PHYWE
excellence in science

Digital Function Generator

13654-99

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Fig. 1: 13654-99 Digital function generator

**Operating Instructions**

CE The unit complies with the applicable EC regulations.

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## 1 SAFETY INSTRUCTIONS



- Read the operating instructions thoroughly and completely prior to starting the unit. This is important for your own protection and for avoiding damage to the unit.
- Use the unit solely for its intended purpose.
- The unit is intended for use in dry rooms where there is no risk of explosion.
- Prior to connecting the unit to the mains power supply, ensure that the protective conductor of the power supply unit is correctly connected to the protective conductor of the mains power supply network. The mains power plug may only be plugged into a mains power socket that is equipped with a protective conductor. Do not eliminate this protective effect by using an extension lead without a protective conductor.
- Ensure that the mains voltage that is stated on the type plate of the power supply unit matches the mains voltage of your power supply network.
- When setting the unit up, ensure that the power supply unit or the device plug is freely accessible. Ensure also that the venting slots of the unit are not covered or blocked.
- Do not open the unit.
- Do not connect any devices to the unit other than the ones that are intended for this purpose.
- Attention: Disconnect the unit from the power supply prior to loosening, replacing, or removing any of the cable connections!


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## 2 PURPOSE AND CHARACTERISTICS

Digital signal generator for use as a programmable voltage source for laboratory and demonstration experiments, in particular in acoustics, electricity/electronics, and experiments concerning the sense of hearing. The function generator can be used as a universal stand-alone unit or it can be controlled via a USB port. A total of 4 outputs are available to the user: an amplifier output, which can be used as a programmable voltage source for higher currents, a headphone output with limited output power for all types of commercially available headphones, a sync output that generates a square-wave signal (TTL level) in the set frequency, and a U~f output that can supply direct voltage that is proportional to the set frequency.

## 3 FUNCTIONAL AND OPERATING ELEMENTS

### 1 Display

The unit is equipped with a graphics display of 128 x 64 pixels with a readable surface of 67 x 33 mm and backlighting. The contrast can be adjusted over a wide range via the menu.

### 2 Menu buttons for the display

The 4 buttons below the display are assigned to the menu items at the top of the display. This enables the quick and intuitive use of the menu.

### 3 Navigation keypad

The arrow keys ◀▶ are used for selecting items on the display. (The value that is to be changed will be displayed in an inverted manner.) The rotary button is used for changing values.

The Menu button with an integrated LED has two functions:

1. Selection of the set-up menu for changing the device settings.
2. In the case of a frequency or voltage ramp, the ramp can be started or stopped with this button. The LED in the button lights when a ramp is being swept.

### 4 USB port

Serial interface for the communication with a PC. Once the connection with a PC has been set up, and if the LED above the USB port lights, the functions of the digital function generator are controlled exclusively via the PC. When the software is started, the parameters that are set in the device will be loaded.

### 5 Headphone output

Headphone output for connecting headphones with a 3.5 mm TRS connector (audio jack). The output can be activated with the aid of the output switch (9). A sine wave signal with a maximum amplitude of 2 $V_{pp}$ will be applied to the output. At the same time, the amplifier output (8) will be switched off.

### 6 Sync output

BNC socket with a frequency-dependent TTL output signal, e.g. for connecting an oscilloscope.

When sweeping through a frequency or voltage ramp, a TTL pulse will be output at the sync output at the start as well as at the end of the ramp.

### 7 U~f output

BNC socket for picking off a frequency-proportional voltage in the range of 0…4 V (0…1 MHz, 0…100 kHz, 0…10 kHz, 0…1 kHz, 0…100 Hz, or freely selectable). It is used for connecting a recorder/oscilloscope or an interface in order to represent the voltage or current measurements as a function of the frequency.

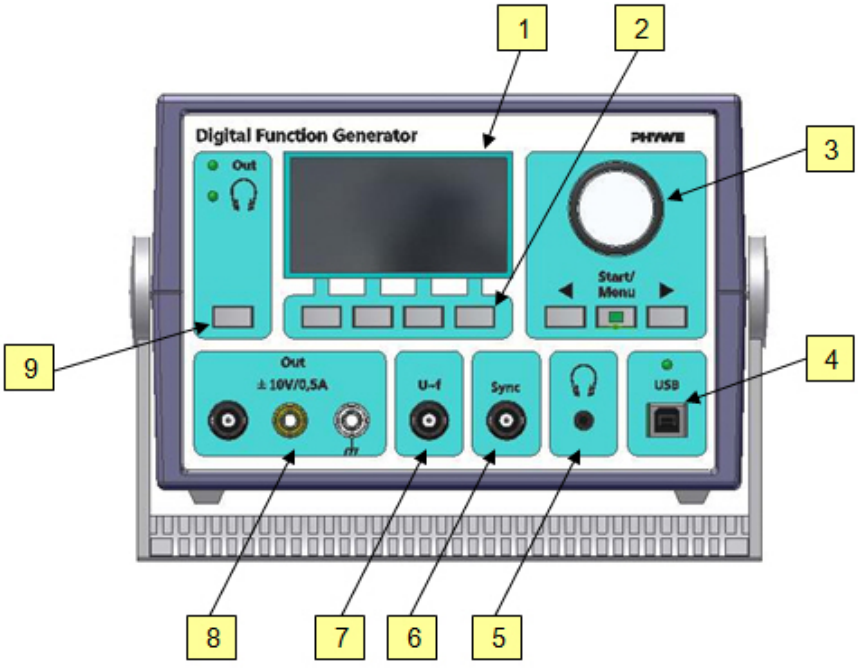
### 8 Amplifier output

4 mm socket and a BNC socket for connecting a consumer or the experiment set-up. The output has an internal resistance of 4 Ω.

Please refer to the technical data for information concerning the current and voltage data.

### 9 Output mode button

This switch toggles between the headphone output (5) and the amplifier output (8). The LEDs on top indicate the active output.





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## 4 OPERATING INSTRUCTIONS

The function generator fulfils the technical requirements that are summarised in the current guidelines of the European Community.

The unit must be used under the supervision of an expert and in an electromagnetically controlled environment at research, teaching, and training facilities (schools, universities, institutes, and laboratories).

This means that, in such an environment, radio transmission devices, e.g. mobile phones, should not be used in the direct vicinity of the unit. The connected cables must not be longer than 2 m. Electrostatic charges or similar electromagnetic phenomena (HF, bursts, indirect lightning discharge, etc.) may affect the unit so that it will not work within the specified data range.

The following measures reduce or eliminate potential interferences:

Avoid carpets; provide equipotential bonding; perform the experiments on a conductive, earthed surface; use shields and shielded cables. Do not use radiofrequency transmitters (radio sets, mobile phones) in the direct vicinity of the unit.

After a total exit, perform a restart by briefly interrupting the power supply.

This unit corresponds to class A, group 1, of the standard EN 55011 and may be used without any restriction only in non-residential areas. If – although the use of the unit is restricted to special classrooms in a school or another training facility – electromagnetic interferences occur in the surrounding residential area, the operator can be required to take the appropriate measures (e.g. shielding, long distance with regard to sensitive equipment, short periods of use, use of the shortest possible connecting cables, etc.) and to pay for these measures.

## 5 HANDLING

This section describes the start-up of the digital function generator and provides an overview of its handling. Please read this section carefully in order to avoid problems or malfunctions.

### 5.1 Switching the unit ON

Switch the unit on by actuating the switch that is located at the back of the unit. During the start-up, the name PHYWE will be displayed, which is followed by the overview screen.

**ATTENTION: Please do not switch the unit on under load since – as protection for the unit – even a short overload (>1 A) will cause an automatic restart.**

### 5.2 Waveforms SINE, SQUARE, and TRIANGLE

The following descriptions all refer to the waveforms SINE, SQUARE, and TRIANGLE.

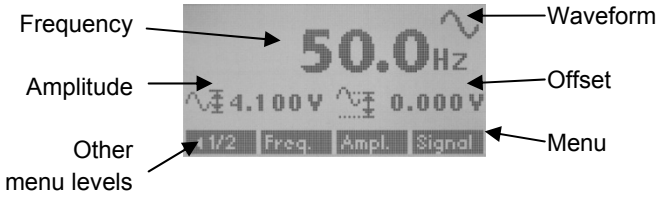



Fig. 3 Overview: sine/square/triangle

#### 5.2.1 Changing the waveform

The waveforms SINE, TRIANGLE, SQUARE, FREQUENCY RAMP, and VOLTAGE RAMP can be selected by selecting the menu item "**Signal**" and by turning the rotary button (the symbols will be displayed in an inverted manner). Select "OK" for confirmation.

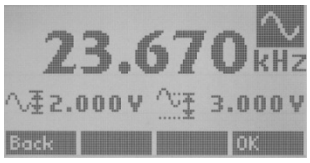



Fig. 4: Signal selection

#### 5.2.2 Adjusting the amplitude

Selecting the menu item "**Ampl.**" calls up the amplitude adjustment window. The display value can be changed with the aid of the navigation buttons and with the rotary button. Selecting the menu item "Zero" sets the value to 0.000 V.

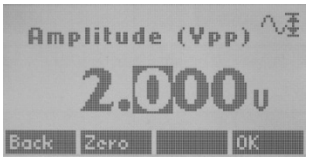



Fig. 5: Amplitude adjustment

#### 5.2.3 Adjusting the frequency

The menu item "**Freq.**" can be used to adjust a frequency in the range of 0.1 Hz to 999.999 kHz. The system will automatically switch from Hz to kHz and vice versa. This means that if you want to switch from the Hz range to the kHz range, you must increase the frequency to a value that is higher than 999.9 Hz.

**ATTENTION: Preceding zeros (on the left of the display value) that are not displayed can also be selected and changed with the aid of the arrow keys.**

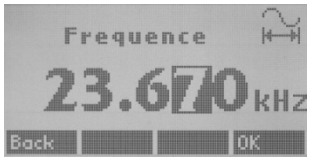



Fig. 6: Frequency adjustment

#### 5.2.4 Adjusting the offset

The menu item "**Offset**" can be used to perform a DC offset. In this case, the DC part is added to the AC voltage ($V_{pp}$).

This menu item is on the second menu level (selection of the menu level via the menu item on the left ◀1/2).




g. 7: Offset adjustment


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### 5.2.5 Adaptation of the proportional output U~f

The output U~f can be adapted to various different frequency ranges.

The adaptation can be performed by selecting the menu item "**U~f**", which is located on the second menu level (selection of the menu level via the menu item on the left ◀1/2).

The following options can be selected with the aid of the rotary button:

0…1 MHz (full frequency range)
0…100 KHz
0…10 kHz
0…1 kHz
0…100 Hz
f1…f2 (frequency ramp waveform)

This means that the selected frequency range corresponds to the voltage signal 0…4 V at the output (7).




Fig. 8: U~f assignment

## 5.3 Waveform FREQUENCY RAMP

The following descriptions all refer to the frequency ramp waveform.

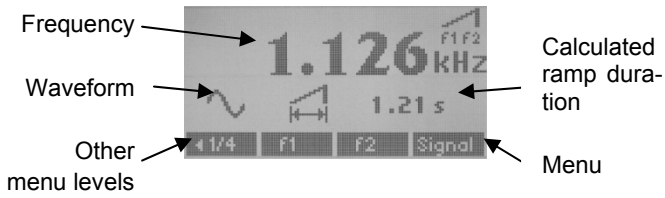



Fig. 9: Frequency ramp overview

### 5.3.1 Changing the start frequency f1

The menu item "**f1**" can be used to enter the frequency at which the frequency ramp will start.

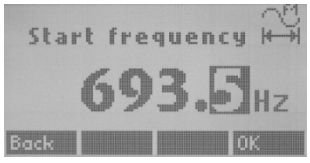



Fig. 10: Input of the start frequency

### 5.3.2 Changing the stop frequency f2

The menu item "**f2**" can be used to enter the frequency at which the frequency ramp will stop.

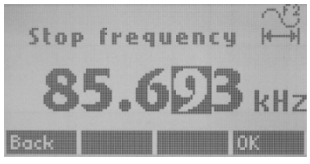



Fig. 11: Input of the stop frequency

### 5.3.3 Changing the waveform of the ramp

The menu item "**Wave**" can be used to change the waveform of a ramp. The available options SINE, SQUARE, and TRIANGLE can be selected with the aid of the rotary button. The menu item is located on the second menu level (selection of the menu level via the menu item on the left ◀1/4).




Fig. 12: Changing the waveform

### 5.3.4 Adjusting a frequency holding time

The menu item "**Hold**" can be used to adjust the holding time for a frequency during the frequency ramp.
The menu item is located on the third menu level (selection of the menu level via the menu item on the left ◀2/4).

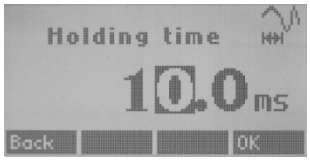



Fig. 13: Adjusting a holding time

### 5.3.5 Selecting a linear or logarithmic ramp

The menu item "**Lin**" or "**Log**" can be used to switch from a linear frequency ramp to a logarithmic one and vice versa.
If a linear ramp is selected, the additional menu item "**Δf**" will be displayed. It can be used to enter a frequency increment.




Fig. 14: Linear frequency ramp

If a logarithmic ramp is selected, the additional menu item "**Sweep**" will be displayed. It can be used to change a factor for the duration of the logarithmic function.

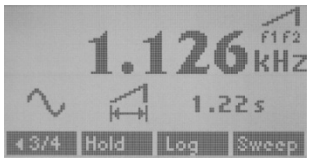



Fig. 15: Logarithmic frequency ramp


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### 5.3.6 Changing the frequency increment

The menu item "**Δf**" can be used to change the increment with which the frequency ramp is to be swept. This means that the frequency value will increase or decrease by the set increment value after the frequency holding time (see 5.3.4).




Fig. 16: Input of a frequency increment

### 5.3.7 Changing the sweep factor

The menu item "**Sweep**" can be used to change the duration of the logarithmic frequency ramp.

The factor can be changed from 1.001 to 1.250.




Fig. 17: Input of a sweep factor

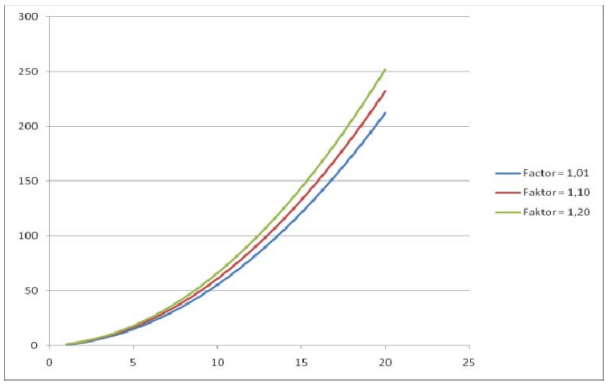



Fig. 18: Various sweep factors

The sweep factor is used as follows for the calculation of the frequency values:

$f_n = f_{n-1} \cdot$ sweep factor

### 5.3.8 Sweeping through a frequency ramp once or multiple times

The menu item "**Single**" or "**Multi**" can be used to sweep through a ramp once (single) or multiple times (periodic repetition).

The menu item changes depending on the setting.

The menu item is located on the fourth menu level (selection of the menu level via the menu item on the left ◀3/4).

### 5.3.9 Assigning the U~f output to a frequency range

The menu item "**U~f**" can be used to assign the U~f output to a specific frequency range. This enables you to achieve a high voltage resolution for your required frequency range at the U~f output (see also 5.2.5).

This menu item is located on the fourth menu level (selection of the menu level via the menu item on the left ◀3/4).

The following options are available can be selected with the aid of the rotary button:

0…1 MHz (full frequency range)
0…100 kHz
0…10 kHz
0…1 kHz
0…100 Hz
f1…f2




Fig. 19: U~f assignment

## 5.4 Waveform VOLTAGE RAMP

The following descriptions all refer to the voltage ramp waveform.

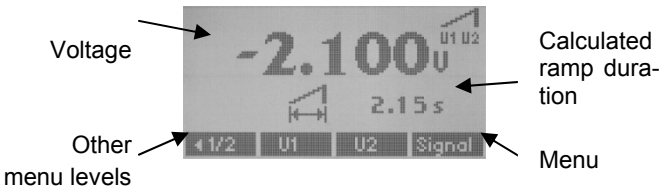



Fig. 20: Voltage ramp overview

### 5.4.1 Changing the start voltage U1

The menu item "**U1**" can be used to enter the voltage with which a voltage ramp will start.

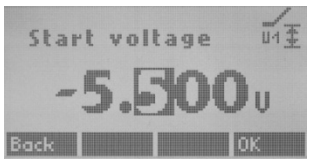



Fig. 21: Input of a start voltage

### 5.4.2 Changing the stop voltage U2

The menu item "**U2**" can be used to enter the voltage with which a voltage ramp will stop.

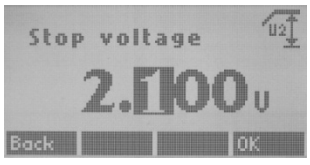



Fig. 22: Input of a stop voltage


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### 5.4.3 Adjusting a voltage increment

The menu item "**ΔU**" can be used to change the increment with which the voltage ramp is to be swept. This means that the voltage values will increase or decrease by the entered increment after the voltage holding time (see 5.4.4).

The menu item is located on the second menu level (selection of the menu level via the menu item on the left ◀1/2).

### 5.4.4. Adjusting a voltage break

The menu item "**Hold**" can be used to adjust the holding time for a voltage during the voltage ramp.

The menu item is located on the second menu level (selection of the menu level via the menu item on the left ◀1/2).

### 5.4.5. Sweeping through a voltage ramp once or multiple times

See 5.3.8.

### 5.5. Starting and stopping frequency or voltage ramps

Ramps can be started and stopped with the aid of the "**Start/Menu**" button that is located under the rotary knob.

ATTENTION: The button has two functions. The button can only be used to start or stop the ramp if the frequency or voltage ramp waveform is active. If the LED in the button is on, the ramp is active. After the sweep of the ramp has been completed or after another actuation of the button (manual stop of the ramp), the LED goes out.

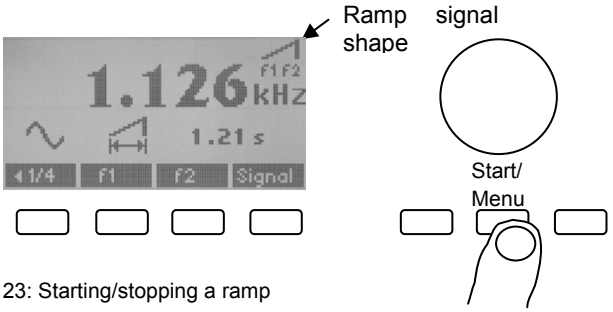



Fig. 23: Starting/stopping a ramp

### 5.6 Set-up menu

In the set-up menu, you can change or view the language settings, contrast settings, and help texts. You can call up the set-up menu with the aid of the "**Start/Menu**" button under the rotary button when the waveform sine, square, or triangle is active.

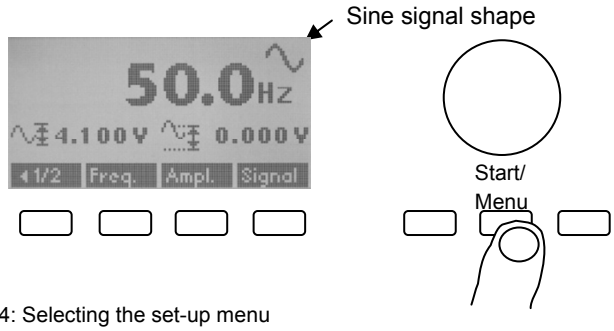



Fig. 24: Selecting the set-up menu

The overview in the set-up menu shows important information, e.g. the firmware version number or the date of creation of the firmware. If you have problems with your device, please send this information together with a description of the problem to the technical support of Phywe Systeme GmbH & Co.KG.




Fig. 25: Overview of the set-up menu

### 5.6.1 Adjusting the contrast of the display

The menu item "**Contr.**" can be used to change the contrast of the display over a wide range with the aid of the rotary button in order to improve its readability. The setting will be saved automatically if you press the OK button for confirmation.

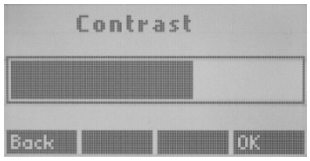



Fig. 26: Contrast setting

### 5.6.2 Language selection

The menu item "**Langu.**" can be used to switch the user interface language from English to German and vice versa. Use the rotary button for the selection. The setting will be saved automatically if you press the OK button for confirmation.

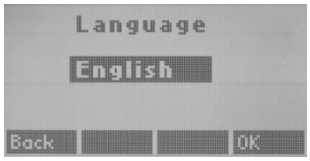



Fig. 27: Setting the language

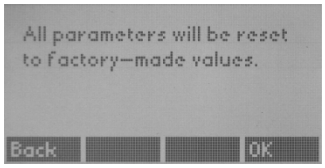
### 5.6.3 Help

The menu item "**Help**" calls up a short description of the context-relative help.

**If the "Menu" button is pressed for more than 3 seconds, a short help text will be displayed for all of the menu items that are mentioned in this manual.**

### 5.6.4 Reset

The menu item "Reset" can be used to reset the function generator to the factory-set default settings.




The reset process will be started when the OK button for confirmation is pressed. The reset process can take 2 to 3 seconds. Then, the set-up menu will be quit automatically.


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### 5.7 Use of a PC

The digital function generator can be connected to a PC via its USB port on the front panel. Please install the “measure” software from the supplied CD prior to connecting the function generator to the PC. The necessary driver will be installed completely. After that, you can start the “measure” software.

## 6 TECHNICAL DATA

| | |
|---|---|
| (Typically for 25 °C) | |
| Operating temperature range | 5…40 °C |
| Relative humidity | <80 % |
| | |
| Frequency range: | 0.1 Hz…1 MHz |
| Increment: | 0.1 Hz |
| Distortion factor: | <0.5 % |
| Waveforms: | Sine, square, triangle, frequency ramp, and voltage ramp |
| Amplifier output | |
| Output voltage: | 0…20 $V_{pp}$ at $R_a$>40 Ω |
| Output power: | 5 W |
| Ri: | 2 Ω |
| Max. current intensity: | typ. 0.5 A (briefly up to 1 A) |
| DC offset: | ±10 V |
| Headphone output | |
| Output voltage: | 0…2 $V_{pp}$ at $R_a$ ≥ 400 Ω |
| Sync output | |
| Output voltage: | 5 V (CMOS level) |
| Ri: | 50 Ω |
| U~f output | |
| Output voltage: | 0…4 V |
| Ri: | 1 kΩ |

Mains power supply

The device is a class I protection device. The power outlets that it is connected to must be equipped with a protective conductor (PE).

| | |
|---|---|
| Connection voltage: | see the type plate (+6 % / −10 %) |
| Mains power frequency: | 50/60 Hz |
| Power consumption: | 50 VA |
| Mains fuse: | see the type plate |
| | |
| Housing dimensions (mm³): | 190 x 140 x 130 (W, H, D) |
| Mass: | 1.4 kg |
| | |
| USB 2.0 | for the connection to a PC |

**Replacement of the primary fuse:**

The fuse holder that is located in the upper part of the device connector at the back of the unit is accessible after the removal of the mains power connecting cable, and it can be levered out with the aid of a screwdriver. Remove the defective fuse from the fuse holder, insert a new fuse (please refer to the type plate), and push the holder back into the device connector. If the fuse melts through again after the unit has been switched on, do not use a fuse with a higher fuse value. In this case, there is a major defect and the unit must be returned to our service department for repair.

## 7 SCOPE OF SUPPLY

- Unit with mains power connecting cable
- “measure” DVD for installing the drivers and the operating software for the use of a PC
- Operating instructions

## 8 ACCESSORIES

| | |
|---|---|
| C4 single-user & school licence | 14550-61 |
| Stereo headphones | 65974-00 |

## 9 WARRANTY

We give a warranty of 24 months for units supplied by us within the EU, and a warranty of 12 months outside the EU. Any damage that is due to non-compliance with the operating instructions, improper use, or natural wear is excluded from the warranty.

The manufacturer can only be held liable for the function and safety-relevant properties of the unit if the maintenance, service, and modifications of the unit are performed solely by the manufacturer or by an institution that is expressly authorised by the manufacturer.

## 10 DISPOSAL

The packaging mainly consists of environmentally-friendly materials that should be returned to the local recycling stations.



Do not dispose of this product with normal household waste. If this unit needs to be disposed of, please return it to the address that is stated below for proper disposal.

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