



FD-3

**Funktionsdecoder
Motorola-Format**

**Function decoder
Motorola-Format**

**Décodeur de fonctions
Format Motorola**

**Functiedecoder
Motorola-Format**

Art.-Nr. 22-01-063

Anleitung

Manual

Mode d'emploi

Handleiding



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* **Märklin** is the registered trademark of Gebr. Märklin & Cie. GmbH, Göppingen , Germany.

** **Intellibox** is the registered trademark of Uhlenbrock Elektronik GmbH, Bottrop , Germany.

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. It is designed for the mounting in a model railway locomotive or in a model railway carriage. It evaluates the Motorola II format data sent by the digital central unit to its address. The decoder switches the four function outputs, which can be variously assigned to the functions keys.

The module is not suitable for children under the age of 14.

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

Any other use of the kit 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 designed,
- impermissibly high humidity,
- condensation building 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 stations only in approved mains sockets installed by an authorised electrician.
- Observe cable diameter requirements.
- After condensation build up, allow up to 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 life-threatening fire, burns and toxic smoke. 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 the module.

Little children can swallow small components with sharp edges. Life threatening! 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.

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, circuit diagram and PCB layout included with this manual.
- Use only original spare parts if you have to repair the 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 and transmits it to the connected loads.

In Motorola I format the programming of the parameters and the controlling of the functions is reduced.

Function outputs

The decoder has four function outputs which can be switched on and off via the function key „function“ and / or the auxiliary function keys F1 to F4. They are available to connect optional accessories (e.g. lighting, smoke generator, sound module, electric coupling).

The set states of the function outputs are saved. Even if the decoder is without current for a longer time, the states are set when the decoder is switched on again.

Assignment: You can assign the function keys to the function outputs freely. It is possible to assign several function keys to one function output. Function outputs that are assigned to the function key „function“ can be switched according to the direction of travel.

Example of use: The lighting of a shunting locomotive is assigned both to the function key „function“ as to the function key F1. In shunting operation you switch the lighting via F1 and in standard operation according to the direction of travel via „function“.

Dimming: All function outputs can be dimmed individually.

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.

Example of use: The front lighting is assigned to two different function outputs. Via one function key you can switch the standard lighting, via another the long distance lighting.

Kick function: It is possible to set the function outputs so that they get the full voltage first for up to seven 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.

Additional function output depending on the direction of travel

Beside the four function outputs to be switched there is another function output available that depends on the direction of travel but cannot be switched. This output can be connected directly to the base of a transistor, whose emitter is connected to the decoder. The output can be loaded with maximum 1 mA and therefore is not suitable for direct connection of auxiliary loads.

Depending on the direction of travel a voltage of 0 or 5 Volt is applied to this output. This allows the switching of a transistor depending on the direction of travel.

Example of use: In a train formation with two rail current collectors it is possible to switch between the two collectors depending on the direction of travel.

Check back of the address

In the programming mode you can query the address. The address is transmitted coded by the flashing of the lighting of the vehicle.

Online-programming

The address and all functions can be programmed online. This means:

- In order to start the programming mode and to set the desired (new) address, it is not necessary to enter the present address.
- In the programming mode the function to be set is active. This makes it easier to assign the outputs to the function keys. The dimming and the kick function can be altered via the speed knob. As soon as they are set as desired, they can be saved directly (online).

Restrictions in Motorola I format

In Motorola I format it is possible to set the address and to assign the function outputs to the function key „function“. It is not possible to perform a reset and to query the address. The functions F1 to F4 cannot be switched.

Technical specifications

Data format	Motorola-II
Supply voltage	12-24 Volt digital voltage
Current consumption (without connected loads)	approx. 10 mA
Max. current per function output to be switched	1.500 mA
Max. total current	2.500 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. 27 x 17 x 3,5 mm
Weight	approx. 2,5 g

Checking the package contents

Check the contents of the package for completeness:

- one decoder,
- one manual

N.B. For technical reasons it is possible that the PCB is not completely inserted. This is not a fault.

Required tools and consumables

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: $\geq 0,1 \text{ mm}^2$).

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.

- Only use tin solder SN 60 Pb (i.e. 60 % tin, 40 % lead) with rosin-based flux.
- When soldering electronic circuits never use soldering-water or soldering grease. They contain acids that can corrode components and copper tracks.
- Solder fast: long soldering 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 tin solder finds its way, then remove the soldering iron.
- The joint should be held still for about 5 seconds after soldering. A glossy and perfect soldering spot should remain.
- To make a good soldering joint you must 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 diagram fig. 1.

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

Solder the connections from the rail current collectors at the points X1 and X2. The assignment of the connecting wires is not important.

Connecting the lighting and other accessories

Disconnect any existing diodes in the leads to the lamps. Connect the lamps and other accessories to the function outputs (X5 to X8) on 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 X3 or X4).

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

Front lighting: X8

Back lighting: X5

Accessory to be switched via F1: X6

Lighting independent of direction of motion: X7



Caution:

If you connect the loads to the return conductor for all functions (point X3 or X4), the load must be insulated. The loads should not make contact with metal parts of the vehicle. Possible short circuit! The function decoder will be damaged in operation.



Caution:

The return conductor for all functions (point X3 or X4) must under no circumstances be connected to vehicle ground. Possible short circuit! The function decoder will be damaged in operation.

Advice: If the second side of the lamps is connected to vehicle ground the lamps often flicker in operation. You can avoid the flickering of the lamps if you connect the second side to the return conductor (point X3 or X4) instead of vehicle ground.

Advice: Some accessories can not be checked for operation by switching on and off in short intervals (e.g. smoke generators). If you have connected accessories like these to the function outputs of the decoder it is recommended to connect a lamp in parallel to the accessory during the programming of the decoder.

Connecting the LEDs

The function outputs of the function 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 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. 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:

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

Connecting a transistor stage

You can connect a transistor stage to the function outputs X9 and X10 which e.g. allows a change-over between the current collectors to be realised. Connect the base of the transistor to point X 9 and the emitter to point X10.

Attention:

The output X9 can be charged with maximum 1 mA. Therefore it is not suitable for the direct connection of auxiliary loads.

Fixing the function decoder

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

Programming the function decoder

You can make the following adjustments from the central unit without intervention at the vehicle:

1. Decoder address
2. Assignment of the function outputs to the function keys
3. Dimming the function outputs
4. Kick function of the function outputs

Accessing the programming mode

Put the vehicle on to a programming track or on the layout and reset the central unit (by simultaneously pushing the buttons "stop" and "go" for some time). Set the function key "function" of the central unit to "off". Enter the address "78" at the central unit.

Attention:

It does not matter if you have already saved another address. You always have to enter the address "78" to access the programming mode.

If you put the vehicle for programming on the layout take off all other vehicles with decoders with online-programming. If not you programm these vehicles as well.

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 vehicle flash (after approx. 2 seconds) you are in the programming mode and can release the direction switch.

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). In order to start the programming mode these central units must be set to Motorola I format for the address "78". As soon as the decoder is in the programming mode, the central unit must be set back to Motorola II format.

Starting from this menu level you can:

Without any further inputs: Set the address and the functions.

After pushing the function key F1: Query the address.

After pushing the function key F2: Perform a decoder reset.

You can finish the programming mode at any time by disconnecting the vehicle (pushing the button „stop“ or taking the vehicle from the track).

Setting the decoder address and the functions

1. Setting the decoder address

You are in the menu point „Setting the decoder address“ when all lighting connected to the function outputs flash regularly. Enter the desired address. You do not need to enter the old address. Confirm your setting by switching the function key „function“ on and off once. After the taking-over of the decoder address the regular flashing of the connected lighting stops and the decoder proceeds immediately to the programming of the first function output.

2. Setting the function outputs

Now the function outputs X8, X5, X7 und X6 are programmed one after the other. The function keys are assigned in succession, and the dimming and the kick function are set for each output.

Assigning the function keys: While the programm continuously switches the output to be programmed on and off (and the lighting connected to the output flashes) switch on the functions key(s) F1 to F4 on your central unit with which you want to switch on the output in later operation. You can assign several function keys to one output of the decoder.

If you want to switch the function output in operation via „function“ you have to make the following settings:

Speed level 1 : Output will be switched on during backwards motion.

Speed level 2 : Output will be switched on during forward motion.

Speed level 3 : Output will be switched on independent of the direction of motion.

Advice: On the Märklin* Central Unit 6021 the speed levels 1,2 and 3 correspond to the settings 20, 40 and 60.

Confirm your settings by switching the function key „function“ on and off once.

Setting the dimming function: The dimming function is set via the speed knob. If lamps are connected speed level 0 stands for minimal voltage at the output to be set and speed level 14 (250 on Märklin* Control Unit 6021) maximal voltage. Confirm your setting by switching the function key „function“ on and off once.

Setting the kick function: The kick function is set via the speed knob as well. Speed level 0 stands for „kick function off“, the output always receives the voltage set during the setting of the dimming function. By operating the speed knob you can set how long the full voltage is applied until the voltage is adjusted to the dimmed value. The period is extended for approx. half a second with each speed level. Accordingly, when setting the speed level 14, the full voltage is applied for approx. 7

seconds before the chosen dimmed value is set. Confirm your setting by switching the function key „function“ on and off once.

Repeat the assignment of the function keys and the setting of the dimming and the kick function for the other three function outputs. You can skip the programming of an output that is not occupied by switching on and off the function key „function“ three times.

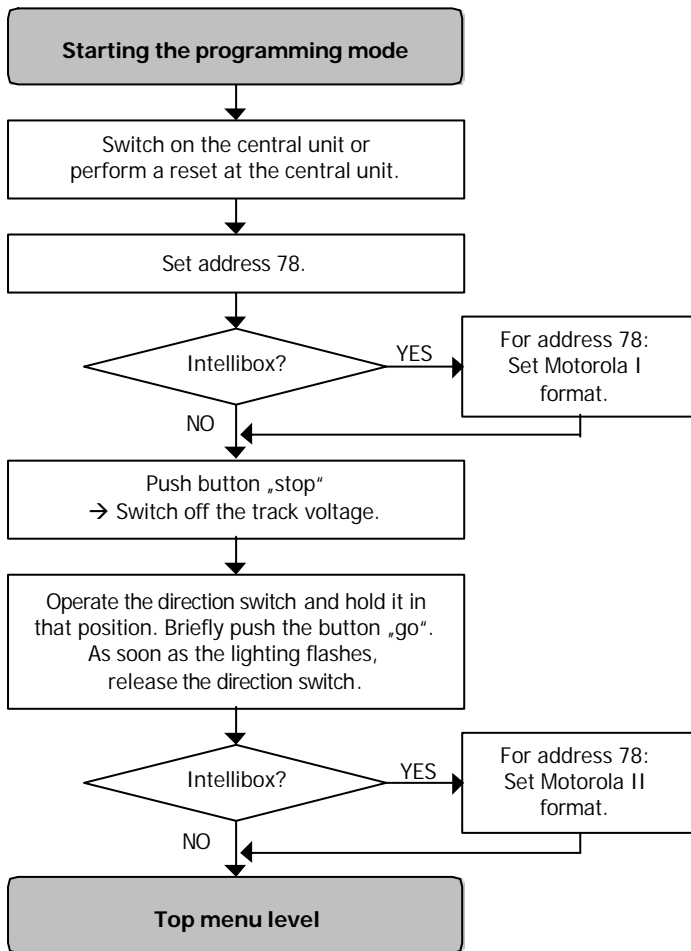
As soon as all functions are set, the programming is closed and you have to disconnect the vehicle.

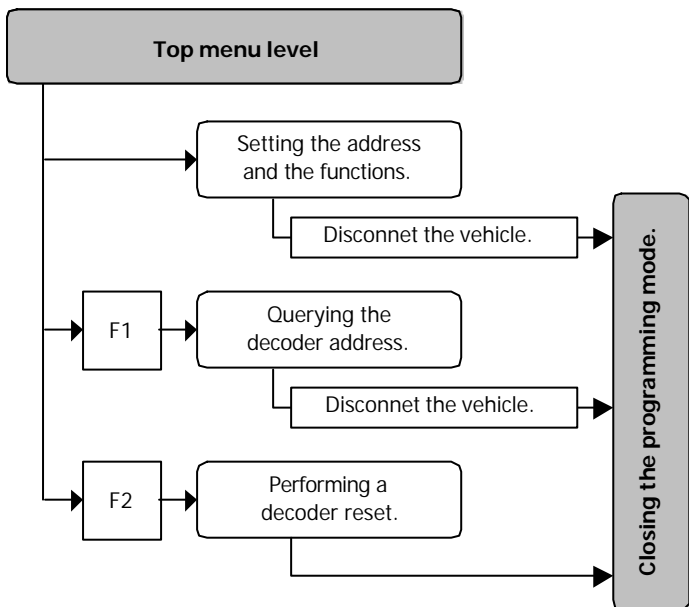
Querying the decoder address

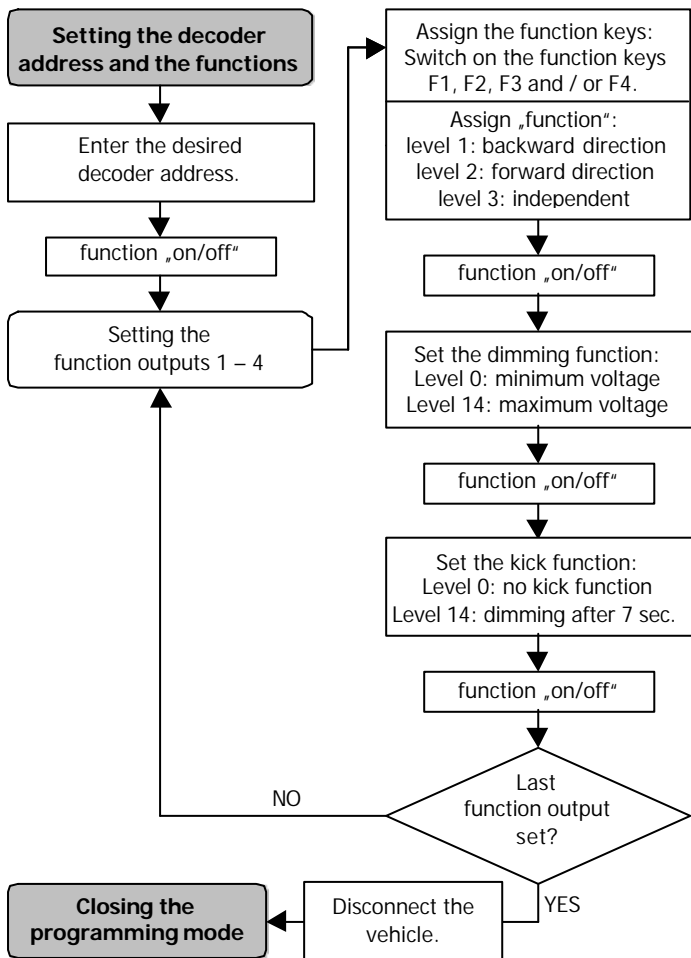
You get to this programming step only by operating the function key F1 on the top menu level after having started the programming mode. The lighting of the vehicle now starts to flash. Two flashing signals interrupted by a short stop transmit the coded address. After a longer pause the two flashing signals are repeated. You'll find the meaning of the flashing signals in the appendix. You get back to the standard operation by disconnecting the decoder.

Performing a decoder reset

You get to this programming step only by operating the function key F2 on the top menu level after having started the programming mode. By operating the function key F2 you restore the factory settings (and all other settings are deleted). Then the decoder continues automatically in standard operation.







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.

- A lamp flickers (this is not a defect).

Possible cause: The lamp is connected with one side to vehicle ground.

→ If you do not want the lamp to flicker, disconnect it from vehicle ground, insulate it and connect it to the return conductor (point X3 / X4).

- The vehicle does not react to F1 to F4.

Possible cause: Instead of Motorola II format, Motorola I format is set at the central unit. → Set Motorola II format.

If you cannot find the problem, please return the decoder for repair.

Manufacturer's note

According to DIN VDE 0869, the person who brings the circuit into operation by extension resp. 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/EWG 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

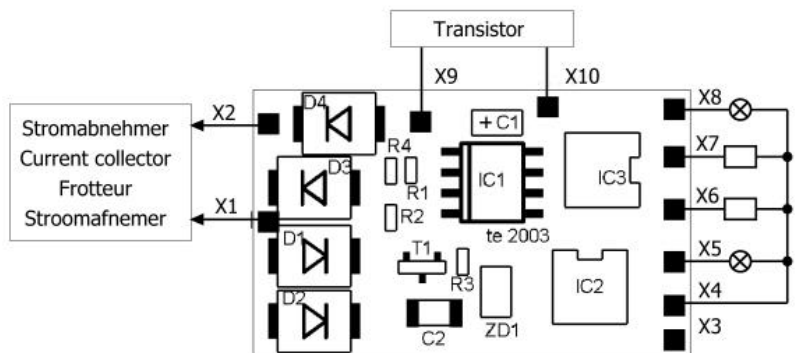
specifications of the circuit when assembled and connected according to the manual.

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.

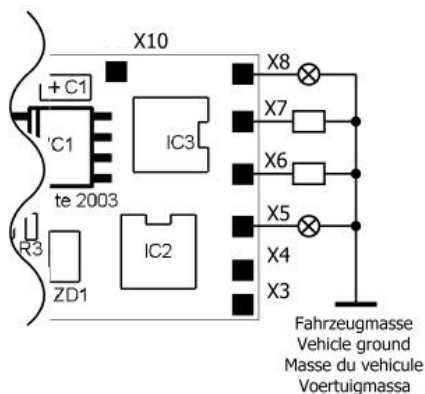
The following invalidate the warranty:

- using an unsuitable soldering iron, solder containing liquid acids or similar,
- if damage is caused by not following the instructions in this manual or the connection diagram(s)
- if the module has been altered and repair attempts have failed,
- if arbitrary changes in the circuit are made,
- 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 - Plan de connexion - Aansluitplan



oder:
or:
ou:
of:



X5 - X8 Beliebige Verbraucher
Optional accessories
Consommateurs quelconques
Gewenste verbruikers

Anschlüsse für werkseitige Einstellung:
Connections for decoder factory settings:
Occupation pour réglage d'origine:
Plaatsing voor de fabrieksmatige instelling:

X5 Beleuchtung Rückwärtsfahrt
Lighting backward direction
Feux marche arrière
Verlichting achteruitrijden

X6 F1

X7 Beleuchtung richtungsunabhängig
Lighting independent of direction of motion
Feux sens indifférent
Verlichting richtingonafhankelijk

X8 Beleuchtung Vorwärtsfahrt
Lighting forward direction
Feux marche avant
Verlichting vooruitrijden

X4, X3 Rückleiter für alle Funktionen
Return conductor for all functions
Pole commun des fonctions
Retourleiding voor alle functies

X1, X2 Stromabnehmer
Current collector
Frotteur
Stroomafnemer

X9, X10 Transistorstufe
Transistor stage
Transistor
Transistortrap

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

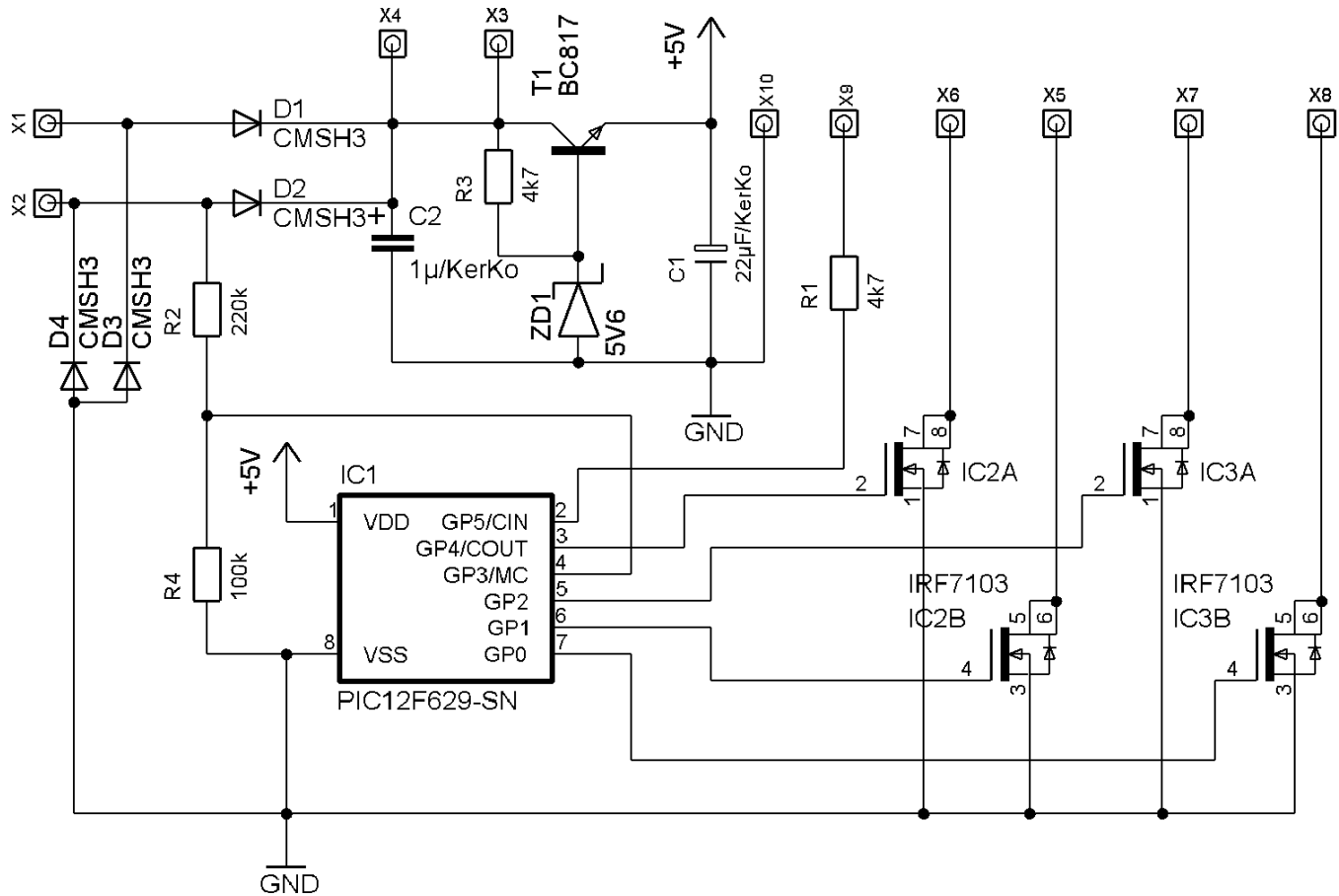


Tabelle: Rückmeldung der Decoderadresse**Appendix: Check back of the address****Tableau : Indiquation de l'adresse du décodeur****Tabel: Terugmelding van het decoderadres**

Flash 1 *	Flash 2 *	Ad. **
1	1	80
1	2	2
1	3	81
1	4	1
1	5	6
1	6	8
1	7	82
1	8	7
1	9	145
1	10	177
1	11	191
1	12	161
1	13	3
1	14	5
1	15	84
1	16	4
2	1	18
2	2	20
2	3	85
2	4	19
2	5	24
2	6	26
2	7	86
2	8	25
2	9	146
2	10	178
2	11	87
2	12	162
2	13	21
2	14	23
2	15	88
2	16	22

Flash 1 *	Flash 2 *	Ad. **
3	1	193
3	2	201
3	3	89
3	4	197
3	5	217
3	6	225
3	7	90
3	8	221
3	9	147
3	10	179
3	11	91
3	12	163
3	13	205
3	14	213
3	15	92
3	16	209
4	1	9
4	2	11
4	3	93
4	4	10
4	5	15
4	6	17
4	7	94
4	8	16
4	9	148
4	10	180
4	11	95
4	12	164
4	13	12
4	14	14
4	15	96
4	16	13

Flash 1 *	Flash 2 *	Ad. **
5	1	54
5	2	56
5	3	97
5	4	55
5	5	60
5	6	62
5	7	98
5	8	61
5	9	149
5	10	181
5	11	99
5	12	165
5	13	57
5	14	59
5	15	100
5	16	58
6	1	72
6	2	74
6	3	101
6	4	73
6	5	78
6	6	---
6	7	102
6	8	79
6	9	150
6	10	182
6	11	103
6	12	166
6	13	75
6	14	77
6	15	104
6	16	76
7	1	194
7	2	202
7	3	105
7	4	198

Flash 1 *	Flash 2 *	Ad. **
7	5	218
7	6	226
7	7	106
7	8	222
7	9	151
7	10	183
7	11	107
7	12	167
7	13	206
7	14	214
7	15	108
7	16	210
8	1	63
8	2	65
8	3	109
8	4	64
8	5	69
8	6	71
8	7	110
8	8	70
8	9	152
8	10	184
8	11	111
8	12	168
8	13	66
8	14	68
8	15	112
8	16	67
9	1	229
9	2	231
9	3	113
9	4	230
9	5	235
9	6	237
9	7	114
9	8	236

Flash 1 *	Flash 2 *	Ad. **
9	9	153
9	10	185
9	11	115
9	12	169
9	13	232
9	14	234
9	15	116
9	16	233
10	1	247
10	2	249
10	3	117
10	4	248
10	5	253
10	6	255
10	7	118
10	8	254
10	9	154
10	10	186
10	11	119
10	12	170
10	13	250
10	14	252
10	15	120
10	16	251
11	1	195
11	2	203
11	3	121
11	4	199
11	5	219
11	6	227
11	7	122
11	8	223
11	9	155
11	10	187
11	11	192
11	12	171

Flash 1 *	Flash 2 *	Ad. **
11	13	207
11	14	215
11	15	124
11	16	211
12	1	238
12	2	240
12	3	125
12	4	239
12	5	244
12	6	246
12	7	126
12	8	245
12	9	156
12	10	188
12	11	127
12	12	172
12	13	241
12	14	243
12	15	128
12	16	242
13	1	27
13	2	29
13	3	129
13	4	28
13	5	33
13	6	35
13	7	130
13	8	34
13	9	157
13	10	189
13	11	131
13	12	173
13	13	30
13	14	32
13	15	132
13	16	31

Flash 1 *	Flash 2 *	Ad. **
14	1	45
14	2	47
14	3	133
14	4	46
14	5	51
14	6	53
14	7	134
14	8	52
14	9	158
14	10	190
14	11	135
14	12	174
14	13	48
14	14	50
14	15	136
14	16	49
15	1	196
15	2	204
15	3	137
15	4	200
15	5	220
15	6	228
15	7	138
15	8	224

Flash 1 *	Flash 2 *	Ad. **
15	9	159
15	10	83
15	11	139
15	12	175
15	13	208
15	14	216
15	15	140
15	16	212
16	1	36
16	2	38
16	3	141
16	4	37
16	5	42
16	6	44
16	7	142
16	8	43
16	9	160
16	10	123
16	11	143
16	12	176
16	13	39
16	14	41
16	15	144
16	16	40

* Anzahl der Blinkzeichen / Number of flashing signals
Flash 1: vor der kurzen Pause / before the short stop
Flash 2: nach der kurzen Pause / after the short stop

* Nombre des clignotements / Aantal knipperingen
Flash 1: avant la courte pause / voor de korte pauze
Flash 2: après la courte pause / na de korte pauze

** Adresse / address / adresse / adres

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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