LD-G-20

Lastgeregelter Lokdecoder
für Gleichstrommotoren
DCC-Format

Locomotive Decoder
with load control for
DC engines - DCC format

Décodeur avec compensation de
charge pour locomotive avec
moteur continu - Format DCC

Lastgeregelde Locdecoder
voor gelijkstroommotoren
DCC-format

Anleitung

Manual

Mode d´emploi

Handleiding

Art.-Nr. 22-01-090 $C \in$

Table of contents

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

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 DCC 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 or operated by children under the age of 14.

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

Any other use is inappropriate and invalidates any guarantees.

⚠ **Caution:**

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

Safety instructions

Mechanical hazards

Cut wires can have sharp ends and can cause serious injuries. Watch out for sharp edges when you pick up the PCB.

Visibly damaged parts can cause unpredictable danger. Do not use damaged parts: recycle and replace them with new ones.

Electrical hazards

- Touching powered, live components,
- touching conducting components which are live due to malfunction,
- short circuits,
- connecting the circuit to another voltage than specified,
- impermissibly high humidity,
- condensation build up

can cause serious injury due to electrical shock. Take the following precautions to prevent this danger:

- Never perform wiring on a powered module.
- Mounting the module should only be done in closed, clean, dry rooms. Beware of humidity.
- Only use low power for this module as described in this manual and only use certified transformers.
- Connect transformers and soldering irons only in approved mains sockets installed by an authorised electrician.
- Observe cable diameter requirements.
- After condensation build up, allow a minimum of 2 hours for dispersion.
- Use only original spare parts if you have to repair the module.

Fire risk

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

Thermal danger

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

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

Dangerous environments

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

Other dangers

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

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

In schools, training centres, clubs and workshops, assembly, mounting and operation must be supervised by qualified personnel.

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

EMC declaration

This product is developed in accordance with the European standards
EN 55014 and EN 50082-1, tested corresponding to the EC - directive
89/336/EWG (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.

Operation overview

The decoder LD-G-20 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.

Automatic recognition of the analogue mode

The decoder can also be used in analogue model railway layouts run with a D.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 analogue model railway layouts run with an A.C. speed control.

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.

Overheating protection

As soon as the decoder´s maximum operating temperature (approx. 60 °C) is exceeded the decoder automatically switches off. As soon as the decoder has cooled down the locomotive starts running again. As a rule the overheating is caused by a too high current consumption of the motor.

The configuration variables of the LD-G-20

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) [*1]
- Version (CV#7) – read only
- Manufacturer identification (CV#8) - read only
- Extended address (CV#17 und CV#18) [*1]
- Configuration data 1 (CV#29)
- Assignment of the outputs X5 and X6 to the function keys F5 to F8 (CV#39 and 40) [*1]
- Configuration data 2 (CV#49) [*1]
- Dimming of the outputs X5 and X6 (CV#50 and C51) [*1]
- Proportional component of the load control "KP" (CV#54) [*1]
- Assignment of the outputs X5 and X6 to the function keys F0 to F4 (CV#55 and 56) [*1]
- Sensitivity of the overheating protection (CV#58) [*1]
- Integral component of the load "KI" (CV#59) [*1]
- Effects for the outputs X5 and X6 (CV#60 and 61) [*1]
- Differential component of the load control "KD" (CV#64) [*1]
- Alternative velocity characteristic for mode 28 speed levels (CV#67 to 94) [*1]

[*1]   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 deocder. 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 three 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.

KD: The differential component of the load control ensures that the control is not converted too quickly. Shaking and vibrating would be the consequence.

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.

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 with a current of max. 100 mA (e.g. lighting).

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 by 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	12-24 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 immediately after unpacking:

- one decoder with soldered connecting wires
- 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 materials

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

- an electronic soldering iron (max. 30 Watt) with a fine tip,
- a soldering iron stand,
- a tip-cleaning sponge,
- a heat-resistant mat,
- a small side cutter and wire stripper,
- a pair of tweezers,
- tin solder (0,5 mm. diameter).

Safe and correct soldering

⚠ **Caution:**

Incorrect soldering can cause dangers through fires and heat. Avoid these dangers by reading and following the directions given in the chapter **Safety instructions**.

- Use a small soldering iron with max. 30 Watt. Keep the soldering tip clean so the heat of the soldering iron is applied to the solder point effectively.
- Only use electronic tin solder with flux.
- When soldering electronic circuits never use soldering-water or soldering grease. They contain acids that can corrode components and copper tracks.
- Solder quickly: holding the iron on the joints longer than necessary can destroy components and can damage copper tracks or soldering eyes.
- Apply the soldering tip to the soldering spot in such a way that the wire and the soldering eye are heated at the same time. Simultaneously add solder (not too much). As soon as the solder becomes liquid take it away. Hold the soldering tip at the spot for a few seconds so that the solder flows into the joint, then remove the soldering iron.
- The joint should be held still for about 5 seconds after soldering.
- To make a good soldering joint you should use a clean and unoxidised soldering tip. Clean the soldering tip with a damp piece of cloth, a damp sponge or a piece of silicon cloth.
- After soldering check (preferably with a magnifying glass) tracks for accidental solder bridges and short circuits. This would cause faulty operation or, in the worst case, permanent damage. You can remove excess solder by putting a clean soldering tip on the spot. The solder will become liquid again and flow from the soldering spot to the soldering tip.

Mounting the 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 in analogue mode does not match the direction of motion set at the speed control 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

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. 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

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

You can programm resp. read out the following locomotive 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).

CV-name	CV-no.	Input value / (State of delivery)	Remarks
Basic address	1	1 ... 127 (3)	
Starting voltage	2	0 ... 255 (5)	= 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 (8)	= 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 (5)	= 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.

CV-name	CV-no.	Input value / (State of delivery)	Remarks
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 (-)	
Configuration data 1	29	(6)	Numerical value *2
			Direction "standard" 0
			Reverse direction 1
			14 speed levels 0
			28 or 128 speed levels 2
			Analoge recognition off 0
			Analoge recognition on 4
			Linear velocity characteristic 0
			Alternative velocity characteristic 16
			Basic adress 0
			Extended adress 32
Assignment F5 – F8 to the outputs: X5 X6	39 40	0 … 15 (0)	Numerical value *2
			Operation with:
			--- 0
			function key F5 1
			function key F6 2
			function key F7 4
			function key F8 8

CV-name	CV-no.	Input value / (State of delivery)	Remarks	
Configuration data 2	49	0 … 127 (1)	Numerical value *2	
			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
Dimming of the outputs:: X5 X6	50 51	0 … 63 (63)	= The voltage that is applied to the output. The value "1" corresponds to the minimum, „63" to the maximum voltage.	
Parameter of load control KP	54	0 … 255 (96)	= Proportional component of the load control.	
Assignment F0 – F4 to the outputs: X5 X6	55 56	0 … 31 (16) (16)	Numerical value *2 Operation with:	
			---	0
			function key F1	1
			function key F2	2
			function key F3	4
			function key F4	8
			function key F0	16

CV-name	CV-no.	Input value / (State of delivery)	Remarks
Overheating protection	58	60 … 100 (80)	= Sensivity of the overheating protection. Raising the value leads to a reduction of the sensivity of the overheating protection. A too high reduction can cause damage!
Parameter of load control KI	59	0 … 255 (22)	= Integral component of the load control.
Effects for the outputs: X5 X6	60 61	0 … 255 (16) (8)	Numerical value [2]
			Flickering active 1
			Strobe active 2
			MARS light active 4
			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
Parameter of load control KD	64	0 … 255 (30)	= Differential component of the load control
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.

[2] 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.

FAQ

- Parts are getting very hot and/or start to smoke.

  Tip: The deocder 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.

- The locomotive does not run in analogue mode.

  Possible cause: The analogue mode is switched off. → Alter the value for CV #29.

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

- 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.

- In digital mode the locomotive suddenly runs very fast.

  Possible cause: Interfering signals from the layout have switched the decoder to analogue mode. → As the origin of the interfering signals´ often cannot be found, it is advisable to switch off the

automatic recognition of the analogue mode during digital operation.

Possible cause: The changing direction impulse for a Motorola decoder has switched the decoder to analogue mode. → If you simultaneously control DCC and Motorola decoders, it is advisable to switch off the automatic recognition of the analogue mode during digital operation.

■ The locomotive stops now and again.

Possible cause: The decoder has got too hot and the overheating protection has been activated.

→ Possibly the decoder. Decoder overheating can be prevented by better cooling.

→ It is possible to reduce the sensitivity of the overheating protection (CV#58). **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.

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 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,
- 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

ODER / OR / OU / OF:
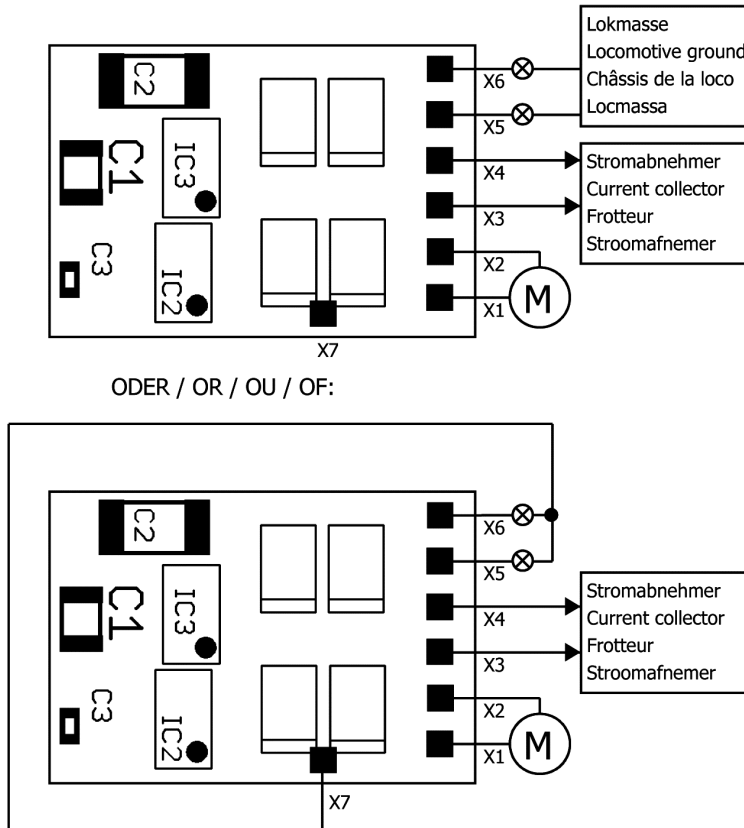
X1	orange / orange / orange / oranje: Motoranschluß 1 / Motor connection 1 Connexion moteur 1 / Motoraansluiting 1
X2	grau / grey / gris / grijs: Motoranschluß 2 / Motor connection 2 Connexion moteur 2 / Motoraansluiting 2
X3	rot / red / rouge / rood: Schienenabnehmer rechts / Current collector right side Frotteur droite / Stroomafnemer rechterhand
X4	schwarz / black / noir / zwart: Schienenabnehmer links / Current collector left side Frotteur gauche / Stroomafnemer linkerhand
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

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:
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