible power drain of 3.6 watts at the output, it will be damaged (if so irreparably).

Connect the negative poles of the LED stripes to the outputs AUX1 and AUX2 (X6 and X4) and the positive poles of the LED stripes to one on the two return conductors for LED stripes (X7 or X8). The LED stripes are supplied with a constant voltage of 11 V, so an additional series resistor is not necessary.

If you intend to change over between standard and orientation light, you have to connect the LED stripes simultaneously to both outputs. In this case you can connect LEDs stripes with a power drain of 3.6 watts in total.
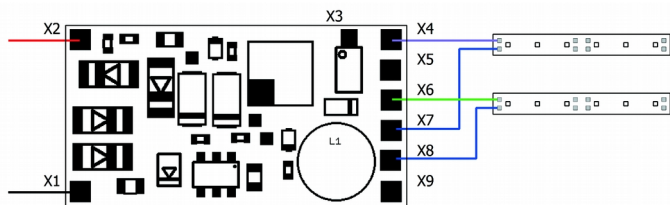

Fig. 2: Connection of LED stripes

Connecting other accessories to the boosted function outputs

You can also connect other accessories requiring a higher voltage supply than 11 V to the outputs AUX1 and AUX2 (e.g. light bulbs, standard vehicle light modules). Connect the return conductor of these accessories to the return conductor for other accessories (X9).

⚠ **Attention:** The maximum current of the boosted outputs is 300 mA. When exceeding the current, they will be damaged (if so irreparably).
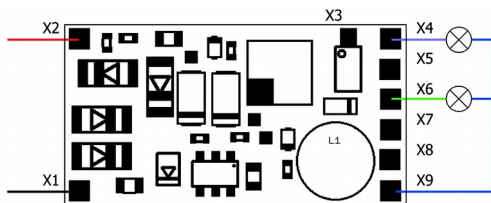

Fig. 3: Connection of other accessories to the boosted function outputs

Connecting LEDs to the not boosted function output

The output AUX3 (X3) is designed for the parallel connection of maximum 2 LEDs. Connect the anodes (+) of the LEDs to AUX3 and the cathodes (-) via series resistors to the return conductor for LEDs (X5). Required values of the series resistors:

- for a red or yellow LED: at least 560 Ohm
- for a white LED: at least 330 Ohm

If the LEDs light too high, you can use higher values for the series resistors.

⚠ **Attention:** The maximum current of the not boosted output is 10 mA. When exceeding the current, it will be damaged (if so irreparably).
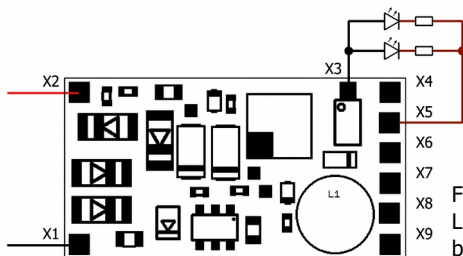
Fig. 4: Connection of LEDs to the not boosted output

Connecting a buffer capacitor

In sections with bad contact to the rails the power supply of the decoder can be interrupted. Possible consequences are e.g. flickering lighting. In these and similar cases you can find a remedy by connecting a buffer capacitor. The electrolytic capacitor should have a capacity of minimum 100 µF and an electric strength of minimum 25 V. Observe the correct polarity when connecting the capacitor!
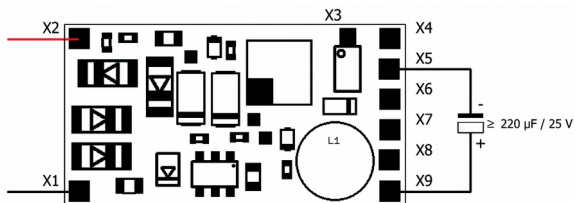

Fig. 5: Connection of a buffer capacitor

Fixing the decoder

After having finished all connections you should fix the decoder, to avoid short circuits by contact to metal parts of the vehicle, for example. You can use double sided adhesive tape for it or a decoder holder (item no. 70-01810 or 70-01820), for example.

7. Programming

Programming with DCC central units

You can programm the configuration variables (CV) of the decoder from the digital central unit, you can use main track programming as well. See the chapter in the manual of your central unit where the byte wise programming of configuration variables (CVs) (Direct programming) and main track programming (POM) are explained. With central units that allow only register-programming it is not possible to program the FD-LED.

Please note: In DCC-Format the feedback signal will not be sent by the central unit unless there is a sufficient current. For that reason you should mount an accessory with a current consumption of minimum 100 mA to one of the boosted outputs before starting to program the function decoder.

Programming with Motorola central units

In Motorola format the settings are saved in registers.

Please note: If you use a central unit for both DCC and Motorola format it is recommended to program the decoder in the DCC format. After having finished programming the decoder it is possible to control it in Motorola format as well.

Please note: You should connect a lamp or a LED stripe to at least AUX1 or AUX2 before starting to program the decoder with a Motorola central unit, as the decoder shows the status of the programming by flashing the lighting connected to the outputs AUX1 and AUX2. The flashing frequency shows, which input the decoder expects:

Slow flashing	Fast flashing
Number of the register to be programmed	**Value** of the register to be programmed

Put the vehicle on a track oval or a track section connected to the central unit's track output (not to the connection for the programming track). Make sure no other vehicle than the one you intend to program is set on the track as the decoder inside this vehicle might be programmed as well.

Starting the programming mode	Programming the decoder
1. Switch on the central unit or perform a reset at the central unit (pushing "stop" and "go" simultaneously).	1. Enter the number of the register as a Motorola-address. If necessary: with a leading "0".
2. Set the current decoder address (default value: 3) or the address "80".	2. Operate the direction switch. → Lighting flashes faster.
3. Set all functions to "off".	3. Enter the value you want to set into the register (as Motorola-address).
4. Push button "stop" → switch off the track voltage.	4. Operate the direction switch. → Lighting flashes more slowly.
5. Operate the direction switch and hold it in that position. Push the button "go" at once.	Repeat steps 1 – 4 for all registers.
6. As soon as the lighting flashes, release the direction switch.	Push button "stop".
→ Programming mode	→ End of programming mode.

Programming with Motorola central units with restricted input options

Some central units do not allow but input values up to 80 or 99. With these central units you cannot use the whole address range. All other settings can be done to the full extent.

Programming with the Central Station and the Mobile Station

With the Central Station I or the Mobile Station of Maerklin** you can program the registers. Select the article no. 29750 from the locomotive database and program the decoder as described for this article in the Central Station´s or Mobile Station´s manual.

Programming with the CV-Navi

Instead of programming the configuration variables or registers of the decoder using the digital central unit, you can use the free software CV-Navi. You will find the free download under:

www.tams-online.de

A central unit RedBox or Master Control is required for using the software.

8. Configuration variables and registers

In the lists you will find in the column "No." the numbers of the configuration variables for programming in DCC format. The numbers of the registers for programming in Motorola format are identical to the CV numbers. The defaults are those values set in the state of delivery and after a reset.

Please note: With variables destined to set several parameters, the input value has to be calculated by adding the numerical values assigned to the desired parameters.

Setting the address

Name of CVs / registers	No.	Input value (Default)	Remarks and Tips
Basic address	1	1 ... 255 (3)	Range of values in DCC-Format: 1 ... 127
Tip: If a value higher than 127 is set for the basic address and the use of extended addresses in CV 29 is set to off, the decoder does not react to signals in DCC format!			
Extended address	17	192 ... 255 (192)	Only for DCC format. Most central units permit entering extended addresses directly. The CVs 17, 18 and 29 are set automatically to the proper values.
	18	0 ... 255 (255)	
Consist address	19	1 ... 127 (0)	= 2nd adress In DCC format only!

Information / Read only

Name of CVs / registers	No.	Input value (Default)	Remarks and Tips
Version	7	---	Read only in DCC format!
Manufacturer	8	--- (62)	

Auxiliary functions

Name of CVs / registers	No.	Input value (Default)	Remarks and Tips
Reset	8	0 ... 255	Any input value restores the settings in state of delivery.

Basic settings

Name of CVs / registers	No.	Input value (Default)	Remarks and Tips	
Configuration data 1	29	0, 2, 32, 34 (2)	14 speed levels	0
			28 or 128 speed levels	2
			Basic addresses	0
		Not for MM mode:	Extended addresses	32

Assignment of the function keys to the outputs

Name of CVs / registers	No.	Input value (Default)	Remarks and Tips	
F0 forward on	33	0 ... 63 (4)	AUX1	1
F0 backward on	34	0 ... 63 (0)	AUX2	2
F1	35	0 ... 63 (1)	AUX3	4
F2	36	0 ... 63 (2)		
F3	37	0 ... 63 (0)		
F4	38	0 ... 63 (0)		
F5	39	0 ... 63 (0)		
...	...	0 ... 63 (0)		
F28	62	0 ... 63 (0)		

Factory settings: AUX1 to be switched with F1. AUX2 to be switched with F2. AUX3 to be switched with F0, switched on at forward motion.

Example: AUX2 to be switched with F5 → CV 39 = 2

Example: AUX1 and AUX2 to be switched with F6 → CV 40 = 3 (= 1+2)

Dimming of the outputs

Name of CVs / registers	No.	Input value (Default)	Remarks and Tips
AUX1	5	1...63	= Reduction of the voltage
AUX2	6	(63)	applied to the output.
			"1" = lowest voltage
			"63" = maximum voltage

9. Performing a POM-Update

Hint: The POM-Update is possible with decoders from version 1.1. For updating decoders with a former firmware version you have to send them in. The version number is saved in CV 7.

Preparations

1. In order to perform the firmware update you do **not** have to dismount the decoder. Put the vehicle with the mounted decoder on the main track. Hint: You can perform a firmware update with several decoders FD-R Basic 2 at once, the current software version of the decoders is of no importance. The individual CV settings of the decoder will not be altered by updating.

2. Save the file with the newest firmware on your PC,

   e.g. FD-R_Basic_2_V1_1_0_0.hex for version 1.1.0.0

   You can download the newest firmware from our homepage without charge. When getting (on the part of any third parties) a packed file (e.g. *.zip) you have to unpack it first.

3. Get ready the CD with the program "POM-Updater.exe" (included in the delivery) or download the program from our homepage.

4. Connect your central unit with the PC. At present (status: 01/2015) the POM-Update can be carried out with the MasterControl (Tams Elektronik), the Intellibox 1 (Uhlenbrock**) and the CS2 (Maerklin**)). You find the current list of central units allowing to perform the POM-update on our homepage.

5. Before starting the update connect at least one lamp or LED to AUX3 as the update´s status is shown by lighting or flashing of the lighting connected to this output.

Changing into the update mode

Execute the programm POM-update.exe, follow the helpfile. Proceed as follows:

1. Make the settings for the update.
2. Enter the addresses of the function decoders FD-R Basic 2 you want to update.
3. Change into the update mode.

The lighting connected to the outputs AUX3 of the decoders which are chosen for an update start to flash slowly. If flashing quickly, the decoder cannot be updated

- because the decoder type does not correspond to the hex-file or
- because the decoder´s firmware already conforms to the version of the hex-file.

The concerned vehicles can stay on the track, they do not affect updating the other decoders. As an alternative you can cut them from current shortly in order to stop them flashing quickly.

Performing the POM-Update

After having changed into the update mode you can start the update. The lighting connected to the outputs AUX3 of the decoders in update mode stop to flash and show permanent lighting.

The duration of the update depends on the central unit in use and the extent of the transferred data. The progress is shown in the screen mask. As soon as the update has been finished the lighting start to flash slowly. Cut the vehicles from current shortly. Now the vehicles are in standard operation again.

When a fault occurs during updating, the update is interrupted and the lighting starts to flash quickly. In this case restart the update after altering the settings if necessary (see helpfile of the programm for further information).

10. Check list for troubleshooting

- Parts are getting very hot and/or start to smoke.

  ⚠ Disconnect the system from the mains immediately!

  Possible cause: one or more connections are soldered incorrectly.
  → Check the connections.

  Possible cause: Short circuit. The decoder is connected to locomotive
  or carriage ground. → Check the connections. A short circuit can
  result in irreparable damage.

Problems with switching of the functions

- After programming, the decoder does not react as desired.
  Possible cause: The input values for the CVs are incoherent.
  → Perfom a decoder reset and first test the decoder with the default
  values. Programm the decoder anew afterwards.

- An accessory / a light does not react to switching commands.
  Possible cause: The accessory is defective or incorrectly connected.
  → Check the accessory / the connections.

  Possible cause: The output is defective (e.g. due to overload or short
  circuit). → Send in the decoder for check / repair (with costs).

- The lighting does not correspond to the direction of motion.
  Possible cause: The configuration data (CV29) of the locomotive decoder
  in the block train are programmed in a different way from the function
  decoder. → Alter the parameters of the locomotive or the decoder.

- The lighting goes on and off when the speed levels are turned up or
  the lighting cannot be switched on or off.
  Possible cause: The speed mode of the decoder and the digital control
  unit do not correspond. Example: The central is set to the mode 28
  speed levels, but the decoder to the mode 14 speed levels. → Change
  the speed mode at the central and / or at the decoder.

Problems with the POM-Update

- While updating the decoder the lighting starts to flash, the update is interrupted.
  Possible cause: The settints for the POM-Update are wrong.
  → Check and alter the settings if necessary. The helpfile contains explanations.

Hotline: If problems with your decoder occur, our hotline is pleased to help you (mail address on the last page).

Repairs: You can send in a defective decoder for repair (address on the last page). In case of guarantee the repair is free of charge for you. With damages not covered by guarantee, the maximum fee for the repair is 50 % of the sales price according to our valid price list. We reserve the right to reject the repairing of a decoder when the repair is impossible for technical or economic reasons.

Please do not send in decoders for repair charged to us. In case of warranty we will reimburse the forwarding expenses up to the flat rate we charge according to our valid price list for the delivery of the product. With repairs not covered by guarantee you have to bear the expenses for sending back and forth.

11. Guarantee bond

For this product we issue voluntarily a guarantee of 2 years from the date of purchase by the first customer, but in maximum 3 years after the end of series production. The first customer is the consumer first purchasing the product from us, a dealer or another natural or juristic person reselling or mounting the product on the basis of self-employment. The guarantee exists supplementary to the legal warranty of merchantability due to the consumer by the seller.

The warranty includes the free correction of faults which can be proved to be due to material failure or factory flaw. With kits we guarantee the completeness and quality of the components as well as the function of the parts according to the parameters in not mounted state. We guarantee the adherence to the technical specifications when the kit has been assembled and the ready-built circuit connected according to the manual   and when start and mode of operation follow the instructions.

We retain the right to repair, make improvements, to deliver spares or to return the purchase price. Other claims are excluded. Claims for secondary damages or product liability consist only according to legal requirements.

Condition for this guarantee to be valid, is the adherence to the manual. In addition, the guarantee claim is excluded in the following cases:

- if arbitrary changes in the circuit are made,
- if repair attempts have failed with a ready-built module or device,
- if damaged by other persons,
- if damaged by faulty operation or by careless use or abuse.

12. EU declaration of conformity

$C\mathcal{E}$ This product conforms with the EC-directives mentioned below and is therefore CE certified.

2004/108/EG on electromagnetic. Underlying standards: EN 55014-1 and EN 61000-6-3. To guarantee the electromagnetic tolerance in operation you must take the following precautions:

- Connect the transformer only to an approved mains socket installed by an authorised electrician.
- Make no changes to the original parts and accurately follow the instructions, connection diagrams and PCB layout included with this manual.
- Use only original spare parts for repairs.

2011/65/EG on the restriction of the use of certain hazardous substances in electrical and electronic equipment (ROHS). Underlying standard: EN 50581.

13. Declarations conforming to the WEEE directive

This product conforms with the EC-directive 2012/19/EG on waste electrical and electronic equipment (WEEE).

Don´t dispose of this product in the house refuse, bring it to the next recycling bay.

Information and tips:

http://www.tams-online.de

Warranty and service:

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fax: +49 (0)511 / 55 61 61
e-mail: modellbahn@tams-online.de