

# S88-3

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s88 Feedback Module  
16-fold

Manual



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**Printing the manual**

The formatting is optimised for double-sided printing. The standard page size is DIN A5. If you prefer a larger display, printing on DIN A4 is recommended.

**\*\* The asterisks**

In deze handleiding zijn de volgende fabrikanten en hun producten genoemd:  
Gebr. MÄRKLIN & Cie. GmbH | Stuttgarter Straße 55-57 | DE-73033 Göppingen  
ESU electronic solutions ulm GmbH & Co. KG | Edisonallee 29 | DE-89231 Neu-Ulm

## Contents

1. Getting started.....	4
1.1. Contents of the package.....	4
1.2. Accessories.....	4
1.3. Intended use.....	5
1.4. Safety instructions.....	5
1.5. Care.....	5
2. Operation overview.....	6
2.1. Sending the feedback in the s88-bus.....	6
2.2. Connection to digital devices and other feedback devices.....	7
3. Assembling the kit.....	9
3.1. Safety instructions.....	9
3.2. Soldering properly!.....	10
3.3. PCB layout and parts list.....	12
3.4. Assembly.....	13
3.5. Performing a visual check.....	14
4. Connections S88-3.....	15
5. Checklist for troubleshooting and error correction.....	17
5.1. Technical Hotline.....	17
5.2. Repairs.....	17
6. Technical data.....	18
7. Warranty, EU conformity & WEEE.....	19
7.1. Guarantee bond.....	19
7.2. EU Declaration of Conformity.....	20
7.3. Declarations on the WEEE Directive.....	20

## 1. Getting started

The instructions will help you step by step with the safe and proper assembly of the kit and installation and use of your s88 feedback module. Before you start to assemble the kit or put the feedback module into operation, read this manual completely, especially the safety instructions and the section on possible errors and their elimination. You will then know what you have to pay attention to and thus avoid errors that sometimes can only be rectified with a lot of effort.

Keep the instructions in a safe place so that you can restore functionality later in the event of any malfunctions. If you pass the feedback module on to another person, also give the instructions with it.

### 1.1. Contents of the package

- 1 one kit S88-3 (item no. 44-01305-01), containing the components listed in the parts list (see section 3.4.) and one PCB or
  - 1 ready-built and tested circuit board S88-3 (item no. 44-01306-01) or
  - 1 s88 feedback module S88-3 in housing (item no. 44-01307-01)
- 1 patch cable (RJ 45)

### 1.2. Accessories

#### **To assemble the kit you will need**

- a soldering iron with temperature control and a thin tip and a deposit stand or a controlled soldering station
- a scraper, rag or sponge
- a heat-resistant pad
- a small pair of side cutters and wire strippers
- tweezers and flat-nose pliers if necessary
- electronic solder (preferably 0.5 to 0.8 mm diameter)

#### **Connection cables**

The use of stranded wire is recommended for making the connections. Stranded wires consist of several thin individual wires and are therefore more flexible than rigid wires with the same copper cross-section. Recommended cross-sections:

- Connections to the tracks:  $\geq 0.25 \text{ mm}^2$

#### **Connection to devices with 6-pole s88 interface**

The feedback module has an additional connection for a 6-core cable for the connection of upstream feedback modules or digital devices (OUT connection), which can be used as an alternative to the RJ 45 connection. If conventional feedback modules with a 6-pole interface are to be connected downstream (IN connection), an S88-A adapter (see section 2.3.) is required.

### 1.3. Intended use

The s88 feedback module is intended for use in model railway layouts as specified in the instructions. Any other use is not in accordance with the intended use and will result in the loss of the warranty claim. Intended use also includes reading, understanding and following all parts of the instructions. The s88 feedback module is not intended to be used by children under the age of 14.

### 1.4. Safety instructions

**Note:**

The s88 feedback module contains integrated circuits (ICs). These are sensitive to electrostatic charging. Therefore, do not touch these components until you have "discharged" yourself. For this purpose, e.g. a grip on a radiator is sufficient.

Improper use and non-observance of the instructions can lead to incalculable hazards. Prevent these dangers by carrying out the following measures:

- Only use the s88 feedback module in closed, clean and dry rooms. Avoid moisture and splash water in the environment. After condensation has formed, wait two hours for acclimatisation before use.
- Disconnect the module from the power supply before carrying out wiring work.
- Supply the s88 feedback module only with extra-low voltage as specified in the technical data. Use only tested and approved transformers.
- Only plug the mains plugs of transformers into properly installed and fused earthed sockets.
- When making electrical connections, ensure that the cable cross-section is sufficient.
- Heating of the s88 feedback module during operation is normal and harmless.
- Do not expose the s88 feedback module to high ambient temperatures or direct sunlight. Observe the information on the maximum operating temperature in the technical data.
- Regularly check the operational safety of the s88 feedback module, e.g. for damage to the connection cables.
- If you notice damage or if malfunctions occur, disconnect the connection to the power supply immediately. Send the s88 feedback module in for inspection.

### 1.5. Care

Do not use any cleaning agents to clean the s88 feedback module. Only wipe the module dry. Disconnect the module from the power supply before cleaning.

## 2. Operation overview

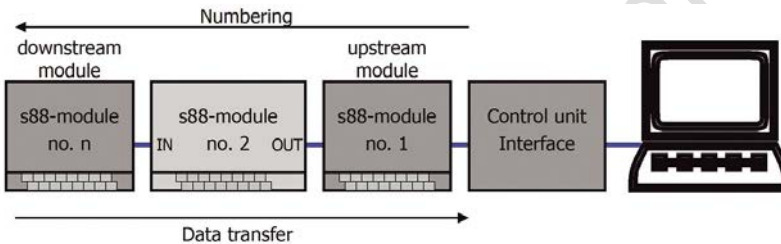
The S88-3 feedback module is compatible with all components that work with the s88 bus developed by the Märklin\*\* company. It can read in 16 ground contacts.

The S88-3 feedback module is optimised for use in centre conductor systems.

### 2.1. Sending the feedback in the s88-bus

The information is transmitted from the S88-3 via the s88-bus to the upstream feedback module or to the connected digital device (interface, memory or central unit). The data transmission from one feedback module to the other takes place in the s88 bus according to the bucket-chain-memory principle.

The number of feedback devices you can connect to a bus line depends on the interface, memory or central unit you use. Please observe the specifications of the device manufacturer.



### Addressing the feedback modules

The addressing of the S88-3 feedback module is done automatically according to its position in the bus line. It is therefore used in linear bus lines with direct connection to the interface, memory or central unit.

## 2.2. Connection to digital devices and other feedback devices



### **Info: Standard s88-N**

The S88-3 has RJ-45 connectors according to the s88-N standard, which regulates the assignment of commercially available patch cables for use in s88 feedback systems. Unlike the commonly used 6-core connection cables, patch cables, which are common in computer networks, are largely shielded against foreign electrical signals. By using patch cables, the susceptibility to interference in the s88 bus is therefore considerably reduced.

### **Connection to digital devices or upstream s88 feedback modules**

The S88-3 feedback module has two outputs connected in parallel and can therefore be connected either via

- the 6-pole interface and a 6-core cable or
- the RJ 45 interface according to S88-N and a patch cable

to a digital device (interface, memory or central unit) or an upstream s88 feedback module.

### **Connection to a downstream s88 feedback module**

The input of the S88-3, via which the connection to a downstream s88 feedback module is established, is designed as an RJ 45 interface corresponding to S88-N. A patch cable is used for the connection to a downstream s88 feedback module with an s88-N interface at the output.

If a connection is to be made to an s88 feedback module with a 6-pin s88 interface, an additional S88-A adapter is required. Four different versions of the adapter are available, which differ in terms of

- connection (socket or plug) and
- mounting direction

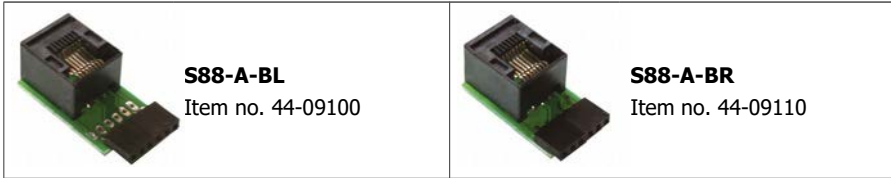
Further information → Section 2.3.

## Versions of the adapters S88-A:

### S88 adapters with socket

can be plugged directly onto the 6-pin connector of an S88 back module.

Recommended use: Modules with connectors coming out from the side



### S88-adapter with plug

are connected via a 6-core cable that is as short as possible (e.g. S88-15, item no. 44-09250-01). These adapters should always be used for the connection to the digital central unit in order to avoid mechanical damage to the S88 interface of the central unit.

Recommended use: digital devices, modules with connectors leading out upwards



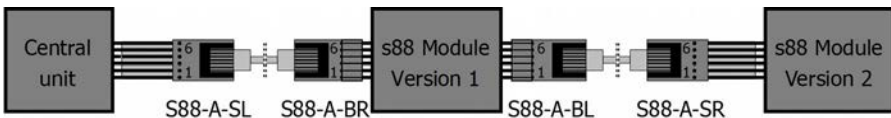
## Mounting directions of the adapters S88-A

Depending on the installation direction, the "R" or "L" versions of the adapter are used.

Versions	Direction of the 6-pole connection*
S88-A-SL and S88-A-BL	Central unit
S88-A-SR and S88-A-BR	Feedback module

\* Explanation: The specification refers to the direction in which the 6-pin connector of the adapter points.

## Application examples



s88 module version 1: with connectors coming out from the side

s88 module version 2: with plugs protruding upwards



### 3. Assembling the kit

You can skip this section if you have purchased a ready-built module or device.

#### 3.1. 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.

##### **Fire risk**

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

##### **Thermal danger**

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

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

##### **Dangerous environments**

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

##### **Other dangers**

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



##### **Caution:**

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

In schools, training centres, clubs and workshops, assembly must be supervised by qualified personnel. In industrial institutions, health and safety regulations applying to electronic work must be adhered to.

## 3.2. Soldering properly!

- Use a soldering iron with temperature control, which you set to approx. 300 °C.
- Only use electronic solder with a flux.
- Never use soldering water or soldering grease when soldering electronic circuits. These contain an acid that destroys components and conductor paths.
- Insert the connecting wires of the components as far as possible through the holes of the board without using force. The body of the component should be close above the board.
- Make sure that the polarity of the components is correct before soldering them.
- Solder quickly: soldering for too long can cause pads or tracks to become detached or even destroy components.
- Hold the soldering tip on the soldering point in such a way that it touches the component wire and the pad at the same time. Add (not too much) solder simultaneously. As soon as the solder begins to flow, remove it from the soldering point. Then wait a moment for the solder to flow well before removing the soldering iron from the soldering joint.
- Do not move the component you have just soldered for about 5 seconds.
- A clean, non-oxidised (scale-free) soldering tip is essential for a perfect soldering joint and good soldering. Therefore, before each soldering, wipe off excess solder and dirt with a damp sponge, a thick damp cloth or a silicone wiper.
- After soldering, cut off the connecting wires directly above the soldering point with a side cutter.
- After assembly, always check each circuit again to ensure that all components are correctly inserted and polarised. Also check that no connections or tracks have been accidentally bridged with tin. This can lead not only to malfunction, but also to the destruction of expensive components. You can re-liquefy excess solder with the clean hot soldering tip. The solder then flows from the board to the soldering tip.

### Preparation

Put the sorted components in front of you on your workbench.

The separate electronic components have the following special features you should take into account in assembling:

### Resistors

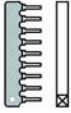


Resistors reduce current.

The value of resistors for smaller power ratings is indicated through colour rings. Every colour stands for another figure. Carbon film resistors have 4 colour rings. The 4th ring (given in brackets here) indicates the tolerance of the resistor (gold = 5 %).

Value:	Colour rings:
1 k $\Omega$	brown - black - red (gold)
4,7 k $\Omega$	yellow - violet - red (gold)
100 k $\Omega$	brown - black - yellow (gold)

## Resistance networks



In resistance networks there are several resistors integrated. The number of the integrated resistors varies depending on the design. One side of the resistors is commonly taken out of the network, the other side separately for every resistor.

## Ceramic capacitors

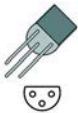


Among other things ceramic capacitors are used for filtering interference voltages or as frequency determining parts. Ceramic capacitors are not polarized.

Normally they are marked with a three-digit number which indicates the value coded. The number 104 corresponds to the value 100 nF.

## Transistors

Transistors are current amplifiers which convert low signals into stronger ones. There are several types in different package forms available. The type designation is printed on the component.



Transistors for a low power rating (e.g. BC types, BS types) have a package in form of a half cylinder (SOT-package). The three pins of bipolar transistors (e.g. BC, BD and BT types) are called basis, emitter and collector (abbreviated with the letters B, E, C in the circuit diagram).

## Integrated circuits (ICs)



Depending on the type, ICs fulfil various tasks. The most common housing form is the so-called "DIP"-housing, from which 4, 6, 8, 14, 16, 18 or more "legs" (pins) are arranged along the long sides.



ICs are sensitive to damage during soldering (heat, electrostatic charging). For that reason in the place of the ICs IC sockets are soldered in, in which the ICs are inserted later.

## Terminal strips

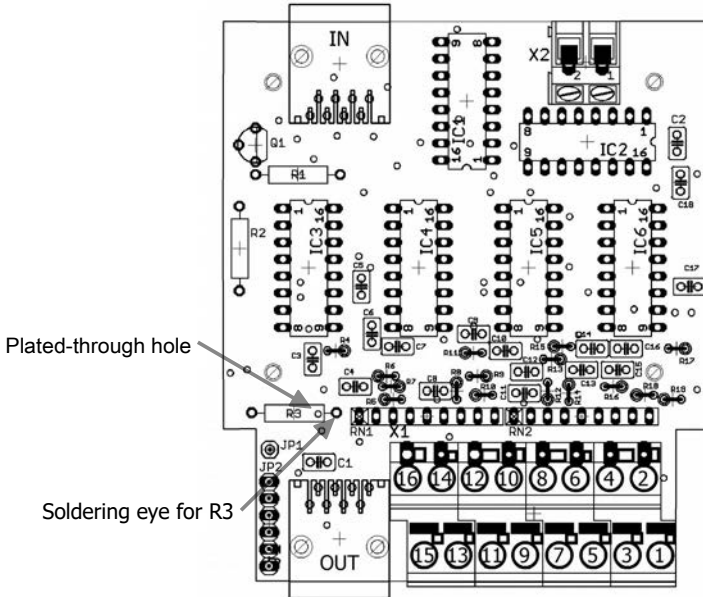
Terminal strips are solder-in screw-type terminals. They provide a solder-free and safe connection of the cables to the circuit, which can still be separated any time.

## RJ-45 sockets

The RJ-45 sockets are standardized and are made to connect commercial Ethernet patch-cables (or RJ-45 cables).

### 3.3. PCB layout and parts list

#### PCB layout



#### Parts list

Carbon film resistors	R4, R5, R6, R7, R8, R9, R10, R11, R12, R13, R14, R15, R16, R17, R18, R19	1 k $\Omega$
	R2	4,7 k $\Omega$
	R1, R3	100 k $\Omega$
Resistance networks	RN1, RN2	47 k $\Omega$
Ceramic capacitors	C1, C2, C3, C4, C5, C6, C7, C8, C9, C10, C11, C12, C13, C14, C15, C16, C17, C18	100 nF
Transistors for a low power rating	Q1	BC547B
Integrated circuits (ICs)	IC1, IC2	4014N
	IC3, IC4, IC5, IC6	4044N
IC-sockets	IC1, IC2, IC3, IC4, IC5, IC6	16-pole
Terminal strips	X2	2-pole
	X1	2 x 8-pole
Solder pins	JP1	not assembled
	JP2	6-pole
RJ-45 sockets	IN, OUT	

### 3.4. Assembly

Proceed according to the order given in the list below. First solder the components on the solder side of the PCB and then cut the excess wires with the side cutter. Follow the instructions on soldering in section 3.2.

#### **Caution:**

Several components have to be mounted according to their polarity. When soldering these components the wrong way round, they can be damaged when you connect the power. In the worst case the whole circuit can be damaged. At the best, a wrongly connected part will not function.

1.	Resistors R1, R2, R3	Mounting orientation of no importance. Please note: There is a plated-through hole under the resistor R3. Do not use this to solder the resistor!
2.	IC sockets	Mount the sockets that way, the markings on the sockets show in the same direction as the markings on the PCB board.
3.	Resistors R4 to R19	Solder the resistor that way, their bodies are standing upright on the PCB. Mounting orientation of no importance.
4.	Resistance networks	Observe the mounting orientation! The common connection is marked with a cross, which is also shown in the assembly print.
5.	Ceramic capacitors	Mounting orientation of no importance.
6.	Transistor	Observe the polarity! The cross section of transistors for a low power rating in SOT-packages is shown in the PCB layout.
7.	Solder pin	
8.	Terminal strips	Put together the double terminal strips before mounting them.
9.	RJ-45 sockets	
10.	ICs in DIL-housing	Insert the ICs into the soldered socket. Do not touch the ICs without first discharging yourself by touching a radiator or other grounded metal parts. Do not bend the "legs" when inserting them into the sockets. Check that the markings on the PCB, the socket and the IC show to the same direction.

### 3.5. Performing a visual check

Perform a visual check after the assembly of the module and remove faults if necessary:

- Remove all loose parts, wire ends or drops of solder from the PCB. Remove all sharp wire ends.
- Check that solder contacts which are close to each other are not unintentionally connected to each other. Risk of short circuit!
- Check that all components are polarised correctly.

When you have remedied all faults, go on to the next part.

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## 4. Connections S88-3

### Pin assignment

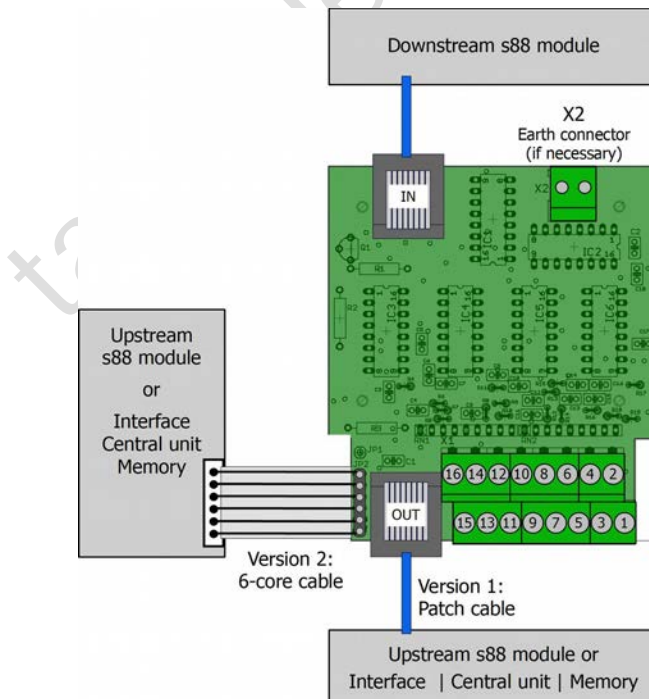
IN	RJ-45 socket for the connection of a downstream s88 module
OUT	RJ-45 socket or 6-pole connector for the connection of an upstream s88 module or digital device
1 ... 16	Inputs for mass contacts
X2	Earth connection (if necessary)

### Connection digital devices and s88 feedback modules

The S88-3 has two RJ-45 sockets (IN, OUT) to connect commercial Ethernet patch-cables (RJ-45 cables), which allow an interference free connection to other feedback modules or digital devices in accordance with the s88-N standard.

Use a 6-conductor connecting cable for the connection of digital devices or upstream customary feedback modules which you connect to the 6-pole connector of the S88-3. Alternatively you can use an adapter S88-A (optional extra) for the connection via a patch-cable.

To connect downstream feedback devices with 6-pin s88 connection, you need an adapter S88-A and, if necessary, a 6-pin ribbon cable (→ section 1.3.).



## Earth connection

In systems with continuous mass (e.g. 3 rail systems fed with boosters with continuous mass) the earth connection between s88 feedback module and other components is made via the earth line in the s88 bus cable.

In digital layouts with boosters galvanically separated, the earth connection X2 of the S88-3 module has to be connected to a separate earth line or to mass of the rails. This applies especially to layouts with DCC conform boosters, but as well to layouts controlled by the central station of Märklin\*\* or the Ecos of ESU\*\*.

## Connecting the track sections and the earth connection

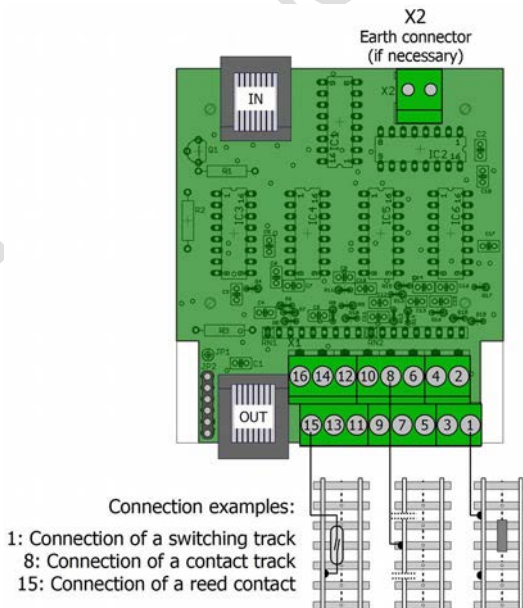
There are terminal strips soldered to the inputs and to the earth connection of the S88-3 which are used to insert and screw on the connecting wires.

## Functional test

First connect the output "OUT" of the S88-3 to the central unit, the memory or the interface for a functional test. Fix a connecting cable to the module's earth connection X2 and connect it one after the other to all 16 inputs. Check if the correct status message is shown for all inputs.


## Installing in the layout

After performing a successful functional test install the S88-3 at the desired place on your model railway. Connect the inputs 1 to 16 to the mass contacts and connect the module to the central unit, the memory or the interface or to another feedback module.





## 5. Checklist for troubleshooting and error correction

 **Warning:** If you notice a strong heat development, immediately disconnect the connection to the supply voltage. **Fire hazard!**

Possible causes:

- One or more connections are faulty. → Check the connections.
- "Kit" version: one or more components are soldered incorrectly. → Carry out a visual inspection (→ section 3.5.) and eliminate the faults, if necessary.
- The module is defective. → Send the feedback module in for inspection.

### Faulty display of the states

The central unit, the memory or the interface do not show the proper status.

Possible causes:

- The connection(s) between the feedback module and other feedback modules and/or digital devices are interrupted. → Check the connections. When using a ribbon cable, check as well, if the connecting socket of the ribbon cable is put on in the right direction.
- The connection between the input and the mass contact is interrupted. → Check the connections.

### 5.1. Technical Hotline

If you have any questions about the use of your s88 feedback module, our technical hotline will help you (telephone number and e-mail address on the last page).

### 5.2. Repairs

You can send us defective modules for repair (address on the last page). In the event of a warranty or guarantee claim, the repair is free of charge for you. As proof of any warranty or guarantee claim, please enclose the proof of purchase with your return.

If there is no warranty or guarantee claim, we are entitled to charge you the costs of the repair and the costs of the return shipment. We charge a maximum of 50% of the new price for the repair according to our valid price list. We reserve the right to refuse the repair if it is technically impossible or uneconomical.

If you want to clarify whether a repair is possible or economical before sending it in, please contact our Technical Hotline (telephone number and email address on the last page).

Please do not send us repair shipments freight collect. In the event of a warranty or guarantee claim, we will reimburse you for the regular shipping costs.

## 6. Technical data

Feedback log	s88
Number of mass contacts	16
Connections to the s88-bus	OUT: RJ-45 according to S88-N or 6-pole plug connector IN: RJ-45 according to S88-N


### Electrical characteristics

Supply voltage	5 – 15 V d.c. voltage (provided by the s88-bus)
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### Protection

Protection class	Ready-made module (without housing): IP 00 Meaning: No protection against foreign bodies, contact and water.  Ready device (in housing): IP 20 Meaning: Protected against solid foreign bodies with diameter $\geq 12.5$ mm and access with a finger. No protection against water.
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### Environment

	For use in closed rooms
Ambient temperature during operation	0 ~ + 30 °C
Permissible relative humidity during operation	10 ~ 85% (non-condensing)
Ambient temperature during storage	- 10 ~ + 40 °C
Permissible relative humidity during storage	10 ~ 85% (non-condensing)

### Other features

Dimensions (approx.)	Circuit board: 72 x 82 mm Ready device including housing: 100 x 90 x 35 mm
Weight (approx.)	Assembled board (ready-made module): 71 g Ready device including housing: 119 g

## 7. Warranty, EU conformity & WEEE

### 7.1. Guarantee bond

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


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

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

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

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

## 7.2. EU Declaration of Conformity

 This product fulfils the requirements of the following EU directives and therefore bears the CE marking.

2001/95/EU Product Safety Directive

2015/863/EU on the restriction of the use of certain hazardous substances in electrical and electronic equipment (RoHS)

2014/30/EU on electromagnetic compatibility (EMC Directive). Underlying standards:

DIN-EN 55014-1 and 55014-2: Electromagnetic compatibility - Requirements for household appliances, electric tools and similar electrical appliances. Part 1: Emitted interference, Part 2: Immunity to interference

To maintain electromagnetic compatibility during operation, observe the following measures:  
Only connect the supply transformer to a professionally installed and fused earthed socket.

Do not make any changes to the original components and follow the instructions, connection and assembly diagrams in this manual exactly.

Only use original spare parts for repair work.

## 7.3. Declarations on the WEEE Directive

This product is subject to the requirements of the EU Directive 2012/19/EC on Waste Electrical and Electronic Equipment (WEEE), i.e. the manufacturer, distributor or seller of the product must contribute to the proper disposal and treatment of waste equipment in accordance with EU and national law. This obligation includes

- registration with the registering authorities ("registers") in the country where WEEE is distributed or sold
- the regular reporting of the amount of EEE sold
- the organisation or financing of collection, treatment, recycling and recovery of the products
- for distributors, the establishment of a take-back service where customers can return WEEE free of charge
- for producers, compliance with the Restriction of the Use of Certain Hazardous Substances in Electrical and Electronic Equipment (RoHS) Directive.



The "crossed-out wheeled bin" symbol means that you are legally obliged to recycle the marked equipment at the end of its life. The appliances must not be disposed of with (unsorted) household waste or packaging waste. Dispose of the appliances at special collection and return points, e.g. at recycling centres or at dealers who offer a corresponding take-back service.

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Further Information and Tips:

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

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