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## How to use this manual

If you have no specialist technical training, 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



### Caution:

Integrated circuits 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.

The module can be used according to the specifications of this manual in a model railway. Mounted in a model railway locomotive with d.c motor it evaluates the DCC format data sent by the digital central unit to its address. The decoder controls the vehicle performance (velocity, direction of travel, acceleration) and switches the two function outputs, which can be variously assigned to the functions keys.

The module should not be assembled 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.

## 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 in accordance with the European standards EN 55014 and EN 50082-1, tested corresponding to the EC - directive 89/336/EEG (EMVG of 09/11/1992, electromagnetic tolerance) and meets legal requirements. To guarantee the electromagnetic tolerance 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, print layout and circuit diagram included with this manual.
- Use only original spare parts if you have to repair the module.

## **Information: Speed mode**

Digital control units for DCC format can send 14, 28 or 128 speed levels depending on the model and the settings. The number of speed levels sent by the digital control unit (= speed mode) must be set at the decoder as well. Otherwise the performance of the locomotive may be incorrect.

## **Information: Configuration variables (CVs)**

You can set the so-called configuration variables of the decoder from the central unit. The programming of the variables allows the adjustment of the decoder to the particular driving characteristics of the locomotive and to the individual needs of the user.

The configuration variables are saved in the decoder and are also preserved if the locomotive is switched off. Changing the configuration variables is possible at any time from the digital control unit.

The configuration variables for the DCC format are standardised. The variables that can be set depend on the decoder type.

## **Operation overview**

The decoder LD-G-15 is designed for operation in DCC format and can be adjusted to one of 127 basic addresses or to one of 10.239 extended addresses. It is designed to be controlled from digital control units that are set on the 14-, 28- or the 128-speed mode.

The decoder can be programmed individually by setting the configuration variables. It is possible to set all configuration variables with central units which support the CV-programming. With central units which only support the so-called register-programming the number of the configuration variables that can be set is restricted.

## The configuration variables of the LD-G-15

The following configuration variables (CVs) can be set from the digital control unit:

- Basic address (CV#1)
- Starting voltage (CV#2)
- Acceleration rate (CV#3)
- Braking rate (CV#4)
- Maximum voltage (CV#5) \*<sup>1</sup>
- Version (CV#7) – read only
- Manufacturer identification (CV#8) - read only
- Extended address (CV#17 und CV#18) \*<sup>1</sup>
- Configuration data 1 (CV#29)
- Assignment of the outputs to the function keys F5 to F8 (CV#39 to 40) \*<sup>1</sup>
- Configuration data 2 (CV#49) \*<sup>1</sup>
- Dimming of the outputs (CV#50 to C51) \*<sup>1</sup>
- Proportional component of the load control "KP" (CV#54) \*<sup>1</sup>
- Assignment of the outputs to the function keys F0 to F4 (CV#55 to 56) \*<sup>1</sup>
- Integral component of the load "KI" (CV#59) \*<sup>1</sup>
- Effects for the outputs (CV#60 to 61) \*<sup>1</sup>
- Alternative velocity characteristic for mode 28 speed levels (CV#67 to 94) \*<sup>1</sup>

\*<sup>1</sup> Not possible with central units with register programming!

## Driving of the motor

The motor is driven with a PWM of 32 kHz. This guarantees a soft and constant run of the motor. The decoder may also be used with coreless (Faulhaber) motors as well.



## Load control

At constant motor voltage, additional loads (e.g. running up a gradient, coupled carriages) cause the locomotive to slow down or even come to a standstill. If the load control is active the motor voltage varies to keep the locomotive operating at constant velocity at a given speed level, independent of additional loads.

It is possible to switch on and off the load control by varying a CV-variable of the decoder. The parameters of the load control may be altered as well.



### Attention:

For most locomotives you will achieve good driving characteristics with the factory settings. Incorrect of the load control parameter settings deteriorate the driving characteristics of the motor considerably. Therefore you should first check the locomotive with the preset values and modify the parameters of the load control only step-by-step.

**Parameters of the load control:** The load control is determined by two parameters which have to be coordinated in order to achieve optimal driving characteristics. Each of the load control parameters is assigned to a configuration variable. The parameters are:

**KP:** The proportional component of the load control ensures the difference between the set and the present value being as small as possible. It cannot have the value „0“ at any time.

**KI:** The integral component of the load control ensures the remaining difference between the set and the present value being reduced to 0.

## Velocity characteristic

The decoder can be adjusted to the 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 linear velocity characteristic.

The operating voltage of the locomotive motor at speed level 1 is set by adjusting the starting velocity. Normally the motor voltage is adjusted so that the locomotive just starts to run at speed level 1.

The operating voltage of the locomotive motor at speed level 14, 28 or 128 is set by adjusting the maximum velocity. The adjustment should be such that the locomotive reaches the desired maximum speed at the highest speed level.

When the speed level mode is set to 28 speed levels, it is possible to assign any motor voltage to all of the 28 speed levels as an alternative to the linear velocity characteristic. This allows the programming of a velocity characteristic which adjusts the individual driving characteristics of the motor. The set values are saved in the alternative velocity table.

### **Shunting gear**

In the speed modes 14 and 28, it is possible to switch into the shunting gear mode via a function key, when so programmed. In the shunting gear mode, the velocity of all speed levels is reduced to approx. 50 % compared to the set velocity.

### **Acceleration and brake delay**

It is possible to program the acceleration and brake delay individually via the central unit.

### **Emergency stop**

By setting a CV-variable it is possible to adjust how an emergency stop is carried out. There are the following possibilities:

- no emergency stop possible,
- emergency stop at change of direction and / or
- emergency stop by operating of F1.

### **Function outputs**

The decoder has two function outputs which can be switched on and off via the function keys F0 to F8. They are available to connect optional accessories.

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

## Effects of the function outputs

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

- Irregular flickering. Example of use: Flickering of the boiler fire of steam engines.
- Strobe (flashing). Example of use: American locomotives with that kind of lighting.
- MARS light (swelling of the brightness). Example of use: American locomotives with that kind of lighting.
- Switching on and off depending on the direction of travel.
- Flashing with a frequency of 2 Hz with two phases which are out-of-phase by 180 degrees. Example of use: individual flash lights or alternating flash lights.
- Flashing with a frequency of 1 Hz.

## Technical specifications

Data format	DCC
Supply voltage	12-18 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. 9,2 x 11,7 x 2,7 mm
Weight	< 1 g

## Checking the package contents

Check the contents of the package for completeness after unpacking:

- one decoder with soldered connecting wires or soldered NEM 651 interface connector, depending on the version.
- one manual.

## Required tools and materials

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),
- wire (diameter:  $\geq 0,05 \text{ mm}^2$  for all connections).

## 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**. If you have had training in soldering you can skip this chapter.

- 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 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

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

Follow the connection diagram fig. 1. 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.

## Connecting the lighting and other accessories

Disconnect any existing diodes in the leads to the lamps. Follow the connection diagram fig. 1.


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 the lamp or the accessory is already connected with one side to locomotive 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 X7).


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

 **Caution:**

If you connect the loads to the return conductor for all functions (point X7), the load must be insulated. The loads should not make contact with metal parts of the locomotive. Possible short circuit! The locomotive decoder will be damaged in operation.


 **Caution:**

The return conductor for all functions (point X7) must under no circumstances be connected to locomotive ground. Possible short circuit! The locomotive decoder will be damaged in operation.

**Tip:** Before starting to program the locomotive decoder you should connect the motor to the decoder. Otherwise there is no confirmation signal from the central unit.

### 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. There are LEDs with 2-5 mA, but also LEDs with 15-30 mA power consumption. 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 up to 5 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. The number of LEDs connected in series to one output depends on the digital voltage.

You can determine the number of the LEDs that can be connected in series to one output from the following formula:

$$\boxed{(\text{number of LEDs} + 2) \times 1,5 < \text{digital voltage}}$$

## Programming the locomotive decoder

The locomotive decoder is programmed from the digital central. See chapter in the manual of your digital control unit where the programming of configuration variables (CVs) is explained.

You can programm or read out the following decoder variables:

NB. With central units with register-programming it is only possible to program the variables CV#1 to CV#4 (= register 1 to 4) and CV#29 (= register 5).

\*<sup>2</sup> Tip: You program the configuration variables CV#29, CV#39 to 40, CV#49, CV#55 to 56 and CV#60 to 61 by entering the sum of the numerical values which are assigned to the desired parameters.

CV-name	CV-no.	Input value (State of delivery)	Remarks
Basic address	1	1 ... 127 (3)	
Starting voltage	2	0 ... 255 (32)	= The voltage to be output to the motor at speed level 1. The value "0" corresponds to 0 Volt, the value "255" to the max. voltage.
Acceleration rate	3	0 ... 255 (3)	= Length of the delay before the switching to the next higher speed level when the locomotive is accelerating. The delay is calculated as follows: (value of CV#3) x 0,9 sec. / number of speed levels
Braking rate	4	0 ... 255 (3)	= Length of the delay before the switching to the next lower speed level when the locomotive is braking. The delay is calculated as described in CV#3.
Maximum voltage	5	0 ... 255 (0)	= The voltage to be output to the motor at the highest speed level. The value "2" corresponds to 0,8 %, the value "255" to 100 % of the max. voltage.
Version	7	---	Read only!
Manufacturer	8	--- (62)	Read only!
Reset	8	0 ... 255	Any value restores the settings in state of delivery.
Extended adress	17 18	1 ... 10239 (-)	



CV-name	CV-no.	Input value (State of delivery)	Remarks
Configuration data 1	29	(2)	Numerical value * <sup>2</sup>
			Direction "standard" 0
			Reverse direction 1
			14 speed levels 0
			28 or 128 speed levels 2
			Linear velocity characteristic 0
			Altern. velocity characteristic 16
Basic adress 0			
Extended adress 32			
Assignment F5 – F8 to the outputs:		0 ... 15	Numerical value * <sup>2</sup>
X5	39	(0)	Operation with: ---
X6	40	(0)	function key F5 0
			function key F6 1
			function key F7 2
			function key F8 4
			function key F8 8
Configuration data 2	49	0 ... 127 (1)	Numerical value * <sup>2</sup>
			Load control active 1
			Emergency stop at change of direction 2
			Emergency stop at F1 4
			Shunting gear mode at F1 8
			Shunting gear mode at F2 16
			Shunting gear mode at F3 32
Shunting gear mode at F4 64			

CV-name	CV-no.	Input value (State of delivery)	Remarks
Dimming of the outputs:		0 ... 63	= The voltage that is applied to the output. The value "1" corresponds to the minimum, „63“ to the maximum voltage.
X5	50	(63)	
X6	51	(63)	
Parameter of load control KP	54	0 ... 255 (32)	= Proportional component of the load control.
Assignment F0 – F4 to the outputs:		0 ... 31	Numerical value *2 Operation with:
			--- 0
X5	55	(16)	function key F1 1
X6	56	(16)	function key F2 2
			function key F3 4
			function key F4 8
			function key F0 16
Parameter of load control KI	59	0 ... 255 (32)	= Integral component of the load control.
Effects for the outputs:		0 ... 255	Numerical value *2
			Flickering active 1
			Strobe active 2
X5	60	(16)	MARS light active 4
X6	61	(8)	at forward motion inactive 8
			at backward motion inactive 16
			Flashing 2 Hz phase A 32
			Flashing 2 Hz phase B 64
			Flashing 1 Hz 128

CV-name	CV-no.	Input value (State of delivery)	Remarks
Alternative velocity characteristic (only with mode 28 speed levels)	67 . . . 94	0 ... 255	= The velocity table for the alternative velocity characteristic. Any motor voltage can be assigned to all of the 28 speed levels. The value "0" corresponds to a voltage of „0“, „255“ to the maximum voltage.

## FAQ

- Parts are getting very hot and/or start to smoke.  
Tip: The decoder may warm up to 45 °C in operation. This does not affect the functioning of the decoder.



### **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.

- 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.

If you cannot find the problem, please return the decoder for repair (address on the cover page).

## Manufacturer's note

According to DIN VDE 0869, the person who brings the circuit into operation by extension or mounting into a housing is the manufacturer of

the product. If he sells the product to another person he is responsible for passing on all the relevant papers and to give his name and address.

## Certification

This product conforms with the EC- directive 89/336/EEG on electromagnetic radiation and is therefore CE certified.

## Conditions of warranty

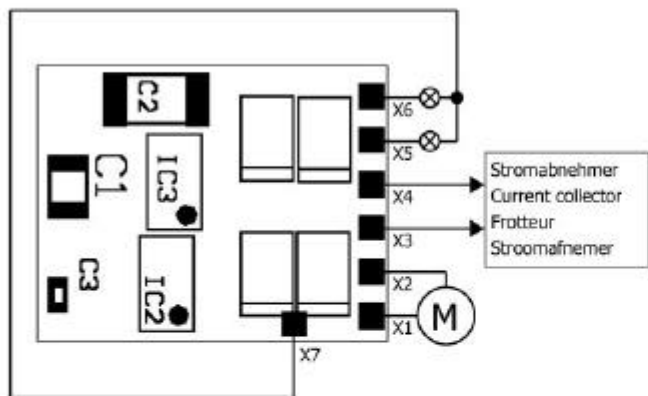
This product is guaranteed for two years. The warranty includes the correction of faults which can be proved to be due to material failure or factory flaw. We guarantee the adherence to the technical specifications of the circuit when assembled and connected according to the manual.

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.

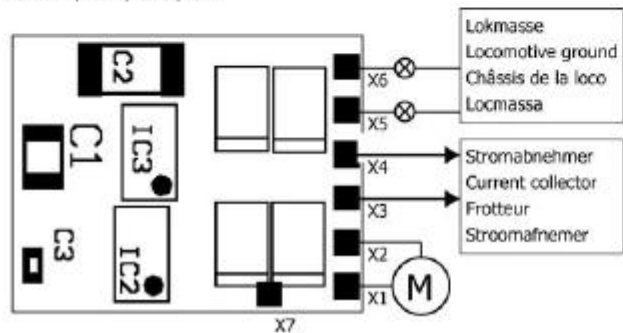
The following invalidate the warranty:

- 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 - Connection Diagram  
Schéma de connexion - Aansluitplan**

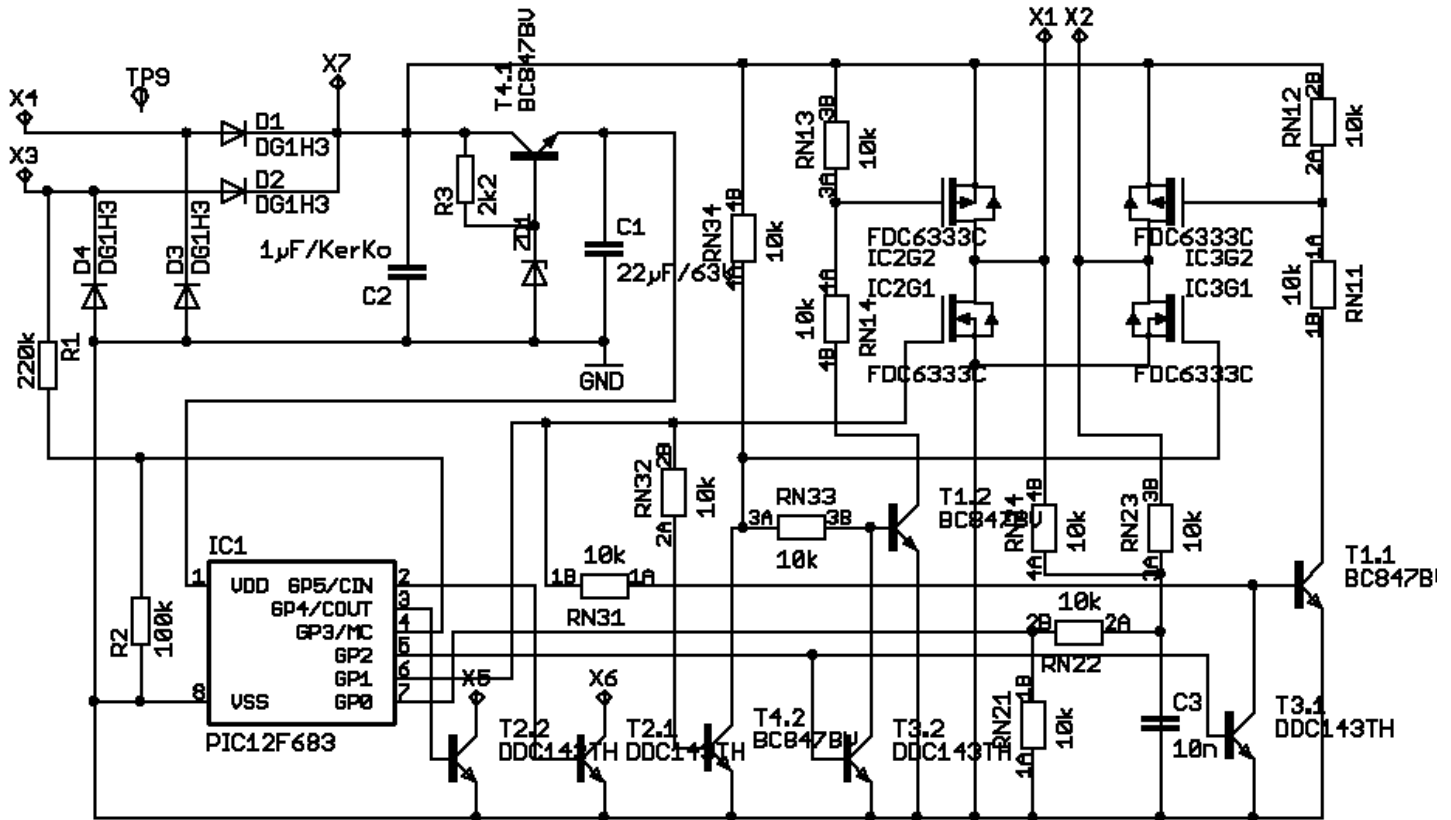


ODER / OR / OU / OF:



- X1 grau / grey / gris / grijs:  
Motoranschluß 2 / Motor connection 2  
Connexion moteur 2 / Motoraansluiting 2
- X2 orange / orange / orange / oranje:  
Motoranschluß 1 / Motor connection 1  
Connexion moteur 1 / Motoraansluiting 1
- X3 schwarz / black / noir / zwart:  
Schienenabnehmer links / Current collector left side  
Frotteur gauche / Stroomafnemer linkerhand
- X4 rot / red / rouge / rood:  
Schienenabnehmer rechts / Current collector right side  
Frotteur droite / Stroomafnemer rechterhand
- X5 gelb / yellow / jaune / geel:  
Beleuchtung hinten / Back lighting  
Feux arrière / Verlichting achter  
oder / or / ou / of:  
Beliebiger Verbraucher / Optional accessory  
Consommateur quelconque / Gewenste verbruiker
- X6 weiß / white / blanc / wit:  
Beleuchtung vorne / Front lighting  
Feux avant / Verlichting voor  
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

Fig. 2: Schaltplan - Circuit Diagram - Schéma de principe - Schakelschema



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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