





## Table of contents

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(Pages I to II in the centre of this handbook are removeable.)	

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

Märklin & Cie. GmbH, Goepingen, Germany

Uhlenbrock Elektronik GmbH, Bottrop, Germany

## 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 locomotive decoder is designed for mounting in a model train with DC motor. It evaluates the Motorola format data sent by the digital central unit to its address and controls the locomotive's motor and additional functions.

The module 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.

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

The decoder is designed for operation in Motorola II format and can be adjusted to one of 255 addresses. It evaluates the digital data sent by the central unit to its address. It controls the locomotive's motor and the driving characteristics. In addition, it switches the locomotive's lighting.

In Motorola I format it is possible to operate the decoder, but the programming of the parameters and the controlling of the functions is restricted.

### Automatic recognition of the analogue mode

The decoder can also be used in analogue model railway layouts run with an A.C. speed control. When putting the locomotive 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 by programming the decoder accordingly.

The decoder is not suitable for being operated in analogue model railway layouts run with an D.C. speed control. The decoder evaluates the data received in such layouts as "braking section", the locomotive therefore does not run.

In analogue mode the decoder reacts to the analogue changing direction signal. The lighting is always switched on according to the direction of travel. Switching on or off the lighting and the additional functions is not possible.

### Driving of the motor

The locomotive decoder drives the motor with a PWM of 32 kHz. This guarantees a soft and constant run of the motor, with which the decoder can also be used with coreless (Faulhaber) motors.

## **Overheating protection**

As soon as the decoder's maximum operating temperature (approx. 60 °C) is exceeded the decoder automatically switches off and the locomotive's lighting starts to flash. It is not possible to put the locomotive into operation again until the rail voltage has been switched off. As a rule the overheating is caused by a too high current consumption of the motor.

## **Load control**

The locomotive decoder has a load control. The load control influences the motor voltage to keep the locomotive at constant velocity, independent of additional loads (e.g. running up a gradient, coupled carriages).

The decoder chooses automatically the optimal values of the load control's parameters for the connected (DC) motor. The range of values from which the decoder chooses the optimal value can be altered by programming the decoder accordingly.

## **Direction of motion**

When changing the direction in digital operation the existing direction is saved and so retained, even if the central unit does not send absolute driving data (e.g. in Motorola I format).

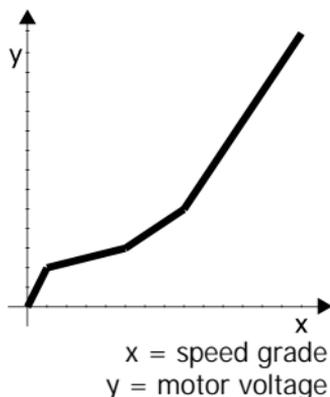
In order to change the direction of travel in analogue operation a voltage impulse is applied to the rails which is distinctly higher than the normal driving voltage. Disturbances from the locomotive motor, tolerances in the connected components or voltage drops in the rails can release unintended changes of direction or hinder intended changes of direction. The voltage needed for a change of direction can be adjusted by programming the decoder accordingly.

## Speed level

The decoder can drive 27 speed levels. Driving all 27 speed levels can be done only with central units which support this mode (e.g. MasterControl). With central units which only allow 14 speed levels only, it is only possible to select every second speed level.

## Velocity characteristic

The decoder can be adjusted to the individual driving characteristics of the motor and the characteristic speed of the locomotive type, by setting the starting velocity and the maximum velocity. From the starting velocity and the maximum velocity the decoder generates a velocity characteristic corresponding to the opposite figure. This characteristic allows a good fine tuning of the speed in the lower speed range.



## Shunting gear

The auxiliary function F4 allows you to switch into the shunting gear mode. In the shunting gear mode the velocity of all speed levels is reduced to ca. 25 % compared to the standard velocity.

## Acceleration and brake delay

It is possible to program the acceleration and brake delay individually. You can switch the acceleration and the brake delay on or off by operating the function key F3. Even if the acceleration and the brake delay are active you can actuate an emergency stop via the central unit by reversing the direction of travel.

## Lighting

The front and back lighting can be switched on and off according to the direction of travel from the central unit via the function "function"("f0").

## CV programming

Setting the address, the driving characteristics (starting and maximum velocity, acceleration and brake delay) and the velocity characteristic as well as adjusting the decoder to the particular locomotive motor (motor frequency, voltage for change of direction, load control parameters) is done by programming the configuration variables (= CV). The CV programming has been laid down for DCC decoders in the NMRA guidelines. The CV programming for this Motorola decoder has been developed following these guidelines, but differs in some points, according to the differences between both formats. In particular programming the decoder on a DCC programming-track is not possible.

## Online programming

Alternatively to the CV programming it is possible to program the address and the driving characteristics "online". This means:

- Right after starting the programming mode you can enter the new address and directly save it.
- While programming the driving characteristics (starting and maximum velocity, acceleration and brake delay) the locomotive is running. By operating the speed knob the driving characteristics are altered. As soon as these are set as desired, they can be saved directly (online).

## Restrictions in Motorola I format

The auxiliary functions F3 (switching on and off the acceleration and brake delay) and F4 (switching on and off the shunting gear) are not available in Motorola I format. Programming the decoder can only be done via CV programming.

## Technical specifications

Data format	Motorola I and II
Supply voltage	12-24 Volt digital voltage
Current consumption (without connected loads)	approx. 10 mA
Max. current for motor	500 mA
Max. current per function output	100 mA
Max. total current	700 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. 12,5 x 9 x 2,3 mm
Weight	approx. 1,1 g

## Checking the package contents

Check the contents of the package for completeness after unpacking:

- one decoder
- one manual

## Required tools and consumables

Make sure you have the following tools 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).

## 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.
- When soldering electronic circuits never use soldering-water or soldering grease. They contain acids that can corrode components and copper tracks.
- Only use electronic tin solder with flux.
- 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 locomotive decoder

Follow the connection diagram fig. 1.

### Connecting the motor

Before mounting the decoder check if the locomotive motor's current is below the maximum permissible value of 500 mA. If it is above 500 mA the decoder is not suitable for mounting in this locomotive. It would be damaged when put into operation.

Open the locomotive housing. Locate the position for the decoder. Disconnect the motor from the rail current collector.



#### **Caution:**

The interference suppression devices mounted to the motor or the connecting wire must not be removed! Motor and interference suppression devices are one unit. If even one part is removed, it can cause extreme interference!

Solder the red wire to the right rail current collector and the black wire to the left rail current collector (in direction of motion). Next solder the grey and the orange wires to the motor. In case the locomotive's direction of motion does not match the set direction of motion you have to swap the motor connections (grey and orange wire).

### Connecting the lighting and other accessories

Before connecting the lighting and other accessories check if the current is below the maximum permissible value of 100 mA. If lightings or other accessories with a current of more than 100 mA are connected the decoder will be damaged when put into operation.

Disconnect any existing diodes in the leads to the lamps. Connect the lamps and other accessories to the function outputs (white or yellow wires). The assignment of the function outputs to the function keys will be made when programming the decoder.

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

Front lighting: white wire

Back lighting: yellow wire

### **Connecting the LEDs**

The function outputs of the locomotive decoder switch against decoder ground. For that reason you must connect the cathode (-) of the LED to the output of the relevant function.



#### **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.

### **Fixing the locomotive decoder**

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

## Programming the locomotive decoder

With the most digital control units supporting the Motorola II format (e.g. Tams MasterControl, Märklin\* Control Unit, Uhlenbrock\* Intellibox) you can choose between two methods of programming after having started the programming mode:

1. CV programming
2. Online programming

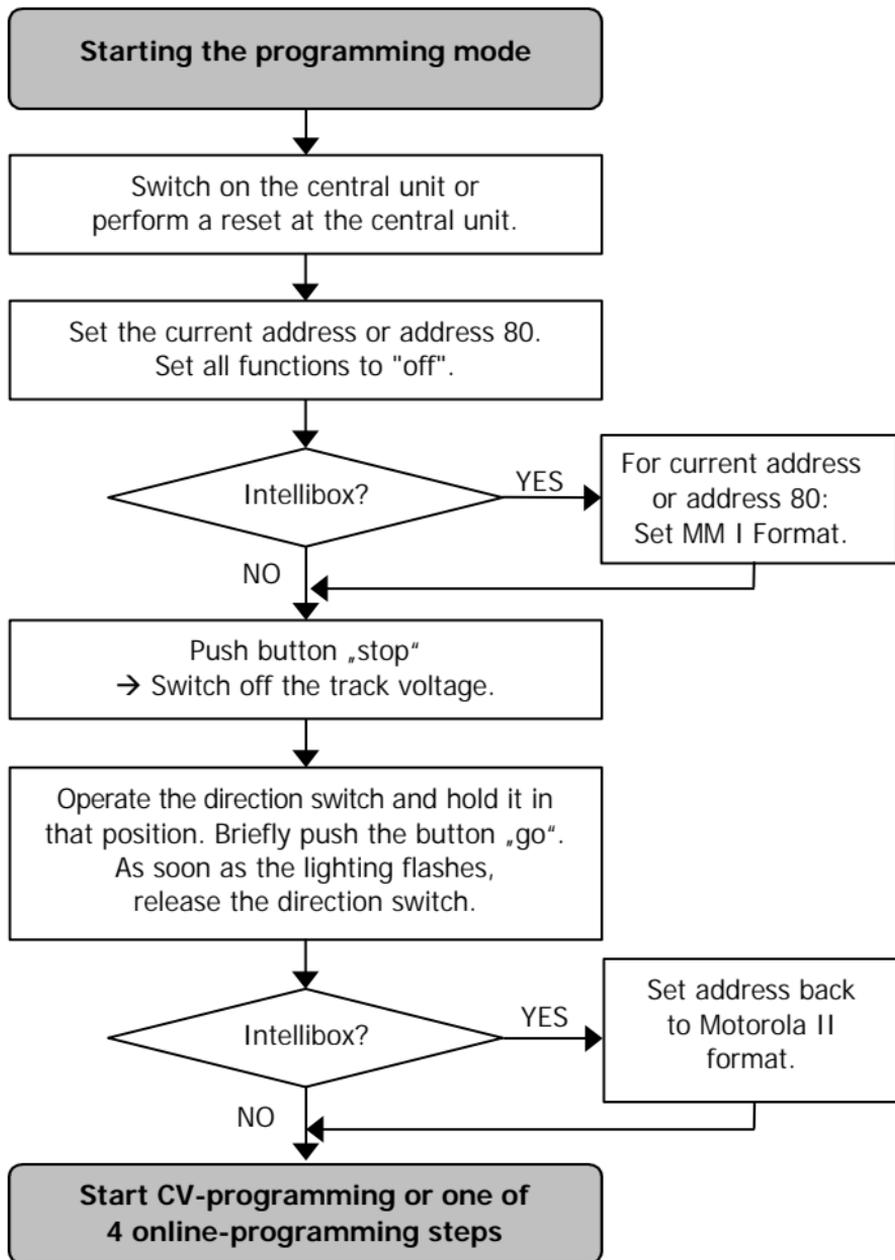
With the Central Station or the Mobile Station of Märklin\* you can program the address, the maximum speed and the acceleration and brake delay. Select the article no. 29750 from the locomotive database and program the decoder as described for this article in the Central Station´s or Mobile Station´s manual.

### Starting the programming mode

Put the locomotive on a track oval. If you want to program the decoder via CV programming it is sufficient to put the locomotive on a track section. Please note: You must connect the track oval or track section to the digital control´s track output and not to control unit´s output for the DCC programming track.

Reset the central unit (by simultaneously pushing the buttons "stop" and "go" for some time) or quickly switch the central unit on and off. First enter the current address or the address "80" (e.g. if you do not know the current address). Manufacturers setting is "78". 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 of the locomotive flash (after approx. 2 seconds) the decoder is in the programming mode and you can release the direction switch. Now you can programm the decoder either by setting the configuration variables (CV) or "online".



**Notice:** Some types of central units do not allow you to access to the programming mode when the Motorola II format is set (e.g. Intellibox from Uhlenbrock\*). These central units must be set to Motorola I format for the current address or the address "80". As soon as the decoder is in the programming mode, the central unit must be set back to Motorola II format.

## CV programming

This programming method follows the standards for the DCC format by the NMRA. Please note: It is not possible to program this Motorola Decoder via the DCC programming track!

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

1. Choose the CV you want to program by setting the CV's number as Motorola locomotive address at your central unit.
2. Operate the direction switch. The locomotive's lighting stops flashing.
3. Set the desired value of the CV by setting the CV's value as Motorola locomotive address at your central unit.
4. Operate the direction switch again. The locomotive's lighting starts flashing again.

Repeat the steps 1 to 4 for all CVs you want to program. In order to choose a variable for programming or to enter a value for a variable you have to confirm the entered number like selecting a Motorola locomotive address. Please note: If you have a multi protol control you have to define the Motorola format for the particular address. The locomotive's lighting shows which kind of entry the decoder expects:

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

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

CV-no.	Range of values	Factory settings	Remarks
1	1, 2, 3 ... 255	78	Address
2	1, 2, 3 ... 80	16	Starting velocity
3	1, 2, 3 ... 80	5	Acceleration delay
4	1, 2, 3 ... 80	5	Braking delay
5	1, 2, 3 ... 63	63	Maximum velocity
6	0 (off), 1 (on)	1 (on)	Analogue mode
7			Only internal importance. Do not enter new values for this CV.
8			
9	100 ... 200	150	Analogue voltage needed for change of direction
10			Not used
11	60 ... 120	78	Shut-off temperature with overheating. The value "78" corresponds to a temperature of 60 °C. . Raising the value leads to a reduction of the sensivity of the overheating protection. A too high reduction can cause damage!
12-15			Not used
16-43	0 ... 255		Velocity table for velocity characteristic. You can assign an individual motor voltage to each of the 27 speed levels. For speed level 0 the value "0" has to be kept!
44-47			Not used

CV-no.	Range of values	Factory settings	Remarks
48	1, 2, 3 ... 80	64	Lowest value of load control parameters *
49	30, 31 ... 255	160	Highest value of load control parameters *
* Proceed in small steps when altering the CV#48 und #49. For most motors the factory settings meet the optimum.			

### Online-programming

After having started the programming mode (and when the locomotive's lighting flashes) you can perform one of four online programming steps:

- directly entering the locomotive address,
- performing a decoder reset,
- setting the acceleration and braking delay and verifying the settings during driving operation,
- setting the starting and the maximum velocity and verifying the settings during driving operation.

After having entered a new address or performing a decoder reset the decoder automatically returns to standard driving operation.

After having set and saved the acceleration and braking delay or the starting and the maximum velocity the decoder first remains in the programming mode and you can alter and save your settings again. The programming step is not finished until pushing "stop". Then the decoder returns to standard driving operation.

Connect your central unit to a track oval for online-programming of the driving characteristics. Please do not place other vehicles on the track oval with a decoder while online programming, because they will possibly be programmed as well.

## Setting the locomotive´s address

Start the programming mode (see above)	The locomotive´s lighting flashes regularly.
	Enter the desired locomotive´s address.
Switch on and off "function" (f0) once	The entered address is saved.
	After having saved the locomotive´s address the lighting stops to flash and the decoder automatically returns to standard driving operation.

## Performing a decoder reset

Start the programming mode (see above)	The locomotive´s lighting flashes regularly.
Switch on function F2.	The factory settings are restored, all other settings are deleted.
	The decoder automatically returns to standard driving operation.

## Setting the acceleration and braking delay

Start the programming mode (see above)	The locomotive´s lighting flashes regularly.
Switch on function F1. Tip: With the online programming it is not possible to set the acceleration and the braking delay individually. This can be done with the CV programming only.	The locomotive´s lighting flashes intermittently. Switch off the function F1. The locomotive accelerates and brakes continuously. By turning the speed control knob you can alter the acceleration and braking delay. Speed level 0 → no delay Highest speed level → maximum delay
Switch on and off "function" (f 0) once	The settings are saved. The locomotive´s lighting flashes regularly.
Push "Stop"	The programming mode is finished.

## Setting the starting and the maximum velocity

Start the programming mode (see above)	The locomotive's lighting flashes regularly.
Switch on function F3	The locomotive's lighting flashes intermittently. Switch off the function F3. Turn the speed control knob until the locomotive drives with the desired starting velocity.
Switch on and off "function" (f0) once	The settings are saved and the locomotive's lighting flashes some times. The decoder changes to the setting of the maximum velocity (the locomotive drives faster).
	Turn the speed control knob until the locomotive drives with the desired maximum velocity.
Switch on and off "function" (f0) once	The settings are saved and the locomotive's lighting flashes intermittently. The decoder changes to the setting of the starting velocity (the locomotive runs slower).
Push "Stop"	The programming mode is finished.

## Operation

### Acceleration and brake delay

In Motorola II format the acceleration and brake delay is switched alternately on or off by switching on the function F3. F3 "off": delay active. The change of the setting takes effect immediately. If the acceleration and brake delay is switched off during braking the locomotive immediately runs with the speed level set at the central unit.

In Motorola I format the acceleration and brake delay is always active.

An emergency stop during acceleration and brake delay can be performed from the central unit by changing the direction of travel.

## Switching the shunting gear

In Motorola II format the shunting gear can be switched on and off via the auxiliary function F4. In Motorola I format the shunting gear cannot be activated.

## FAQ

- Parts are getting too 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: The connection of the motor is connected to locomotive ground. → Disconnect the connection from locomotive ground.

- After programming the decoder the locomotive does not run or runs badly.

Possible cause: The set values for the CV are inconsistent.  
→ Perform a decoder reset and program the decoder anew.

- The locomotive does not run in analogue mode.

Possible cause: The analogue mode is switched off. → Alter the value for CV #6.

Possible cause: The analogue model railway layout is run with a D.C. speed control; the analogue mode however is only possible with A.C. speed controls.

- In digital mode the locomotive suddenly runs very fast.

Possible cause: Interfering signals from the layout have switched the decoder to analogue mode. → So long as the interfering signals' origin cannot be found it is advisable to switch off the automatic recognition of the analogue mode during digital operation.

- The locomotive runs too fast or too slow.

Possible cause: Different locomotives drive differently with the same decoder settings. → Adjust the decoder settings to the individual driving characteristics of the locomotive.

- The locomotive stops and the locomotive's lighting starts to flash.  
Possible cause: The decoder has got too hot and the overheating protection has been activated.  
→ Possibly the decoder overheating can be prevented by better cooling.  
→ It is possible to reduce the sensitivity of the overheating protection (CV#11). **Caution:** In case the sensitivity of the overheating protection is reduced too much, the decoder may be damaged before it is activated.  
→ Possibly the decoder is not suitable for controlling the locomotive's motor, as the motor's current consumption is too high. Mechanical malfunction of the locomotive as well may cause a too high current consumption.
- The locomotive does not react to F3 or F4.  
Possible cause: The central unit is set to Motorola I format. → Set the central unit to Motorola-II format.

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

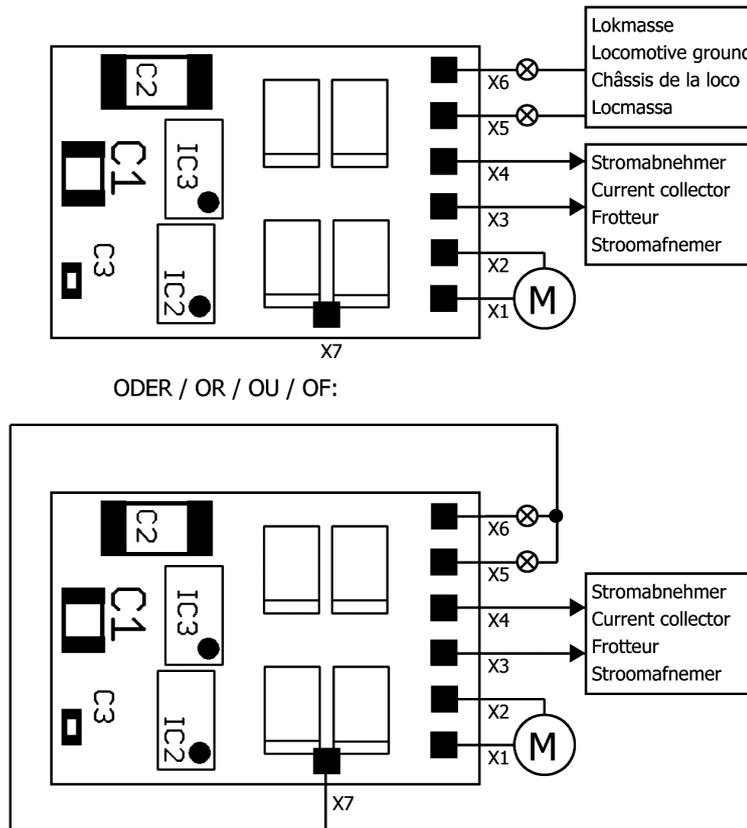
This product is guaranteed for two years. The warranty includes the correction of faults which can be proved to be due to material failure or factory flaw. We guarantee the adherence to the technical specifications of the circuit when assembled and connected according to the manual.

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.

**Fig. 1:** Anschlussplan – Plan de connexion - Connections - Aansluitplan



- X1** orange / orange / orange / oranje:  
 Motoranschluß 1 / Motor connection 1  
 Connexion moteur 1 / Motoraansluiting 1
- X2** grau / grey / gris / grijs:  
 Motoranschluß 2 / Motor connection 2  
 Connexion moteur 2 / Motoraansluiting 2
- X3** rot / red / rouge / rood:  
 Schleifer / Slider / Frotteur / Sleper
- X4** schwarz / black / noir / zwart:  
 Gehäuse / Housing / Masse / Huis
- X5** weiß / white / blanc / wit:  
 Beleuchtung vorne / Front lighting  
 Feux avant / Verlichting voor  
 oder / or / ou / of:  
 Beliebiger Verbraucher / Optional accessory  
 Consommateur quelconque / Gewenste verbruiker
- X6** gelb / yellow / jaune / geel:  
 Beleuchtung hinten / Back lighting  
 Feux arrière / Verlichting achter  
 oder / or / ou / of:  
 Beliebiger Verbraucher / Optional accessory  
 Consommateur quelconque / Gewenste verbruiker
- X7** Rückleiter für alle Funktionen  
 Return conductor for all functions  
 Pole commun des fonctions  
 Retourleiding voor alle functies



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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