

FD-M



Funktionsdecoder
DCC- und Motorola-Format

Function decoder
DCC- and Motorola-Format

Décodeur de fonctions
Format DCC et Motorola

Functiedecoder
DCC- en Motorola-format

Art.-Nr. 22-01-091

Anleitung

Manual

Mode d'emploi

Handleiding



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How to use this manual

This manual gives step-by-step instructions for safe and correct fitting of the module, and operation. Before you start, we advise you to read the whole manual, particularly the chapter on safety instructions and the FAQ chapter. 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 module on to another person, please pass on the manual with it.

Intended use

The function decoder is designed for mounting in a model railway locomotive or in a model railway carriage. It evaluates the data sent to it by the digital central unit either in DCC or Motorola format. It can switch four amplified and one unamplified output.

The module should not be mounted or operated by children under the age of 14.

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

Any other use is inappropriate and invalidates any guarantees.



Caution:

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

Safety instructions

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,
- connecting the circuit to another voltage than specified,
- impermissibly high humidity,
- 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.
- Mounting the module 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 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 module.

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, mounting and operation must be supervised by qualified personnel.

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

EMC declaration

This product is developed and tested in accordance with the European standards EN 55014-1 and EN 61000-6-3 and meets the EC - directive 2004/108/EG and legal requirements.

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, circuit diagram and PCB layout included with this manual.
- Use only original spare parts if you have to repair the kit or the ready-built module.

Operation overview

Digital Operation

The decoder FD-M is a multiple protocol decoder, that can operate with and automatically recognises 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), in Motorola format only in 14 speed levels.

Programming the decoder is done in DCC format by setting the configuration variables and in Motorola format through the registers.

Analogue mode

The decoder can also be used in analogue model railway layouts. It can be run with an A.C. speed control as well as with a D.C. speed control. When putting the vehicle on the rails the decoder recognizes automatically if it is run in analogue or digital mode and sets the corresponding operation mode. The automatic recognition of the analogue mode can be switched off.

Switching the function outputs on or off is not possible in analogue mode. They can be programmed so that they are either switched on or off in analogue mode. The effects set for the outputs are active in analogue mode as well.

Outputs to be switched with F0 are switched on or off in analogue mode according to the direction of travel.

Function outputs

The decoder has four amplified function outputs with a maximum current of 1.000 mA each, which are available to connect optional accessories (e.g. lighting, smoke generator, sound module, electric coupling) and one unamplified output with a maximum current of 10 mA. The decoder's maximum total current is 1.500 mA.

In DCC format the function outputs can be switched via the function keys F0 to F12. In Motorola format the function outputs can be switched via the function keys F0 to F4. The functions F5 to F9 can be switched via the function keys F1 to F4 and F0 by assigning them to a second address. The functions F10 to F12 are not available in Motorola format.

You can assign the function keys to the function outputs freely. It is possible to assign several function keys to one function output.

SUSI interface

A SUSI module can be connected to the FD-M and programmed via the decoder. It is not possible to read the SUSI module's data via the decoder.

The function decoder transmits the function status and the speed level set at the central unit, to the SUSI module. This affects the SUSI module's outputs depending on the speed level (e.g. motor sound). The FD-M allows the setting of the acceleration and braking delay so that the functions depending on the speed level correspond to the driving characteristics during accelerating and braking.

Effects of the function outputs

It is possible to set the following effects for all function outputs individually:

Dimming: Example of use: The electric bulbs of older vehicles made for analogue operation can be dimmed and thus must not be exchanged after the mounting of the decoder.

Kick function: It is possible to set the amplified function outputs so that they get the full voltage first for up to 20 seconds and then are dimmed. Example of use: For some types of electric couplings you need the full voltage for decoupling and the voltage then reduced to protect the couplings.

Switching on and off depending on the direction of travel: This function can be assigned either to the individual outputs or to the function keys.

Blinken. Both the frequency and the keying ratio can be set. E.g. single and alternating flash lights or strobe lights.

Technical specifications

Data format	DCC and Motorola
Supply voltage	12-24 Volt digital voltage
Current consumption (without connected loads)	approx. 10 mA
Max. current of the four amplified function outputs	1.000 mA each
Max. current of the unamplified function output	10 mA
Max. total current	1.500 mA
Protected to	IP 00
Ambient temperature in use	0 - + 60° C
Ambient temperature in storage	-10 - + 80° C
Comparative humidity allowed	max. 85 %
Dimensions	approx. 23 x 12,5 x 3 mm
Weight	approx. 1,05 g

Checking the package contents

Check the contents of the package for completeness immediately after unpacking:

- one decoder, with or without soldered connecting wires, depending on the version.
- one manual.

Required tools and materials

Make sure you have the following tools, equipment and materials ready for use:

- an electronic soldering iron (max. 30 Watt) with a fine tip,
- a soldering iron stand,
- a tip-cleaning sponge,
- a heat-resistant mat,
- a small side cutter and wire stripper,
- a pair of tweezers,
- tin solder (0,5 mm. diameter),
- wire (diameter: $\geq 0,05 \text{ mm}^2$ for all connections).
- When the total current consumption is more than 1,0 A: a heat sink, e.g. a SMD heat sink with a base of 7 x 19 mm.

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.

Mounting the function decoder

Follow the connection diagrams fig. 1 and 2.

Open the vehicle's housing. Locate the position for the decoder.

Solder the connections from the rail current collectors at the points X1 and X2. Assign the connections as follows:

X1: left rail current collector (seen in direction of motion)

X2: right rail current collector (seen in direction of motion)

Tip: It is not possible to send a confirmation signal to the central unit in DCC format when there is not sufficient current consumption. Therefore you should connect up at least one accessory with a minimum current consumption of 150 to 200 mA before starting to program the decoder.

Tip: When programming the decoder with a Motorola central unit the switch into the programming mode, and the status of the programming, are shown by flashing the lighting connected to the outputs AUX1 to AUX 4. You should therefore connect lighting to at least one output before starting to program the decoder with a central unit of that kind.

Connecting accessories to the amplified outputs

Before connecting the lighting and other accessories to the amplified outputs check if the current is below the maximum permissible value of 1.000 mA per output and the total current is below 1.500 mA. If lighting or other accessories with current larger than 1.000 mA are connected, or if the total current is higher than 1.500 mA the decoder will be damaged when put into operation.

Disconnect any existing diodes in the leads to the lamps. Connect the lamps and the accessories to the function outputs (AUX1 to AUX4) of the decoder. The assignment of the function outputs to the function keys will be made when programming the decoder.

If the lamp or the accessory is already connected with one side to vehicle ground, the connection is complete. If not, connect the second side of the lamp or the accessory to the return conductor of the decoder (point X4).

**Caution:**

If you connect the accessories to the return conductor for all functions (point X4), the accessories must be insulated. The accessories should not make contact with metal parts of the vehicle. Possible short circuit! The decoder will be damaged in operation.

**Caution:**

The return conductor for all functions (point X4) must under no circumstances be connected to vehicle ground. Possible short circuit! The decoder will be damaged in operation.

Decoder factory settings

If you want to use the decoder factory settings, you have to connect the lighting and the accessories as follows:

Front lighting: AUX1

Back lighting: AUX2

Accessory switched via F1: AUX3

Accessory switched via F2: AUX4

Connecting accessories to the unamplified output

It is possible to connect an accessory with a maximum current of 10 mA (e.g. **one** LED) to the function output X7, or a transistor stage to switch other accessories. Connect the input of the transistor stage to point X7 and the emitter to point X3 (decoder ground). The output at the collector is then amplified.

**Caution:**

The output X7 can be loaded with maximum 10 mA. That is suitable for a single LED so do not try to connect lighting or other accessories.

Connecting a SUSI module

The decoder has four soldering points for the connection of a SUSI module. You will find the pin connection in fig. 3.

Connecting the LEDs

The amplified function outputs of the decoder (AUX1 to AUX4) switch respective to the decoder ground. For that reason you must connect the cathode (-) of the LED to the function outputs.

When using the unamplified output (X7) connect up the LED anode (+). As soon as the output is switched on, it is fed with 5 V.

Caution:

If you use light-emitting diodes (LEDs) you must always operate them via a series resistor. LEDs are available in many different models. The series resistor limits the current flow of the LED and will need to be calculated for each model. Ask for the max. current rating when buying your LEDs.

You can connect several LEDs in parallel to each output. In this case every LED must have a series resistor of its own. If you connect several LEDs to one output in series, only one series resistor is needed.

Connecting a smoothing capacitor

In track sections with bad contacts the power supply may be interrupted shortly. You can solder a capacitor between the points X3 and X4 to counteract this effect (see fig. 1).

Fixing the decoder

After completing all connections fix the decoder with double-sided adhesive tape, for example.

Caution:

The locomotive decoder can get warm during operation. For that reason it should not be covered with shrinking hose or hot adhesive.

**Caution:**

When the total current consumption is more than 1,0 A you should cool the decoder. As a heat sink you could use a SMD heat sink with a base of 7 x 19 mm. Fix the heat sink on the diodes D1 to D4, using an appropriate glue (e.g. super glue). Take care that the heat sink does not contact the adjoining components. Risk of short circuit!

Programming the function decoder

Programming with DCC central units

You can programm the configuration variables (CV) of the decoder from the digital central unit. See the chapter in the manual of your central unit where the byte wise programming of configuration variables (CVs) is explained. With central units that allow only register-programming it is only possible to program the variables CV#1, CV#3, CV#4 and CV#29 (= register 1, 3, 4 and 5).

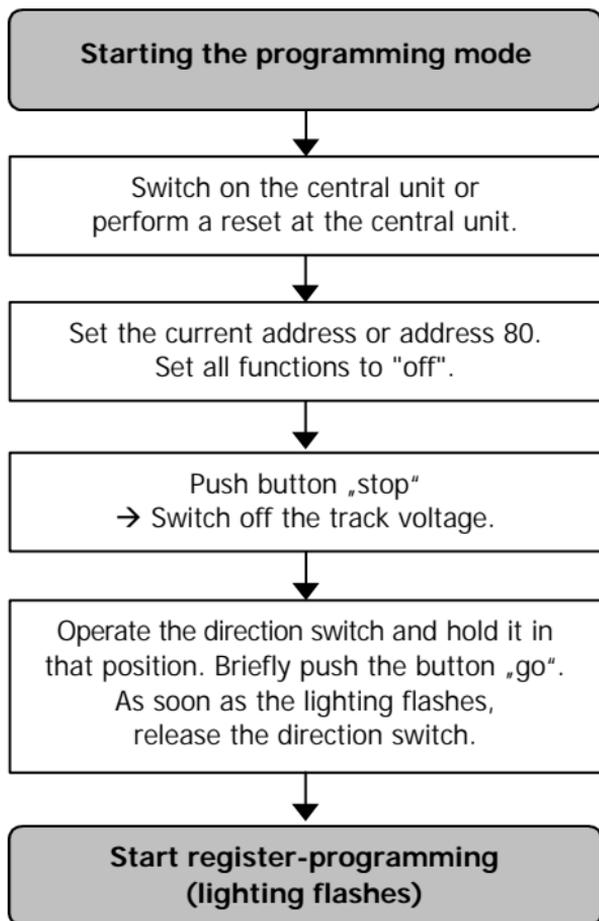
Programming with the Central Station and the Mobile Station

With the Central Station or the Mobile Station of Märklin* you can program the registers, but the value to be set is limited to 80. 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 Motorola central units

Put the locomotive on a track oval or a track section connected to the central unit´s track output. 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.

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.



Reset the central unit (by simultaneously pushing the buttons "stop" and "go" for some time) or quickly switch the central unit off and on. First enter the current address or the address "80" (e.g. if you do not know the current address). Manufacturer's setting is "3". Set all functions (function, f1 to f4) to "off".

Push the "stop" button at the central unit. Next, operate the direction switch and hold it in that position while briefly pushing the "go" button. As soon as the lamps connected to the outputs AUX1 to AUX4 flash (after approx. 2 seconds) the decoder is in the programming mode and you can release the direction switch.

After having started the programming mode (and when the locomotive's lighting flashes) you can program the decoder's registers as follows:

1. Choose the register you want to program by setting the register's number with the Motorola locomotive address at your central unit. Please note that with some central units a leading "0" has to be entered.
2. Operate the direction switch. The lighting stops flashing.
3. Set the desired value of the register by setting the register's value as Motorola locomotive address at your central unit.
4. Operate the direction switch again. The lighting starts flashing again.

Repeat the steps 1 to 4 for all registers you want to program. In order to choose a register for programming or to enter a value for a register you have to confirm the entered number like selecting a Motorola locomotive address. The lighting shows which kind of entry the decoder expects:

- lighting flashes → entry of a CV's number
- lighting stops to flash → entry of a CV's value

In order to stop the programming mode push "stop".

Configuration variables / Register of the FD-M

In the following list you will find in the column "CV-no." the numbers of the configuration values for programming in DCC format and in the column "Reg.-no." the numbers of the registers for programming in Motorola format. The defaults are those values set in the state of delivery and after a reset.

* For some configuration variables, the input values have to be calculated by adding the numerical values assigned to the desired parameters.

Name of CVs / Registers	CV-no.	Reg. no.	Input value (Default)	Remarks and Tips
Basic address	1	01	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!

Acceleration rate	3	44	0 ... 6 (6)	= Length of the delay before switching to the next higher / lower speed level. When the vehicle is accelerating / braking. The value "6" corresponds to the maximum delay. The input value influences the functions of the SUSI module according to the speed.
Braking rate	4	45	0 ... 6 (6)	

Version	7	---	---	Read only in DCC format!
---------	---	-----	-----	--------------------------

Name of CVs / Registers	CV-no.	Reg. no.	Input value (Default)	Remarks and Tips	
Programming a SUSI module	7	02	9	To start the programming of a CV of a SUSI module. The next CV set, is valid for the SUSI-module. The CV-no. is entered without a leading "9".	
<p>Example: Programming the CV#902 of the SUSI module to the value "8": By entering the value "9" for CV#7 of the decoder, the programming mode is started. Next the CV of the SUSI module is chosen by entering a "2" or "02" (leaving out the leading "9") and for the CV#902 the value "8" is set. The decoder automatically goes back to the programming of it's own CVs. In order to programm another CV of the SUSI module, the operation has to be repeated completely.</p>					
Manufacturer	8	---	(62)	Read only in DCC format!	
Reset	8	03	0 ... 255	Any input value restores the settings in state of delivery.	
Analogue mode	12	06	0, 1 (0)	0 = a.c. mode 1 = d.c. mode	
functions active in analogue mode (only for F1 to F8, not for F9 to F12)	13	41	0 ... 255 (0)	Numerical value*	
				F1 on	1
				F2 on	2
				F3 on	4
				F4 on	8
				F5 on	16
				F6 on	32
				F7 on	64
F8 on	128				

Name of CVs / Registers	CV-no.	Reg. no.	Input value (Default)	Remarks and Tips
Extended address	17	04	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	05	0 ... 255 (255)	

Configuration data 1	29	07	0 ... 64 (6)	Numerical value*
				Direction "Standard" 0
				Reverse direction 1
				14 speed levels 0
				28 or 128 speed levels 2
				Analoge recognition off 0
				Analoge recognition on 4
				Basic addresses 0
Not for MM mode:			Extended addresses 32	

Example: CV#29 = 0. → Direction = "Standard". 14 speed levels. Basic addresses. Automatic analogue recognition = "off".

Example: CV#29 = 38. → Direction = "Standard". 28 or 128 speed levels in DCC-mode. Extended Addresses. Automatic analogue recognition = "on".

Tip: If the use of extended addresses is activated in CV#29, the decoder does not react to signals in Motorola format!

Name of CVs / Registers	CV-no.	Reg. no.	Input value (Default)	Remarks and Tips	
Assignment of the function keys to the outputs				Numerical value* Assigned output:	
F0 forward on	33	08	0 ... 31 (1)		
F0 backward on	34	09	0 ... 31 (2)		
F1	35	10	0 ... 31 (4)		
F2	36	11	0 ... 31 (8)		AUX1 1
F3	37	12	0 ... 31 (16)		AUX2 2
F4	38	13	0 ... 31 (0)		AUX3 4
...	0 ... 31 (0)		AUX4 8
F12	46	21	0 ... 31 (0)		X7 16
Factory settings: AUX1 to be switched with F0, switched on at forward motion. AUX2 to be switched with F0, switched on at backward motion. AUX3 to be switched with F1. AUX4 to be switched with F2. X7 to be switched with F3.					
Example: AUX2 to be switched with F5 → CV#39 = 2					
Example: AUX1 and AUX3 to be switched with F6 → CV#40 = 5 (= 1+4)					

Dimming of the outputs:				= Reducing the voltage applied to the output A. value of "1" corresponds to the minimum, "64" to the maximum voltage.
AUX1	49	22	1 ... 64 (64)	
AUX2	50	23	1 ... 64 (64)	
AUX3	51	24	1 ... 64 (64)	
AUX4	52	25	1 ... 64 (64)	

Dependant on the direction of motion of the outputs and function keys				Numerical value* independent of direction 0
AUX1 / F1	53	26	0 ... 63 (0)	F off at forward motion 1
AUX2 / F2	54	27	0 ... 63 (0)	F off at backward motion 2
AUX3 / F3	55	28	0 ... 63 (0)	AUX off at forward motion 4
AUX4 / F4	56	29	0 ... 63 (0)	AUX off at backward motion 8
				Shunting light AUX at F3 16
				Shunting light AUX at F4 32

Name of CVs / Registers	CV-no.	Reg. no.	Input value (Default)	Remarks and Tips
Factory settings: The function keys F1 to F4 switch the assigned outputs independent of the direction of motion. The function key F0 always switches depending on the direction of motion.				
Example: Shunting light at AUX1 to be switched with F3 and at forward motion off → CV#53 = 20 (= 16 + 4)				
Example: All outputs to be switched with function key F2 at backward motion off → CV#54 = 2				

Kick function of the outputs				= Setting of the period of time after the maximum voltage is reduced to the dimmed value (CV# 49-52).
AUX1	57	30	1 ... 255 (0)	
AUX2	58	31	1 ... 255 (0)	
AUX3	59	32	1 ... 255 (0)	
AUX4	60	33	1 ... 255 (0)	
Increasing the input value by 8 extends the period of time by approx. 1 second. Examples: CV # 57-60 = 24 → Output gets the maximum voltage for approx. 3 seconds CV # 57-60 = 80 → Output gets the maximum voltage for approx. 10 seconds				

Keying ration of the flash lights				= Phase ´s length of the on-/off states of the lighting
AUX1	61	34	0...255 (255)	
AUX2	62	35	0...255 (255)	
AUX3	63	36	0...255 (255)	
AUX4	64	37	0...255 (255)	
0 → lighting off 128 → regular flashing light 255 → continuous lighting				

Flashing frequency of the lighting	112	38	10 ... 255 (48)	Settings common for all lighting.
				10 → highest frequency
				255 → lowest frequency
Examples for the flashin frequency: CV#112 = 10 → 2 Hz / CV#112 = 48 → 0,7 Hz CV#112 = 100 → 0,25 Hz / CV#112 = 255 → 0,125 Hz				

Name of CVs / Registers	CV-no.	Reg. no.	Input value (Default)	Remarks and Tips
Analogue voltage needed for change of direction	113	39	100 ... 200 (144)	= Value of the voltage that has to be exceeded to change the direction with an analogue a.c. driving transformer.
Tip: In case the input value is too high, the direction of motion is not changed with a change of direction in analogue mode. In case the value is too low, unintended changes of direction in analogue mode can happen.				
2nd Motorola address	114	40	1 ... 255 (4)	= Address needed to switch additional functions in Motorola format. The function keys F5 to F8 are reached via the function keys F1 to F4, the function key F9 via the function key F0.

FAQ

- 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.

- After programming, the decoder does not react as intended.

Possible cause: The set values for the CV are inconsistent.

→ Perform a decoder reset and first test the decoder with the default values. Program the decoder anew.

- A function or an output cannot be switched on.
Possible cause: The values set in CV# 53 to 56 for a function and an output, contradict one another. → Alter the values for CV #53 to 56.
 - The lighting does not correspond to the direction of travel.
Possible cause: The configuration data (CV29) of the locomotive decoder in the train vary from the configuration data programmed in the function decoder. → Change the programming or the function 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.
 - The decoder does not react in analogue mode.
Possible cause: The analogue mode is switched off. → Alter the value for CV #29.
 - The decoder does not react to the change direction command in analogue mode.
Possible cause: The wrong analogue mode has been defined in CV#12. → Alter the value for CV #12.
- If you cannot find the problem, please return the decoder for repair (address on the cover page).

Manufacturer's note

The person who brings the circuit into operation is the manufacturer of the product. If he sells the product to another person he is responsible for passing on all the relevant papers. Domestic appliances assembled from a kit are deemed industrial products and must comply with health and safety regulations.

Certification

This product is developed and tested in accordance with the European standards EN 55014-1 and EN 61000-6-3. This product conforms with the EC- directive 2004/108/EG on electromagnetic radiation and is therefore CE certified.

Conditions of warranty

This product is guaranteed for two years. The warranty includes the correction of faults which can be proved to be due to material failure or factory flaw. We guarantee the adherence to the technical specifications of the circuit when assembled and connected according to the manual.

Other claims are excluded. By law, we are not responsible for damages or secondary damages in connection with this product. We retain the right to repair, make improvements, supply spare parts or return the purchase price.

The following invalidate the warranty:

- using an unsuitable soldering iron, solder containing liquid acids or similar,
- if damage is caused by not following the instructions in this manual,
- if the module has been altered and repair attempts have failed,
- if arbitrary changes in the circuit are made,
- if additional components are added which are not described in the manual,

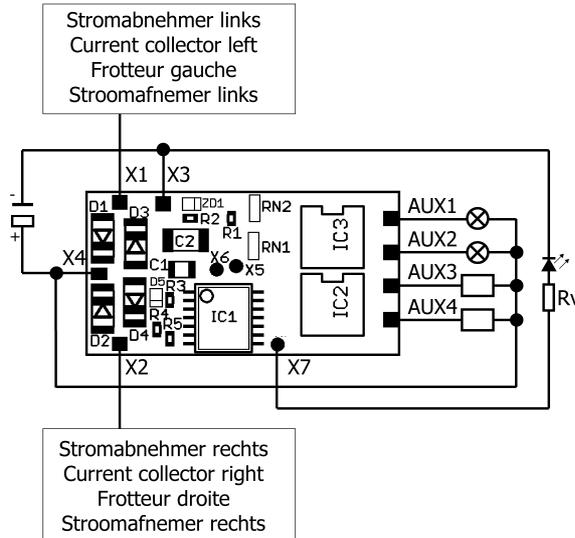
- if the copper tracks or soldering eyes are damaged,
- if damage occurs due to an overload of the module,
- if connected to a incorrect voltage or current,
- if damaged by other persons,
- if damaged by faulty operation or if damaged by careless use or abuse,
- if damaged by touching components before electrostatic discharging of the hands.

* The following manufacturers and their products are mentioned in this manual:

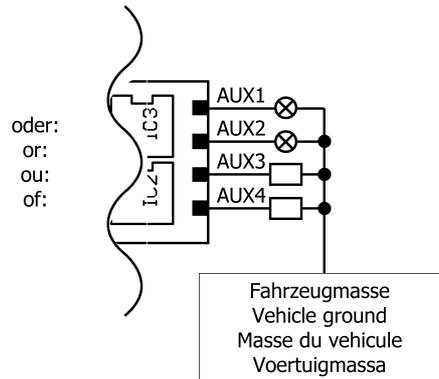
Märklin & Cie. GmbH, Goeppingen, Germany

Fig. 1:

Anschluss FD-M
Connections FD-M
Connexion FD-M
Aansluiten FD-M

**Fig. 2:**

Anschluss der Ausgänge
an Fahrzeugmasse
Connection of the outputs
to vehicle ground
Raccordement des sorties
via la masse du vehicule
Verbinding van de uitgangen
met de voortuigmasse



AUX1 bis AUX4	Verstärkte Ausgänge (max. 1.000 mA) Amplified outputs (max. 1.000 mA) Sorties amplifiées (max. 1.000 mA) Versterkte uitgangen (max. 1.000 mA)
X7	Unverstärkter Ausgang (max. 10 mA) Unamplified output (max. 10 mA) Sortie non amplifiée (max. 10 mA) Onversterkte uitgang (max. 10 mA)
X1	Schienenabnehmer links Rail current collectors left Prises de courant de la voie gauches Railstroomafnemers links
X2	Schienenabnehmer rechts Rail current collectors right Prises de courant de la voie droites Railstroomafnemers rechts
X3	Decodermasse Decoder ground Masse du décodeur Decodermasse
X4	Rückleiter für alle Funktionen Return conductor for all functions Pole commun des fonctions Retourleiding voor alle functie
	Elko z.B. 100 µF/35V - falls erforderlich Elko e.g. 100 µF/35V - if necessary Elko p.e. 100 µF/35V - si necessaire Elko b.v. 100 µF/35V - indien noodzakelijk
	LED mit Vorwiderstand LED with series resistor DEL avec une résistance placée en série LED met voorschakelweerstand

Aktuelle Informationen und Tipps:

Information and tips:

Informations et conseils:

Actuele informatie en tips:

<http://www.tams-online.de>

Garantie und Service:

Warranty and service:

Garantie et service:

Garantie en service:

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