EmStat4S

Operator's Manual

PalmSens BV
Version 012, 2026-09-04

PalmSens

If you have problems

First make sure to check the "Troubleshooting" section in this document and the Knowledge Base on our website: www.palmsens.com/knowledgebase/. This page contains support information on installation, software updates, and training. Please make sure your software and firmware are up-to-date.

In case of persistent problems

- Use the contact form: www.palmsens.com/contact/
- Give us a call: +31 30 2459211
- Or send an email: info@palmsens.com

Please describe the problem in as much detail as possible. Sending us the relevant method files, data files and screenshots can be helpful. Please include your instrument model and serial numbers, as well as any applicable software and firmware version you are using.

Limited Warranty

Except as otherwise provided herein, PalmSens BV warrants to buyer three years from the date title to the product passes (transfer date of goods from seller to buyer), each product sold hereunder will be free of defects in materials or workmanship and will conform to specifications set forth in PalmSens BV's published data sheets or, where applicable, operator's manuals for PalmSens BV's system products in effect at the time title passes.

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See our website for more detailed information:
www.palmsens.com/terms-and-conditions/

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PalmSens BV is not liable for any direct, indirect, incidental, or consequential damages resulting from the use or misuse of its instruments, including but not limited to:

- Damage to the instrument caused by improper handling, unauthorized modifications, or use outside the recommended specifications.
- Malfunction or incorrect results due to improper sample preparation, contamination, or incorrect experimental setup.
- Loss of data or research results caused by software crashes, hardware failures, or power interruptions.
- Personal injury or property damage resulting from incorrect wiring, exposure to hazardous chemicals, or misuse of electrical connections.

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By using PalmSens instruments, the user acknowledges and accepts these limitations and responsibilities.

See Appendix A for CE declaration of conformity.

Copyrights

EmStat4S – Operator's Manual.

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Chapter 1. Introduction

1.1. Scope of this manual

This manual covers the handling, characteristics, troubleshooting, and other practical information regarding the hardware specifics of the EmStat4S, as well as maintenance and compliance.

Please refer to the **Quick Installation Guide** that was supplied with the instrument for instructions on installing the instrument and the software. Additionally, the section **Getting Started** in the digital **PSTrace Manual**, that is installed with the software, provides detailed instructions for conducting first measurements with your instrument.

> Initial setup and basic operational instructions for conducting initial measurements are detailed in the "Quick Installation Guide" supplied with the instrument.

The PSTrace Manual is an in-depth document covering not only the PSTrace software but also the hardware limitations for each technique supported by the instrument. It is written to give you a full understanding of both the software and hardware aspects, making sure you are well equipped to use all the functionalities of the EmStat4S.

1.2. About the EmStat4S

The EmStat4S LR and HR are a USB-powered potentiostat / galvanostat and impedance analyzers. The EmStat-series are available in a standard shielded housing or as bare PCB. The EmStat communication protocols are well described and made available to allow users to embed the potentiostat as part in another system.

With their reliable communication protocols and versatile form factors, the EmStat-series devices are well-suited for a variety of laboratory and research applications

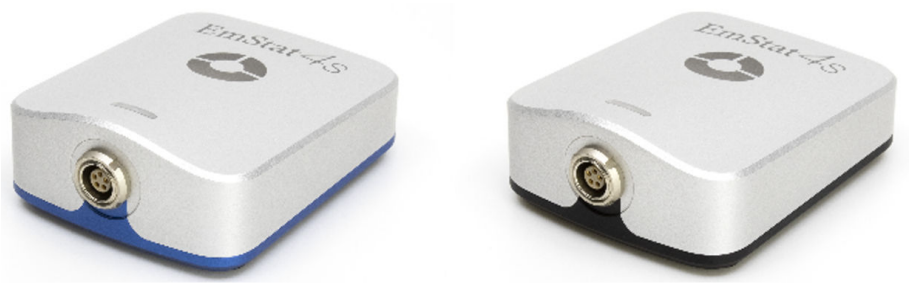


Figure 1. The EmStat4S LR (left) and EmStat4S HR (right)

The EmStat4S LR and HR have been on the market since 2021. They are the successor of the EmStat3 and EmStat3+ models. The EmStat4S comes in two different versions; the Low Range (LR) and High Range (HR) version.

- **Low Range:** for lower currents and potentials. This version can be identified by its blue bottom shell.
- **High Range:** for higher currents and potentials. This version can be identified by its black bottom shell.

Chapter 2. Operating the EmStat4S

The EmStat4S is powered and controlled directly by means of a standard USB-C cable. They do not have a power switch or any other type of switch.

2.1. USB Power considerations for EmStat4S HR

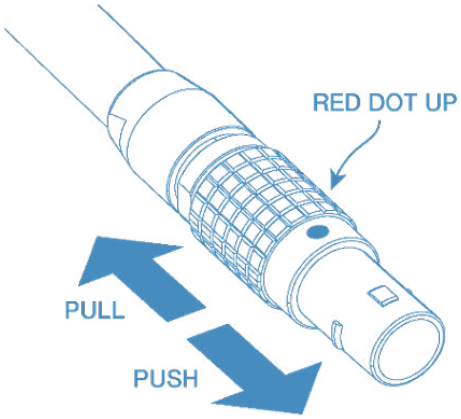
For optimal performance, PalmSens recommends using only the shielded USB-C cables supplied as standard with the instrument. Use of other or longer cables may increase susceptibility to electromagnetic interference and may affect measurement performance. Similarly, if feasible, it is recommended to refrain from utilizing a USB hub or docking station.

During measurements in the 100 mA range, the EmStat4S HR may demand more current than what is officially provided by standard USB 2.0 ports (5V at 500 mA). In cases where the available USB port cannot deliver 5V at 900 mA (or more), or if there is uncertainty about the power output of the USB port, it is essential to utilize the provided USB Y-cable with an additional USB port. This special cable configuration allows the instrument to draw additional power from a second USB port, ensuring optimal performance and accurate measurements. Refer to Figure 2 for an illustration of the USB Y-cable.

Figure 2. USB Y-Cable in case a single USB port does not provide sufficient power for the EmStat4S HR

2.2. Cell cable

The EmStat4S cell cable connects to the high-end LEMO connector.



The EmStat4S cell connector is a push-pull connector. Do not try to twist it!

The EmStat4S HR version comes with an additional Sense lead. In contrast with the EmStat3+, the Sense lead of the EmStat4S HR is active for every current range and should always be connected. This allows the Sense lead to be used in four-electrode measurements.

For more information about making a connection to the cell, see also section: “Connecting a cell to the potentiostat” in the PSTrace Manual.

2.3. Status LED indicator

The EmStat4S has a multi-color status indicator. The following table explains the meaning for each color.

Table 1. EmStat4S status led indicator

Color	State
Steady green	Booting
Steady blue	Cell off (open circuit)
Steady red	Cell on
Blinking green	Uploading new firmware
Blinking orange	Error state
Blinking red	Fatal error (not responding)

2.4. Cell connector pin-out

The following schematic shows the EmStat4S cell connector pin-out and pin functions.

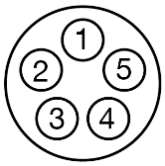


Figure 3. Front view of the female cell connector on the EmStat4S

Table 2. Cell connector pin functions of the EmStat4X

Pin	Function	Connector color
1	Reference Electrode (RE)	Blue
2	Reference Electrode Shield	N/A
3	Counter / Auxiliary Electrode (CE)	Black
4	Working Electrode Sense (Sense)	White
5	Working Electrode (WE)	Red
Connector housing	Analog Ground (AGND)	Green

Chapter 3. Running measurements

The PSTrace software for Windows allows you to perform all electrochemical techniques supported by the connected EmStat4S instrument. This section outlines how to set up a typical measurement using this application. For detailed information on specific techniques, including their options and limitations, please refer to the **PSTrace Manual**.

> The options and limitations for each technique are described in the PSTrace Manual.

More theoretical background information about electrochemical techniques can be found in:

- Christopher M.A. Brett and Ana Maria Oliveira Brett, Electroanalysis (Oxford Chemistry Printers, 64) Oxford Science Publications, ISBN-13: 978-0198548164
- Joseph Wang, Analytical Electrochemistry 4th ed, John Wiley & Sons, ISBN-13 978-1119787693

3.1. Connecting a cell to the potentiostat

This section describes how to connect the EmStat4S to an electrochemical cell using the 1-meter cell cable. The 1-meter cell cable is terminated with 2-mm plugs as the lead connectors for the cell/electrodes/sample. Each lead is accompanied by a crocodile (alligator) clip of the same color. See Table 2 for EmStat4S standard cable lead colors.

> We advise keeping an unused lead connected with its crocodile clip. This practice prevents accidental electrical contacts with the exposed 2-mm plug, minimizing the risk of unintended electrical contacts.

Each electrode cable is individually shielded, and the entire cable features an external shielding mesh. The shielding extends up to the beginning of the 2-mm plug. When you are using a Faraday cage, it is advisable to keep the entire 2-mm plugs inside the Faraday cage housing to ensure the cage shields the 2-mm plug.

3.1.1. 2-electrode cell connection

For a 2-electrode setup, combine the counter and reference electrode leads. The counter electrode plug of the cell cable is stackable, allowing easy combination.

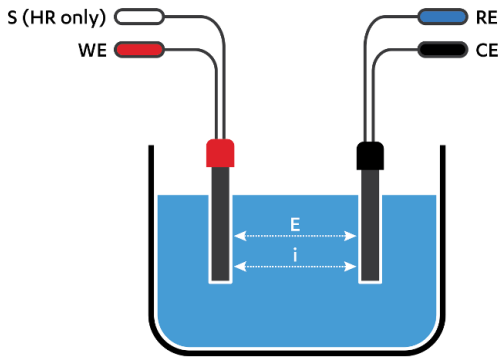


Figure 4. 2-electrode cell connection

During a measurement in a 2-electrode setup, the potential will be applied between the two electrodes, and the current will flow between the same two electrodes. This means the applied potential includes the potential drop across the working electrode's interface, the potential drop across the solution, and the potential drop across the counter electrode's interface. Any changes at the counter electrode will influence the result. If your counter electrode is expected to be stable during the measurement due to low currents or a short duration of the measurement, you can use this setup almost equivalent to a 3-electrode setup. Otherwise, this setup is only used for applications where the full cell potential is an interesting parameter, for example, fuel cells, batteries, capacitors, dummy cells or electronic components.

For EmStat4S HR: Make sure to connect or stack the sense lead with the WE lead when connecting it to the cell.

3.1.2. 3-electrode cell connection

The 3-electrode setup is the most common configuration for electrochemical measurements.

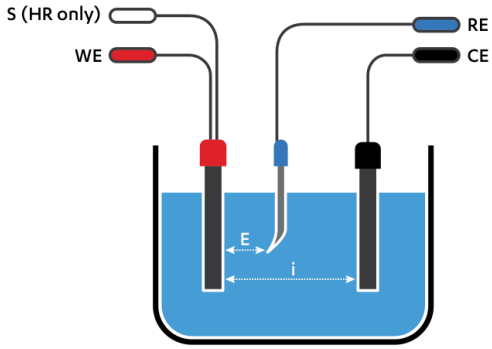


Figure 5. 3-electrode cell connection

Similar to the 2-electrode setup, the working electrode carries the current and potential. In this setup, the counter electrode also carries the current and polarizes versus the working electrode (WE). However, the potential is measured between the working and reference electrodes, denoted as WE vs. RE. This potential is the one set and read in the plot results.

The potential WE vs. CE is referred to as the 'cell potential', and it is recorded in special cases. In potential-controlled experiments, the potentiostat maintains a loop to ensure that the potential read (WE vs. RE) remains as programmed in the setup, consistently driving this potential towards the WE vs. CE polarization.

This has the advantage that the potential drop across the counter electrodes interface is compensated. Another advantage is that the reference electrode does not carry any current and will thus keep a stable potential during the measurement. This means the potential of the working electrode is more accurate and reproducible.

For EmStat4S HR: Make sure to connect or stack the sense lead with the WE lead when connecting it to the cell.

3.1.3. 4-electrode cell connection

In a 4-electrode configuration, all leads are connected individually to their respective electrodes, and no stacked lead combinations are used.

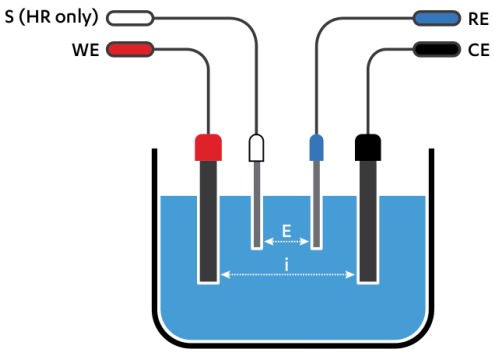


Figure 6. 4-electrode cell connection

For EmStat4S HR only: The 4-electrode setup requires a dedicated sense lead, which is available exclusively for the EmStat4S HR. This setup is not supported by the EmStat4S LR.

The potential is measured between the sense lead and the reference electrode, while polarization drives the current flow between the working electrode and the counter electrode. This arrangement ensures that the potential drops across the counter or working electrodes' interfaces, and the associated reactions, do not contribute to the measurement. Processes specifically across the solution and obstacles, such as a membrane, between the sense and reference electrode, become the primary contributors to the measurement.

This setup is rarely used, with some examples including research into solid-state electrolytes, membranes, or liquid-liquid interfaces.

3.1.4. Using the EmStat4S as ZRA

The EmStat4S can also be used as a Zero-Resistance Ammeter (ZRA). A Zero-Resistance Ammeter is a specialized mode used in potentiostats, primarily for measuring current between two electrodes while maintaining zero voltage (potential) difference between them. The ZRA mode ensures that no significant potential is applied between two electrodes, while the current flow between them is accurately measured.

While keeping the potential difference near zero, the potentiostat measures the current flowing between two electrodes. This current is the main variable of interest in ZRA mode, providing valuable insights into processes such as corrosion, galvanic coupling, and other electrochemical phenomena where a potential difference is not deliberately applied but current is exchanged.

If a potentiostat is used as a ZRA, in most setups it needs to be floating (Galvanically Isolated). The reference electrode (blue) and counter electrode (black) connections of the potentiostat need to be stacked and left disconnected to anything else. See the following image for a schematic representation.

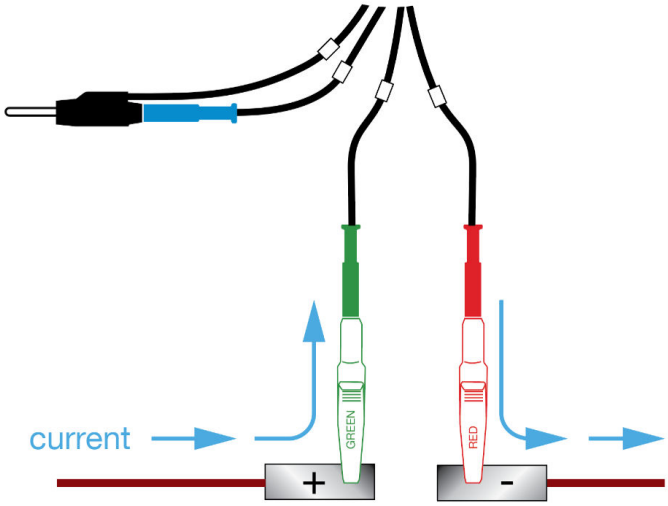


Figure 7. Connecting the EmStat4S cell cable for ZRA measurements

The current flows through the working electrode lead (red), and the ground lead (green). The working electrode is connected to the negative (-) input of the current follower and the positive (+) input is connected to ground. The voltage difference between the working electrode and ground is zero and the current will be measured.

Use the technique Chronoamperometry in software to record the currents. The applied potential setting can be ignored.

For EmStat4S HR: Make sure to connect or stack the sense lead with the WE lead when connecting it to the negative electrode terminal.

Chapter 4. Specifications

The Emstat4S comes in two versions: LR (Low Range) and HR (High Range). The version of your EmStat4S can easily be recognized by the color of the bottom shell. The HR as a black bottom shell, and the LR has a blue bottom shell. The following table shows the main differences between the LR and HR versions.

Table 3. EmStat4S LR and EmStat4S HR specifications

EmStat4S model differences		
model	EmStat4S LR	EmStat4S HR
potential range	±3 V	±6 V
max. compliance voltage	±5 V	±8 V
current ranges	1 nA to 10 mA (8 ranges)	100 nA to 100 mA (7 ranges)
max. current	±30 mA	±200 mA
electrode connections	WE, RE, CE, and ground, 2 mm plugs	WE, RE, CE, S, and ground, 2 mm plugs

Specifications are subject to change, due to regular firmware updates. See the EmStat4S product page on our website for accurate and detailed specifications.

Chapter 5. Troubleshooting

5.1. Verifying your potentiostat

Your instrument can be tested by using the test sensor or dummy cell supplied with the instrument.

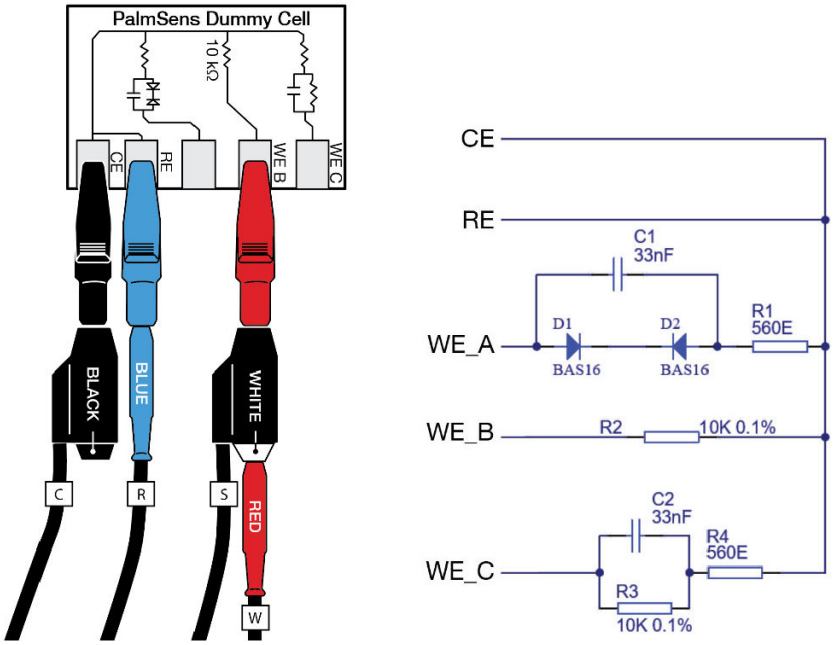


Figure 8. PalmSens Dummy Cell

The easiest way to verify the functioning of your instrument is to use the "WE B" circuit, which consists of a resistor with a value of 10 kΩ with a max deviation of 0.1%. The WE lead is connected to one side and both RE and CE to the other side of the resistor. In case you are using the EmStat4S HR: Make sure to connect the sense lead to the WE lead as well.

> Make sure to stack the sense lead with the WE lead when connecting it to the dummy cell.

Any of the electrochemical techniques can be applied. The current response obtained with a resistor with value R is equal to the applied potential or potential pulse divided by the value of R. So, if a potential of 0.5 V is applied on a resistor of 10 kΩ, the obtained current should be 0.5 V / 10 kΩ = 50 µA.

Contact PalmSens BV if the problems are found: **info@palmsens.com** and report the problems in as much detail as possible.

5.2. Noise

Our instruments are designed with hardware noise suppression filters to reject noise from internal and external sources. If a higher level of noise is your issue, the solving strategies are rather numerous, but the sources for noise are also numerous. Here we describe the most successful and common methods for noise reduction. To determine the noise levels for your instrument, please refer to section **"Measuring the noise level of the instrument"** in the PSTrace Manual.

5.2.1. Power grid

Your power grid is usually using an alternating current. This undulating current influences the measured currents. PSTrace and PStouch have a filter for this mains frequency. In PSTrace, check in the 'Tools' menu under 'General Settings' if the mains frequency is set correctly (50 Hz or 60 Hz).

5.2.2. Electrical fields

Our environment is filled with electrical fields. Some of them are created by devices around us as side effects or in case of wireless communication on purpose. Although it is a bad idea to measure directly next to an electric arc furnace, it is usually not possible to have a workspace free of electrical fields, especially not during point-of-care measurements. Nearby RF transmitters (Wi-Fi routers, mobile phones, industrial radios) may be interpreted by the instrument as valid electrochemical signals. Measurements performed near such sources may therefore deviate from stated specifications. A Faraday cage is usually sufficient to create a field-free environment. A metal box or cage out of metal mesh is a good Faraday cage. Even a shield out of aluminum foil can help. Place your electrochemical cell inside the Faraday cage and connect the cage to the ground lead (green) of the potentiostat. The cable delivered with your instrument has an inbuilt shield and should protect your signal outside the Faraday cage. This is one of the most effective methods to reduce noise.

5.2.3. Cables

Cables should not be unnecessarily long, since they act as antennas for noise, but the cable delivered with your instrument has an inbuilt shield and as long as you use the original cable, there is little reason to worry about cable induced noise.

5.2.4. Contacts

Check if the contacts are corroded. If so, remove the stains, for example with sandpaper.

Chapter 6. Maintenance and compliance

6.1. Temperature compliance

Our instruments are designed for indoor use at ambient temperatures between 0 °C and 45 °C.

6.2. Humidity compliance

PalmSens instruments have not been tested in high humidity environments. Elevated humidity however may cause measurement errors if condensation forms on the electronics. This affects measurements in the nA ranges or lower. Prolonged exposure to a condensing environment may severely decrease the life expectancy of the instrument and void its warranty.

6.3. Temperature drift

PalmSens instruments are calibrated at 21 °C. The most sensitive components of the instrument have temperature drift of 50 ppm. For instance at 1 °C or 41 °C, measurement drift of up to 0.1% may be experienced.

6.4. Atmospheric pressure

PalmSens instruments are not intended for use in safety-critical applications. Consequently, the power supplies utilized are not selected based on a specific pressure rating.

6.5. Cleaning

Make sure to disconnect your instrument from any cell or power source prior to cleaning. Use a cloth lightly dampened with either clean water or water containing a mild detergent to clean the outside of the instrument. Alternatively, you can use isopropyl alcohol. Avoid using a wet rag and prevent any fluids from entering the instrument. It is crucial not to immerse the instrument in any cleaning solution.

6.6. Periodic calibration and preventive maintenance

PalmSens instruments are designed in a way that eliminates the need for periodic calibration. While not mandatory, PalmSens does provide a calibration service for users with specific demands such as QC/ISO purposes. This service includes a new calibration certificate.

It's important to note that PalmSens instruments do not require preventive maintenance, further simplifying their use and reducing the overall maintenance demands on users.

6.7. Service and repair

Except for the battery in some models, your PalmSens instrument contains no userserviceable parts internally. Any service or maintenance needs should be directed to a qualified service technician employed by PalmSens BV. Attempting to access or modify internal components without proper expertise may result in additional damage to the instrument and void warranties. It is recommended to rely on authorized service personnel for any required maintenance or repair

6.8. RoHS Compliance

All instruments from PalmSens have been built using lead-free components and lead-free solder. They are in compliance with the European RoHS (Restriction of Hazardous Substances) initiative.

Appendix A: CE Declaration

PalmSens

EU DECLARATION OF CONFORMITY

Certificate number: PSDOC-ES4S-B

Manufacturer: PalmSens BV
Address: Vleugelboot 22,
3991 CL Houten,
The Netherlands

This declaration is valid for the following product:

EmStat4S (HR/LR), Portable electrochemical analyser

- USB power and communications
- 1 meter cell cable

The object of the declaration described above is in conformity with the Electromagnetic-Compatibility Directive 2014/30/EU (EMCD) and applicable standards listed below:

EMC

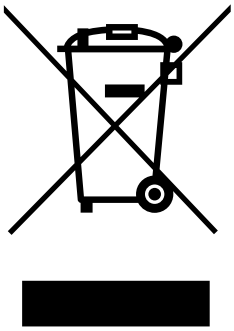
- EN 61326-1

This declaration is issued under the sole responsibility of PalmSens BV.

Date: 29th of November 2023

C.J. van Velzen, CTO

Appendix B: EU Waste Electrical and Electronic Equipment (WEEE) Directive



The pictogram shown above, located on the product and/or accompanying documents means that used electrical and electronic equipment (WEEE) should not be mixed with general household waste. For proper treatment, recovery and recycling, please take this product to designated collection points where it will be accepted free of charge.

Alternatively, in some countries, you may be able to return your product to your local retailer upon purchase of an equivalent new product. Disposing of this product correctly will help save valuable resources and prevent any potential negative effects on human health and the environment, which could otherwise arise from inappropriate waste handling. Please contact your local authority for further details of your nearest designated collection point. Penalties may be applicable for incorrect disposal of this waste, in accordance with your national legislation.

024.0086

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