KIPP & ZONEN
SINCE 1830

Instruction Manual

AMPBOX • Signal Amplifier

Important user information

Dear customer, thank you for purchasing a Kipp & Zonen instrument. It is essential that you read this manual completely for a full understanding of the proper and safe installation, use, maintenance and operation of your new AMPBOX signal amplifier.

We understand that no instruction manual is perfect, so should you have any comments regarding this manual we will be pleased to receive them at:

Kipp & Zonen B.V.
Delftechpark 36, 2628 XH Delft, - or
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Warranty and liability

Kipp & Zonen guarantees that the product delivered has been thoroughly tested to ensure that it meets its published specifications. The warranty included in the conditions of delivery is valid only if the product has been installed and used according to the instructions supplied by Kipp & Zonen.

Kipp & Zonen shall in no event be liable for incidental or consequential damages, including without limitation, lost profits, loss of income, loss of business opportunities, loss of use and other related exposures, however incurred, rising from the faulty and incorrect use of the product.

Modifications made by the user may affect the instrument performance, void the warranty, or affect the validity of the CE declaration or other approvals and compliances to applicable International Standards.

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EC Declaration of Conformity

CE

Kipp & Zonen B.V.
Delftechpark 36, 2628 XH Delft
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declares under our sole responsibility that the product

AMPBOX Signal Amplifier

to which this declaration relates is in conformity with European Harmonised Standards as published in Official Journal of the EC, issue: **C321/1 23-10-2012**

The compliance of the product has been based on the following standard

EN 61326-1:2006 [EMC - Emissions]
EN 61326-1:2006 [EMC - Immunity]

following the provisions of the directives
EMC-directive **2004/108/EC**

Delft, 1st October 2014

Dr. F. Kuik - CEO
Kipp & Zonen B.V.

This Declaration of Conformity is compliant with the European Standard EN 45014 *General Criteria for supplier's Declaration of Conformity*. The basis for the criteria has been found in international documentation, particularly in ISO/IEC, Guide 22, 1982, *Information on manufacturer's Declaration of Conformity with standards or other technical specifications*

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1. Introduction

Throughout this manual the following symbols are used to indicate to the user important information.

General warning about conditions, other than those caused by high voltage electricity, which may result in physical injury and/or damage to the equipment or cause the equipment to not operate correctly.

Note Useful information for the user.

1.1 Product overview

AMPBOX is a digital amplifier perfectly suited to combine with our instruments. Most Kipp & Zonen solar radiation radiometers are passive instruments that do not require any power to operate. The thermopile or photo-diode detector generates the output signal. However, the output is a very low voltage, typically in the region of 10 mV on a bright sunny day.

Not every data acquisition system can measure the small output voltage from most of our solar radiation radiometers. The AMPBOX can provide a solution for this problem. On the input it will receive the voltage output from our solar radiation radiometer, and on the output it will sink a current between 4 to 20 mA. In combination with a shunt resistor higher-level voltage measurements can be realized to suit the input channels of the data acquisition system. The input and output of the AMPBOX are galvanically isolated to protect the data collection equipment.

The AMPBOX can also provide a solution when cable lengths between the radiometer and the data acquisition system are over 50 meters.

Current sink units (like the AMPBOX) are powered from the current loop. They take less than 4 mA to operate and regulate the current flow to produce the 4 to 20 mA signals. The advantage is that these units are small, low power and only require a single 2-wire connection cable. However, the power for the amplifier and the current signal must be provided. Industrial DAQ systems normally have input channels that can be configured to take the 4 to 20 mA signals directly and provide the power for the current loop. Otherwise an external power supply must be connected to power the loop.

The instrument will find usage in many applications like; wind farms, solar energy farms, agricultural monitoring, scientific research, meteorology and many other areas. The AMPBOX was designed with the aim of simplicity and functionality and it has low power consumption.

If any questions should remain, please contact your local Kipp & Zonen representative or e-mail the Kipp & Zonen customer and product support department at: **support@kippzonen.com**

Please go to **www.kippzonen.com** for information about other Kipp & Zonen products, or to check for any updates to this manual.

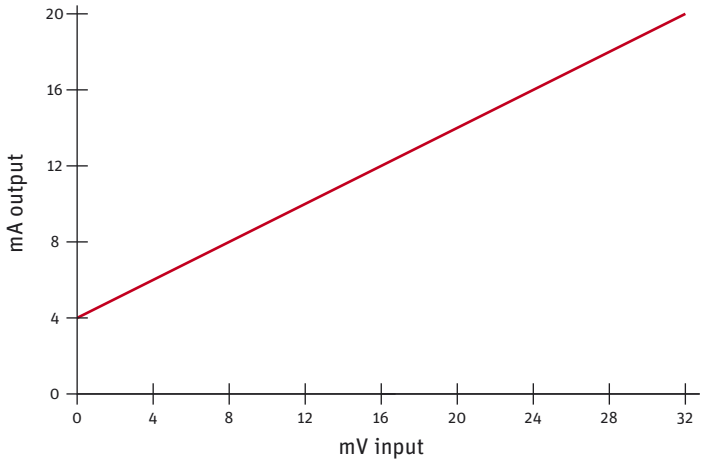
2. Gain

Gain is another word for amplification. The gain of the AMPBOX is programmeable using special tools. Kipp & Zonen can supply three different settings of the AMPBOX.

Part number	Article
0365900	AMPBOX signal amplifier standard gain setting
0365901	AMPBOX signal amplifier gain adjusted
0365903	AMPBOX signal amplifier gain adjusted for pyrgeometers
Note: For a new radiometer supplied with an AMPBOX the adjustment is included in the radiometer part number, and price For an existing radiometer please specify the model, serial number and sensitivity when ordering	

2.1. Standard gain

The standard gain of 1 mA / 2 mV means the AMPBOX is configured for 1 mA change in output at 2 mV change in input. This means it will sink the current from 4 to 20 mA at 0 to 32 mV input coming from the radiometer.



Any incoming voltage level higher than 32 mV will still result in the maximum current sink of 20 mA.

Note Until the end of 2011 the standard AMPBOX gain setting was 1 mA / 1 mV, this was changed to 1 mA / 2 mV at the beginning of 2012.

2.2. Adjusted gain

The adjusted gain can have various different settings.

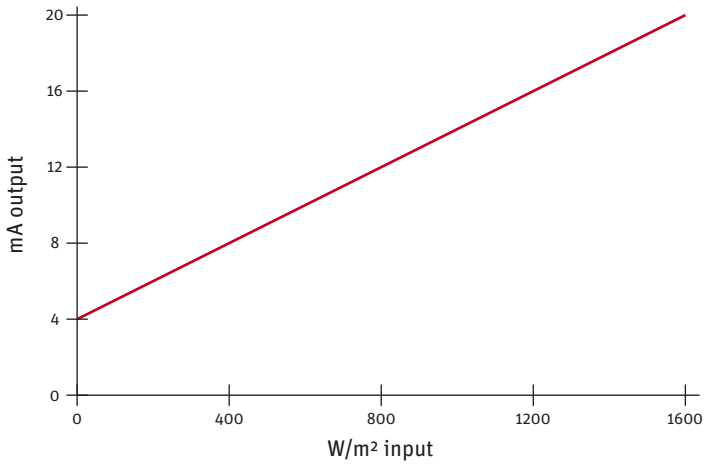
For pyranometers this gain is adjusted to 1 mA / 100 W/m² (except CM 4)
For the CM 4 Pyranometer the gain is adjusted to 1 mA / 250 W/m²
For pyrgeometers the gain is adjusted to 1 mA / 25 W/m² or 50 W/m²
For CUV radiometers the gain is adjusted to 1 mA / 6.25 W/m²
For the CHP 1 Pyrheliometer the gain is adjusted to 1 mA / 100 W/m²
For the PQS 1 PAR Quantum Sensor the gain is adjusted to 1 mA / 200 µmol/s/m²
For the NR Lite2 Net Radiometer the gain is adjusted to 1 mA / 100 W/m²

Eeach instrument (or gain adjustment) can have its own zero offset. For example a pyrgeometer starts at -600 W/m².

AMPBOX	4	20	mA
CG / CGR	-600	200	W/m²
CH / CHP	0	1600	W/m²
CM / CMP / SP Lite / SP Lite2	0	1600	W/m²
CM 4	0	4000	W/m²
CMA	0	1600	W/m²
CUV 4 / CUV 5	0	100	W/m²
NR Lite / NR Lite2	-400	1200	W/m²
PAR Lite / PQS 1	0	3200	µmol/ s·m²
CNR 4 short wave - upward	0	1600	W/m²
CNR 4 short wave - downward	0	1600	W/m²
CNR 4 long wave - upward	-600	200	W/m²
CNR 4 long wave - downward	-200	600	W/m²
Eppley PSP	0	1600	W/m²

Note These gain adjustments are based on practical outdoor measurements. Customized adjustments can be possible.

The next illustration displays the current sink against the incoming radiation for a pyranometer (1 mA / 100 W/m² gain setting).



Note An AMPBOX with an adjusted gain can only be used with the corresponding solar radiation instrument.

3. Installing the AMPBOX

Before installing the AMPBOX you should be aware that we do not supply the cable between the AMPBOX and the data acquisition system. In fact the AMPBOX is supplied without any cables. The cable from the radiometer to the AMPBOX can be ordered together with the radiometer.

Note Install the AMPBOX as close as possible to the radiometer. The cable between the AMPBOX and data acquisition system can be over 100 meters.

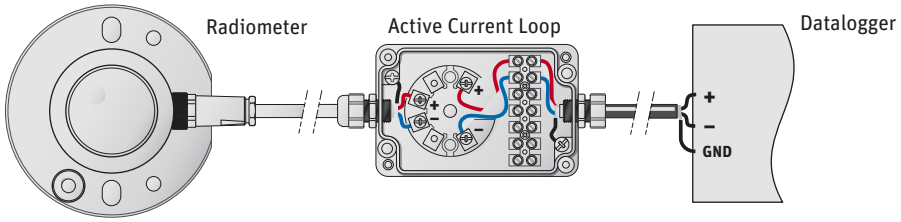
Example:
You would like to connect a CMP10 pyranometer to the 4 to 20 mA inputs of your data acquisition system. The distance between the two components is 45 meters.

Solution:
Order a CMP10, including adjusted AMPBOX and 50 meters of cable. When receiving the instrument and the cable with plug attached, cut off 45 meters of cable and use the plug with 5 meters of cable to connect the instrument to the AMPBOX. The other 45 meters can be used to connect the AMPBOX to the data acquisition system.

Another option would be to purchase a separate cable with the specific length.

3.1 Installing AMPBOX on 4 to 20 mA current loop input

The next illustration shows how to connect the AMPBOX to a data acquisition system that can be configured to provide the power for the current loop.



Note Install the AMPBOX as close as possible to the radiometer. The cable between the AMPBOX and data acquisition system can be over 100 meters.

E = irradiance level
I_{out} = current recorded by the data acquisition (4 to 20 mA)
I_{offset} = zero offset from AMPBOX (4 mA)
Gain setting = (see chapter 2.2)
E_{offset} = zero offset from irradiance

Examples of irradiance calculations:
• Standard gain setting of 2 mV / 1 mA
$E = (I_{out} - I_{offset}) * \text{gain setting} / S_{instrument}$

• Adjusted gain for radiometers (except pyrgeometers)
$E = (I_{out} - I_{offset}) * \text{gain setting}$

• Adjusted gain for pyrgeometers
$E = (I_{out} - I_{offset}) * \text{gain setting} - E_{offset}$

Example when using standard gain setting of 2 mV / 1 mA and output is 12,04 mA and sensitivity is 13,15 µV

$E = (I_{out} - I_{offset}) * \text{gain setting} / S_{instrument}$

E = (12,04 mA – 4 mA) * 2 mV / 13,15 µV

E = 1222,81 W/m²

Example when using adjusted gain setting of 100 W/m² / 1 mA and output is 12,04 mA

$E = (I_{out} - I_{offset}) * \text{gain setting}$

E = (12,04 mA – 4mA) * 100 W/m²

E = 804 W/m²

Example when using adjusted gain setting of 25 W/m² / 1 mA for the pyrgeometer starting at -300 W/m² and output is 16 mA

$E = (I_{out} - I_{offset}) * \text{gain setting} - E_{offset}$

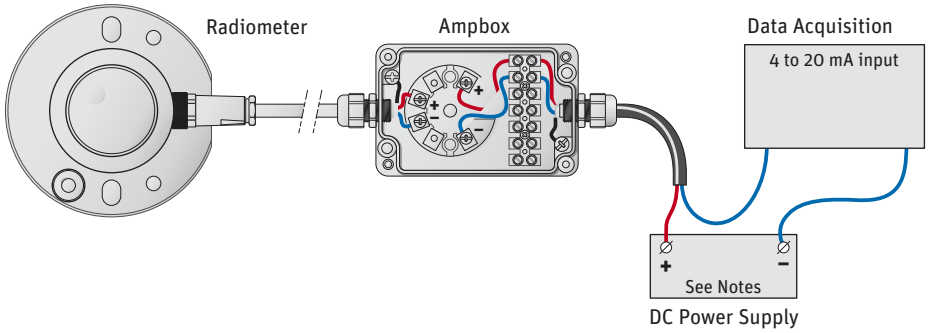
E = (16 mA - 4mA) * 25 W/m² – 300 W/m²

E = 0 W/m²

Note Gain setting can be calculated by dividing the entire span by 16.
Example: -600 to +200 W/m² span = 800/16 = 50 W/m² per 1 mA

3.2. Installing AMPBOX on 4 to 20 mA input that does not supply the 4 to 20 mA current loop

Some data acquisition systems cannot supply the power for the 4 to 20 mA current loop. In such situations an external power supply unit is necessary. This power supply will then supply the active current loop required for the AMPBOX.



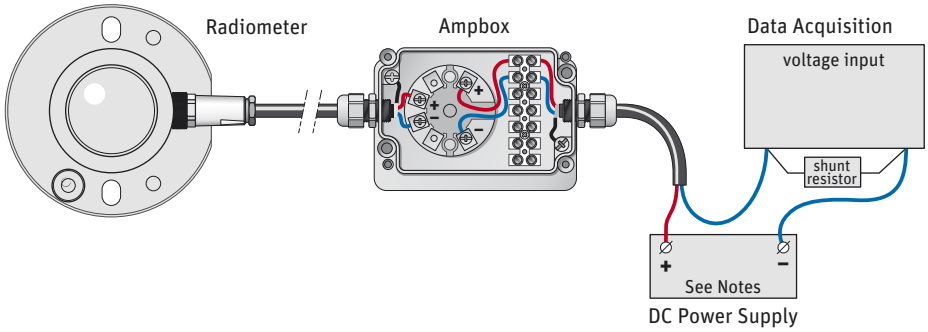
Note There is an internal diode that protects the AMPBOX from any damage when the power supply unit is connected the wrong way around.

Note The power supply should be suitable to supply 7.2 VDC for the AMPBOX + the voltage drop over the cable loop at 20 mA. The practical minimum is 7.5 VDC and the maximum is 35 VDC. The voltage drop over the 4 to 20 mA current loop cables can be calculated when the specifications of the cable are known.

Note Install the AMPBOX as close as possible to the radiometer. The cable between the AMPBOX and data acquisition system can be over 100 meters. It's therefore advised to install the PSU as close as possible to the data acquisition system.

3.3 Installing AMPBOX on voltage input

Some data acquisition systems do not have a current input or a voltage input suitable for the low voltage levels of our radiometers. In such situations an external power supply unit and shunt resistor are required. This power supply will then supply the active current loop required for the AMPBOX, and the shunt resistor provides the ability to measure the voltage drop over it. Depending on the resistor value, customized voltage measurements can be achieved suitable for the particular voltage input of the data acquisition system.



For a 2 to 10 V voltage range a 500 Ω shunt resistor is required (2 V represent 4 mA and 10 V represents 20 mA)
For a 0.4 to 2 V voltage range a 100 Ω shunt resistor is required (0.4 V represent 4 mA and 2 V represents 20 mA)
For a 0.2 to 1 V voltage range a 50 Ω shunt resistor is required (0.2 V represent 4 mA and 1 V represents 20 mA)

The shunt resistor needs to be a precision resistor of 0.05 % and needs to be mounted as close as possible to the data acquisition system. Preferably directly screwed into the differential inputs, otherwise you will measure the voltage over the resistor minus the voltage drop of the additional cable which affects the accuracy of your measurement.

Note There is an internal diode that protects the AMPBOX from any damage when the power supply unit is connected the wrong way around.

Note The power supply should be suitable to supply 7.2 VDC for the AMPBOX + the maximum voltage drop over the shunt resistor + the voltage drop over the cable loop at 20 mA. The maximum supply voltage at the AMPBOX is 35 VDC. The voltage drop over the cables can be calculated when the specifications of the cable are known.

Note Install the AMPBOX as close as possible to the radiometer. The cable between the AMPBOX and data acquisition system can be over 100 meters. It's therefore advised to install the PSU as close as possible to the data acquisition system.

Example when using adjusted gain setting of 1 mA / 25 W/m² for the pyrgeometer starting at -100 W/m² (CNR 4 downward) and output is 2000 mV when using a shunt resistor of 100 R.

$E = (U_{out} - U_{offset}) / \text{shunt resisitor} * \text{gain setting} - E_{offset}$
$E = (2000\ mV - 400\ mV) / 100 * 25\ W/m^2 - 300\ W/m^2$
$E = 100\ W/m^2$

4. Calibration

We advise to re-calibrate our solar instruments every two years. It is important to realize that an adjusted AMPBOX needs to be re-adjusted together with the solar radiation measuring instrument.

The AMPBOX with a standard gain of 1 mA / 2 mV does not have to be re-adjusted. In this case the calculation of the radiation in the data logger or data acquisition system needs to be reconfigured to the new instrument sensitivity.

5. Specifications

Specifications	
Current output range	4 to 20 mA
Input voltage range	-12 mV to +150 mV
Gain standard	1 mA / 2 mV
Gain adjusted	To suit a specific radiometer
Input impedance	10 MΩ
Operating temperature range	-40 °C to +85 °C
Current loop power	Needs to be supplied by DAQ or PSU
Supply Voltage range	7.2 VDC to 35 VDC
Voltage drop	7.2 VDC
Ingress protection	IP66
Temperature dependence of gain	Within ± 0.01 % of span/K
Zero drift	< ±1 µV/K
Non-linearity	< 0.2 %
Update time	440 ms
Inaccuracy, the greater of	± 0.05 % of span or ± 10 µV
Dimensions	64 x 98 x 34 mm
Weight	0.25 kg
Cable diameters	3 to 7 mm

5.1. Effect on radiometer accuracy

This section of the manual describes the additional inaccuracy introduced by the AMPBOX, in combination with a CMP pyranometer.
(Preset range of 0 to 1600 W/m² = 4 to 20 mA)

The total inaccuracy is the greater of the absolute and basic values.
The basic inaccuracy is < 1 W/m², temperature coefficient is < 0.1 W/m² / °C
The absolute inaccuracy is <0.05 % (of span), temperature coefficient is < 0.01% (of span) / °C
For a span of 1600 W/m² this results in an absolute inaccuracy of 0.8 W ±0.16 W/m² / °C

In practice this means that the inaccuracy of the AMPBOX is <1 W/m² (@ 22 °C)
The additional temperature coefficient is <0.16 W/m² / °C.

6. Frequently asked questions

Q: How can I adjust the gain of the AMPBOX.

A: You cannot. It needs to be done with a programmer connected to a PC using specific programming software. Kipp & Zonen offices, the factory in Delft and some distributors have the necessary tools. Please send with the AMPBOX the model, serial number and sensitivity of the radiometer that you wish to use with the AMPBOX.

Q: I have a solar simulator that starts at 500 W/m². Can the AMPBOX be setup for a 500 to 1500 W/m² configuration?

A: Yes. Please have this described on the order details.

Q: Inside the AMPBOX there is a terminal strip present. Can we use this to extend the wires from the temperature sensor?

A: Yes. The terminal strip can be used to extend any wires safely without amplifying them. (It can be used as a high quality junction box).

Q: I already have an instrument from Kipp & Zonen and need an AMPBOX for it. How can I order one?

A: Order an adjusted version of the AMPBOX, and submit the instrument type, sensitivity and serial number. We will configure the AMPBOX accordingly.

Q: I have connected the AMPBOX to the data logger but it is not measuring anything?

A: Please check if the data logger supplies the power for the current loop (4 to 20 mA) otherwise an additional power supply is required.

Q: Can I order the shunt resistors from Kipp & Zonen?

A: We only have the 500 R resistor available (part number 2686-002) suitable for a 2 to 10 V signal range, others should be purchased locally.

Q: How is the pyranometer configured?

A: Normally it is configured to supply 4 to 20 mA at 0 to 1600 W/m² input. This range is suitable for all measurements outdoors under natural sunlight.

0 W/m² = 4 mA
400 W/m² = 8 mA
800 W/m² = 12 mA
1200 W/m² = 16 mA
1600 W/m² = 20 mA

Other measurement ranges can be configured, for example to suit solar simulator light sources.

Q: Why does a pyrgeometer start at -600 W/m²?

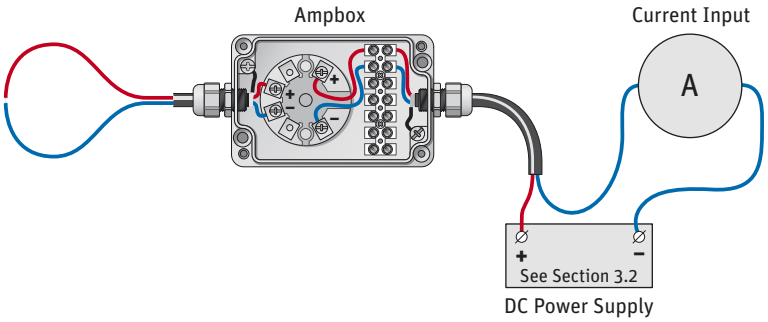
A: The output of a pyrgeometer is in most cases negative (from -150 W/m² to 0 W/m² are common values).

7. Troubleshooting

Most common faults are:

- Power supply unit connected the wrong way around (so no output is measurable)
- Data acquisition system is recording strange values (by incorrect calculations)

There is an easy way to check both issues by disconnecting the installation from the data acquisition system and short circuit the input side of the AMPBOX. Please use either a voltmeter or current meter depending on your measurement configuration.

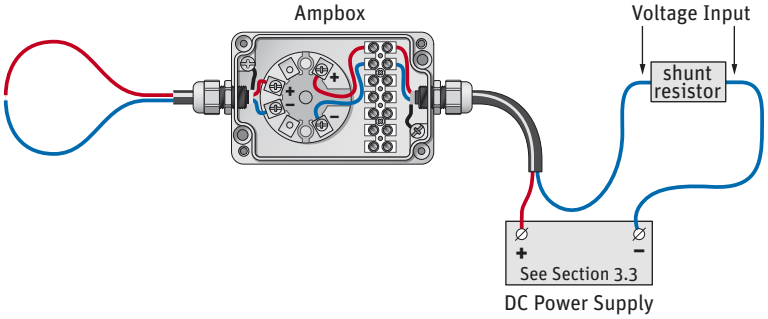


The short circuit will simulate 0 W/m² input. This means the output of the AMPBOX should be 4 mA.

Note The AMPBOX configured for a pyrgeometer will provide a different output (most likely 16 mA) as they have an offset.

This will ensure that you have a working power supply and a well configured AMPBOX at 4 mA. You can then connect this to the data acquisition and should also record the same 4 mA. When this is not the case you should consider checking formulas, offsets or configuration of the data acquisition system.

The same can be applied when using a voltage input. Disconnect the AMPBOX from the data acquisition system and measure the voltage drop over the resistor when the AMPBOX is short-circuit at the input side.



A 500 R shunt resistor should provide a 2 V reading on the voltmeter when the input of the AMPBOX is short-circuit.

8. Customer support

If you require any support for your Kipp & Zonen product please contact your local representative in the first instance. The information can be found in the 'Contact' section (home tab) of our website at **www.kippzonen.com**

Alternatively, you can contact us directly at **www.kippzonen.com/support**

Please include the following information:

- Instrument model
- Instrument serial number
- Details of the fault or problem
- Examples of data files
- Readout device, data acquisition system and operating system
- Interfaces and power supplies
- History of any previous repairs or modifications
- Pictures of the installation
- Overview of the local environment conditions

Kipp & Zonen guarantees that your information will not be shared with other organisations.

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Our customer support remains at your disposal for any maintenance or repair, calibration, supplies and spares.

Für Servicearbeiten und Kalibrierung, Verbrauchsmaterial und Ersatzteile steht Ihnen unsere Customer Support Abteilung zur Verfügung.

Notre service 'Support Clientèle' reste à votre entière disposition pour tout problème de maintenance, réparation ou d'étalonnage ainsi que pour les accessoires et pièces de rechange.

Nuestro servicio de atención al cliente esta a su disposición para cualquier actuación de mantenimiento, reparación, calibración y suministro de repuestos.

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