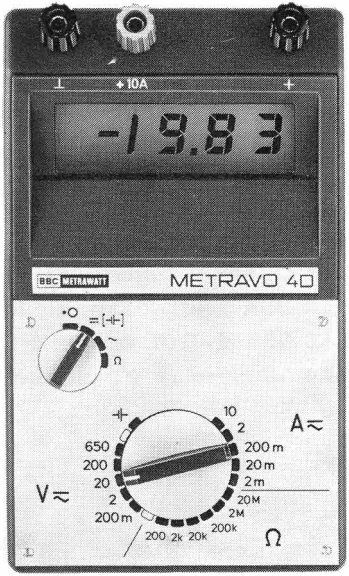
# METRAVO® 4D

## Operating instructions

Nr. 3.348.252.03

L 2-5.2

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BBC GOERZ METRAWATT

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# 1. Description

## 1.1 General

The METRAVO 4 D is a digitally indicating multimeter featuring liquid crystal display. It offers a plurality of applications in the field of electronics, e.g. in research and development, in production, operation, test rooms and service.

It features a constant input resistance of 10 MΩ || 100 pF on all voltage measuring ranges. On 26 measuring ranges, it measures DC and AC voltages up to 650 V, DC and AC currents up to 10 A (temporarily up to 20 A), and resistances up to 20 MΩ.

Several well-tuned protective means protect the instrument against damage through improper handling and overload:

- Overdimensioned precision resistors
- Melting fuse in conjunction with protective power diodes
- Overvoltage arrester.

The rugged design of the METRAVO 4 D, particularly in conjunction with the rubber bag, assures extreme protection in case of rough mechanical application.

The METRAVO 4 D is fitted with a liquid crystal display (LCD), the high contrast of which is also maintained in environments of very bright light.

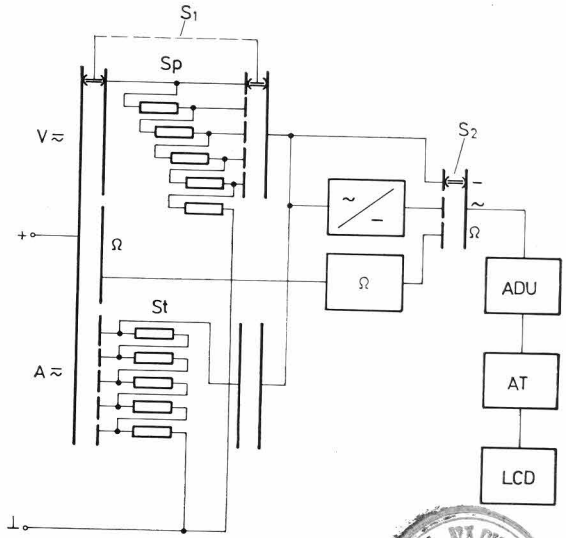
The instrument operates mains-independent on commercially available Mignon cells. Thanks to the electronic components in LSI technique and the liquid crystal display, current consumption is extraordinarily low so that a long life of a set of batteries is assured.

The measuring instrument is constructed to comply with the safety rules of VDE 0411 and, if handled with care, assures protection against hazards of electric shocks which is required by VDE 0110 and DIN 40 050.

## 1.2 Theory of operation

By means of the range selector switch ($S_1$) ① the measured variable is applied to a precision voltage divider (Sp) for voltage measurement, to the precision shunts (St) for current measurement, and to a constant current source for resistance measurement (Figure 1).

For AC variables and for resistance measurement, analogue switching groups are interconnected across the function switch ($S_2$ ②) so that on all measuring ranges a DC voltage of like magnitude, proportional to the measured variable, is available at the input of the analogue-to-digital converter (ADU). The analogue-to-digital converter works on the dual-ramp or dual-slope principle and is combined in a large-scale integration C-MOS circuit. Across a matching circuitry (AT) the measuring signal, now being available in digital form, is passed to the liquid crystal display.




ADU = Analogue-to-digital converter
AT = Matching circuitry (display-driver)
LCD = Liquid crystal display
$S_1$ = Range selector switch
$S_2$ = Function switch
Sp = Voltage divider
St = Shunts

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Figure 1 Basic Circuit Diagram of the METRAVO 4 D

## 2. Specifications

### Measuring ranges

| Voltage | Resolution | Input resistance $R_i$ | maximum measuring error | Overload-protected to |
|---|---|---|---|---|
| 200 mV≂ | 100 µV | 10 MΩ ‖ approx. 100 pF | ± (0.5% of reading + 1 digit) on DC<br>± (1 % of reading + 2 digits) on AC, f = 50 Hz | 250 V≂ |
| 2 V≂ | 1 mV | | | 250 V≂ |
| 20 V≂ | 10 mV | | | 650 V≂ |
| 200 V≂ | 100 mV | | | 650 V≂ |
| 650 V≂ | 1 V | | | 650 V≂ |

| Current | Resolution | Voltage drop ΔE | maximum measuring error | |
|---|---|---|---|---|
| 2 mA≂ | 1 µA | approx. 200 mV | ± (1 % of reading + 1 digit) on DC<br>± (1.5% of reading + 2 digits) on AC, f = 50 Hz | 250 V≂ [1] |
| 20 mA≂ | 10 µA | approx. 200 mV | | 250 V≂ [1] |
| 200 mA≂ | 100 µA | approx. 300 mV | | 250 V≂ [1] |
| 2 A≂ | 1 mA | approx. 1 V | | 250 V≂ [1] |
| 10 (20)[2] A≂ | 10 mA | approx. 200 (400) mV | | – |

| Resistance | Resolution | Current constant | Voltage at full scale value | maximum measuring error | Open-circuit voltage $E_L$ | |
|---|---|---|---|---|---|---|
| 200 Ω | 0,1 Ω | 1 mA | 200 mV | ± 0.5% of reading $^{+3}_{-1}$ digit | approx. 1.2 V | 250 V≂ [1] |
| 2 kΩ | 1 Ω | 100 µA | 200 mV | ± (0.5% of reading + 1 digit) | approx. 1.2 V | 250 V≂ [1] |
| 20 kΩ | 10 Ω | 10 µA | 200 mV | ± (0.5% of reading + 1 digit) | approx. 1.2 V | 250 V≂ [1] |
| 200 kΩ | 100 Ω | 1 µA | 200 mV | ± (0.5% of reading + 1 digit) | < 5.5 V[4] | 250 V≂ [3] |
| 2 MΩ | 1 kΩ | 100 nA | 200 mV | ± (0.5% of reading + 1 digit) | < 5.5 V[4] | 250 V≂ |
| 20 MΩ | 10 kΩ | 10 nA | 200 mV | ± (1% of reading + 1 digit) | < 5.5 V[4] | 250 V≂ |

[1]) Protected by G-melting fuse link FF 2 G/250 V in conjunction with protective power diodes

[2]) 20 A for one minute

[3]) 250 V DC, AC for ½ minute
220 V DC, AC for 5 minutes.

[4]) The open-circuit voltage at the terminals corresponds to approximately the value indicated when checking the battery voltage.

**Reference conditions**

| | |
|---|---|
| Ambient temperature | +23 °C ± 2 °C |
| Frequency | 50 Hz |
| Position of use | any |

**Influencing quantities and rated operating ranges**

| | |
|---|---|
| Temperature error | on the range from +5 . . . +40 °C |
| on V DC | ± (0.5% of reading + 1 digit) / 10 K |
| on V AC | ± (1 % of reading + 2 digits) / 10 K |
| on A DC | ± (1 % of reading + 1 digit) / 10 K |
| on A AC | ± (1.5% of reading + 2 digits) / 10 K |
| on Ω | ± (0.5% of reading + 1 digit) / 10 K |
| Limit temperatures | |
| for accuracy | + 5 . . . +40 °C |
| for operation | −10 . . . +40 °C |
| for storage | −20 . . . +65 °C |
| Frequency range | typical error |
| 49 Hz . . . 1 kHz | ± (1 % of reading + 2 digits) on V AC<br>± (1.5% of reading + 2 digits) on A AC |
| 1 kHz . . . 5 kHz | ± (3 % of reading + 2 digits) on V AC up to 20 V AC |
| Interference voltage | normal-mode rejection on V, A DC<br>> 40 dB at f ≧ 50 Hz |
| Waveform effect | with square-wave variable indication is too high by 11%, with triangular-wave variable too low by 4% |



**Response time**

| | |
|---|---|
| to full scale value | |
| on V, A DC | 1 s |
| on V, A AC | 4 s |
| on Ω | 2 s (on 20 MΩ 7 s) |

**Digital display**

| | |
|---|---|
| Type of display | field effect liquid crystal display |
| Height of numerals | 13 mm |
| Number of digits | 3½ digits ≙ 2000 counts |
| Full scale value | 1999 |
| Overrange indication | only left digit 1 lights |
| Polarity indication | plus pole on terminal "⊥": minus sign |
| Decimal point selection | by range selector switch |

**Analogue-to-digital conversion (ADC)**

| | |
|---|---|
| Principle | dual-slope with automatic zero balancing |
| Sampling rate | automatic |
| Conversion rate | approx. 2.5 readings/s |

**Power supply**

| | |
|---|---|
| Rated voltage | +6 V and −6 V |
| Supply voltage | range ± (4.75 . . . 6.4) V |

| | |
|---|---|
| Batteries | 8 each 1.5 V Mignon cells according to IEC R 6[5])<br>Lifespan of a set of manganese-dioxide batteries is approximately 100 hours<br>Alkaline-manganese batteries or NiCd storage batteries may also be used. NiCd batteries are particularly recommended for ambient temperatures below 0 °C. |
| Battery check | Indication $\geqq$ 4.50 |

**Fuse**

| | |
|---|---|
| Melting fuse | FF 2 G/250 V DIN 41 571[5]);<br>protects the 2 mA . . . 2 A and 200 Ω . . . 20 kΩ ranges in conjunction with power diodes;<br>Switching capacity 750 A DC/1500 A AC on 250 V |

**Case**

| | |
|---|---|
| Protection class | II according to VDE 0411 |
| Protection type | IP 50 according to DIN 40 050,<br>IP 20 at the terminals |
| Test voltage | 4 kV, measuring circuit to case |
| Dimensions | 110 x 181 x 62 mm |
| Weight | approx. 0.75 kg including batteries<br>approx. 0.55 kg without batteries |

[5]) Available from special dealers



# 3. Overload protection

## 3.1 Internal resistance

Thanks to both the very high internal resistance and the over-dimensioned precision resistors, the voltage measuring ranges and the highly resistive resistance measuring ranges can continuously be overloaded as follows:

| | Measuring range | max. permissible continuous overload |
|---|---|---|
| **Voltage** | 200 mV | 250 V$\sim$ |
| | 2 V | 250 V$\sim$ |
| | 20 V | 650 V$\sim$ |
| | 200 V | 650 V$\sim$ |
| | 650 V | 650 V$\sim$ |
| **Resistance** | 200 kΩ | 250 V$\sim$ for ½ minute / 220 V$\sim$ for 5 min. |
| | 2 MΩ | 250 V$\sim$ |
| | 20 MΩ | 250 V$\sim$ |

## 3.2 Melting fuse FF 2G/250 V, DIN 41 571

The superquick-action melting fuse FF 2 G/250 V, in conjunction with power diodes, protects the 2 mA, 20 mA, 200 mA and 2 A current measuring ranges, and the 200 Ω, 2 kΩ, and 20 kΩ resistance measuring ranges.

**Current measuring ranges** 2 mA . . . 2 A

| | |
|---|---|
| Loading capacity | 2.5 A continuously; take into account, however, that the fuse may blow after about 5 minutes. |
| Switching capacity | 750 A DC / 1500 A AC on 250 $V_{rms}$ |

**Resistance measuring ranges** 200 Ω, 2 kΩ and 20 kΩ:

| | |
|---|---|
| Loading capacity | continuously 1 A, maximum, continuous overload with currents above 1 A is not permissible! |
| Switching capacity | 70 A DC, AC on 250 $V_{rms}$, maximum |

The 10 A range is not protected; the maximum loading capacity is 20 A for 1 minute.

The fuse is located immediately behind the connection terminal "+" ⑥. When the fuse blows, only the 10 A range and the battery check continue to function.

### 3.3 Overvoltage arrester

The overvoltage arrester responds at voltage peaks above approximately 2.5 kV and prevents the insulation from being damaged.

## 4. Operation

### 4.1 Start-up

**Installing the batteries**

**CAUTION:** The measuring instrument shall not be connected to a measuring circuit and shall not be operated without the bottom cover!

- Loosen the slotted screw on the bottom of the case and remove the bottom cover.
- Pull out the battery holder and insert 8 each 1.5 V Mignon cells in accordance with the symbols.
- Slide the battery holder back into the instrument; verify that the 3 connection contacts point towards the connection terminals. Only in this way the battery holder can be inserted into the instrument.



**CAUTION:** Use leakproof batteries only:
8 each 1.5 V Mignon cells according to IEC R 6.

**Checking the battery voltage**

- Set the function switch ② to position "⎓ [⊣⊢] "
- Set the range selector switch ① to position " ⊣⊢ "

If a value of more than 4.50 is indicated, the battery voltage is sufficient, that means it is guaranteed that the error limits according to the information given in 2. "Specifications" are maintained.

### 4.2 Information on using the instrument

**Connection terminals ④ ⑤ ⑥**

The instrument has three connection terminals. The left terminal "⊥" ④ is the common terminal for all measuring ranges and is internally connected to the shielding. The middle terminal "+10 A" ⑤ is provided for the highest current range 10 A DC, AC only, while the right terminal "+" ⑥ is provided for connection of all other measuring ranges.



**Range selector switch ①**

When measuring voltages and currents of unknown magnitude, **first** set the range selector switch ① **to the highest measuring range.** Then work down to the lower measuring ranges until optimum indication is obtained. Changing-over does not interrupt the measuring circuit.

**CAUTION:** Upon cut-out of a protective means, first eliminate the cause of overload, and only then continue switching the range selector switch ①!

**ON/OFF and function switch ②**

Independent of the measured variable applied and the position of the range selector switch ①, the function switch ② can be switched between "•○", "—" and "∼".

Set it to

"⎓ [+]" to DC voltage and DC current measurements and for battery check.

"∼" for AC voltage and AC current measurements

"Ω" for resistance measurements

"•○" to turn off the instrument.

To avoid unnecessary load on the batteries, turn off the instrument when not in use for extended periods. The average lifespan of a set of manganese-dioxide batteries is approximately 100 hours (typical value).

**Liquid crystal display (LCD) ⑦**

The liquid crystal display indicates the measured value in digital form and with proper location of the decimal point. When measuring DC variables, a minus sign ③ appears in front of the digits when the positive pole of the measured variable is applied to the "⊥" terminal ④ and the negative pole to the "+" terminal ⑥. If the full scale value of 1999 is exceeded, the three digits at the right are blanked; merely the 1 at the left is displayed.

The high contrast of the liquid crystal display is also maintained at very bright environments.

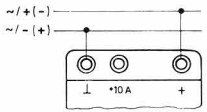


## 4.3 Voltage measurement

Regardless of the magnitude of the voltage being measured, for safety reasons, the sum of the voltage being measured and the voltage to earth shall not exceed 650 V when the METRAVO 4 D is connected directly!

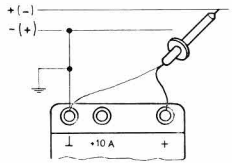
If possible, take the left connection terminal ④, marked "⊥", immediately to earth or to the point having the lowest potential to earth. The 200 mV and 2 V ranges can continuously be loaded up to 250 $V_{rms}$, the 20 V and 200 V and 650 V ranges continuously up to 650 $V_{rms}$.

### 4.3.1 DC and AC voltages up to 650 V (direct connection)




- Set the function switch ② to position "⎓" or "∼".
- Set the range selector switch ① to position 650 V . . . 200 mV

### 4.3.2 DC voltages up to 30 kV with high voltage probe GE 4196 (1000 MΩ)




- Set the function switch ② to position "⎓".
- Set the range selector switch ① to position 20 V, 200 V or 650 V.

| Measuring range | 2 kV | 20 kV | 30 kV |
|---|---|---|---|
| Range selector switch | 20 V | 200 V | 650 V |
| Factor | x 0.1 | x 0.1 | x 0.1 |

The additional error in indication is +5%, −7% maximum of the reading.

**CAUTION:** For safety reasons, observe the following when making measurements of voltages above 650 V to earth:

Lay the METRAVO 4 D on an insulated surface and connect the measuring leads in such a way that the protective lead of the probe and the "⊥" terminal ④ are directly taken to the protective conductor (earth) potential. First, set the funnction and the range selector switch to the positions indicated above, and only then turn on the voltage and scan it with the probe respectively.

Do not touch the instrument when the voltage to be measured is applied!

## 4.4 Current measurement

Always connect the METRAVO 4 D into the line having the lowest voltage to earth. For safety reasons, the voltage to earth shall not exceed 650 V!

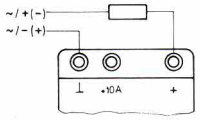
All current measuring ranges from 2 A to 2 mA can be selected without interrupting the circuit.

The 2 mA to 2 A ranges are protected by a superquick-action 2 A melting fuse (FF 2 G/250 V) in conjunction with power diodes. The breaking capacity is 1500 A AC and 750 A DC at a rated voltage of 250 V.

**CAUTION:** Upon cut-out of the protective means, eliminate the cause of overload and only then put the instrument back to serviceable condition!

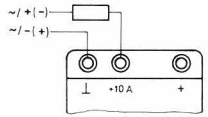


### 4.4.1 DC and AC currents up to 2 A (direct connection)




- Set the function switch ② to position "⎓" or "∿".
- Set the range selector switch ① to position 2 A . . . 2 mA.

### 4.4.2 DC and AC currents up to 10 A (direct connection)

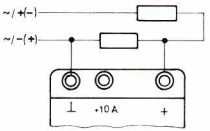



A separate connection terminal ⑤ is provided for direct current measurements above 2 A up to 10 A.

- Set the function switch ② to position "⎓" or "∿".
- Set the range selector switch ① to position 10 A.

**CAUTION:** The 10 A range is not fused! It is permissible to measure currents of up to 20 A for a maximum of 1 minute.

### 4.4.3 DC and AC currents above 10 A with external shunt




Currents above 10 A can be measured with shunts, e.g. 100 A/ 100 mV or 300 A/300 mV.

- Set the function switch ② to position "⎓" or "∿".
- Set the range selector switch ① to position 200 mV or 2 V, depending on the voltage drop across the shunt.

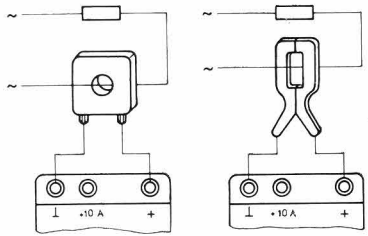
### 4.4.4 AC currents with (split-core) current transformers

**CAUTION:** Prior to closing the primary circuit, verify that the secondary circuit is closed. If current transformers are operated in open state on the secondary side, e.g. through defective or not connected leads, through blown fuses due to prior overload, or due to a wrong position of the range selector switch ① (not on the current range), dangerously high voltages can appear at the connection terminals.

Therefore, first check that the current circuit of the measuring instrument and the secondary winding of the transformer, which is connected to the instrument, form an uninterrupted measuring circuit. This can be made for all current measuring ranges (except for the 10 A range) by means of a resistance measurement on the 200 Ω range.

Perform the resistance measurement in accordance with Section 4.6.

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Split-core current transformers allow for measurements of



AC currents without the need to interrupt the operating circuit.

For the use of both bushing type current transformers and split-core current transformers, the maximum permissible operating voltage is the rated voltage of the current transformer. Take into account the additional error in indication.

- Set the function switch ② to position "∼".
- Set the range selector switch ① to position . . . A or mA.

## 4.5 Measurement of composite voltages and composite currents

The METRAVO 4 D allows for separate measurements of DC and AC components of composite voltages and composite currents.

**CAUTION:** The sum of the DC and AC components of the measured variable shall not exceed the permissible limit values according to Section 3. (overload protection) and the response value of the protective means respectively.

### 4.5.1 DC voltage and DC current measurement with superimposed AC component

Perform the measurement according to 4.3.1, 4.4.1 and/or 4.4.2.

To maintain a steady display, the AC component should not exceed 1/20 of the full scale value (e.g. on the 2 V DC range approximately 100 mV AC). If the AC component is greater, the display starts to run.

Observe the maximum permissible limit values according to Section 3.!

### 4.5.2 AC voltage measurement with superimposed DC voltage

Perform the measurement according to Section 4.3.1.

The rms value of the composite voltage shall not exceed the limit values according to Section 3. — 250 $V_{rms}$ on the 200 mV and 2 V ranges, 650 $V_{rms}$ on the 20 V, 200 V and 650 V ranges!

### 4.5.3 AC current measurement with superimposed DC current

Perform the measurement according to Section 4.4.1 and/or 4.4.2. The sum of the AC and DC components shall not exceed the full scale value. At higher values, the protective diodes would respond and falsify the measured result. It is of advantage to first measure the DC component and to determine the AC component on the same measuring range thereafter.

## 4.6 Resistance measurement

The 200 Ω, 2 kΩ and 20 kΩ resistance measuring ranges are protected by a superquick-action 2 A melting fuse (FF 2 G/250 V) in conjunction with power diodes. They can be overloaded at a maximum up to 1 A. The breaking capacity of the protective means (melting fuse in conjunction with power diodes) is 70 A DC, AC at a rated voltage of 250 V.

Thanks to the high internal resistance, the 200 kΩ, 2 MΩ and 20 MΩ ranges can be overloaded as follows:

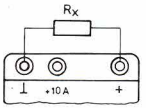
200 kΩ range: 250 V DC, AC for a maximum of ½ minute;
220 V DC, AC for a maximum of 5 minutes

2 MΩ and 20 MΩ ranges: 250 V DC, AC continuously.



**CAUTION:** Upon cut-out of the protective means, first eliminate the cause of overload and only then put the instrument back to serviceable condition.

The resistance measurement is made with constant currents of 10 nA to 1 mA, depending on the resistance measuring range. The polarity at the terminals corresponds to the terminal marking.




- Set the function switch ② to position "Ω"
- Set the range selector switch ① to position 20 MΩ . . . 200 MΩ

For measurements on the 20 MΩ range, use measuring leads as short as possible, or use shielded cable!

The 2 MΩ and 20 MΩ ranges can be used for diode tests. At a measuring voltage of 200 mV, many diodes already show a measurable resistance in forward direction.

On the resistance measuring ranges, the METRAVO 4 D can also be used as constant current source up to a load voltage of approximately 300 mV. The constant currents are listed in the range table in Section 2. "Specifications".

# 5. Maintenance

**CAUTION:** Disconnect the measuring instrument from the measuring circuit before removing the bottom cover for battery or fuse replacement!

### 5.1 Batteries

From time to time, check the state of the batteries. Discharged or deteriorated batteries shall not be left in the battery compartment.

If a check of the battery voltage according to Section 4.1 yields an indication of less than 4.50, then the batteries need to be replaced as described in Section 4.1.

**NOTE:** Install leak-proof batteries only. Use 8 each 1.5 V DC Mignon cells according to IEC R 6. Always replace the whole battery set.

Instead of manganese-dioxide cells, alkaline-manganese batteries and NiCd storage batteries can be used as well. NiCd storage batteries are particularly recommended at ambient temperatures below 0 °C.

### 5.2 Melting fuse

The melting fuse blows when one of its associated current or resistance measuring ranges is overloaded. The fuse is located immediately behind the connection terminal "+" ⑥. When the fuse has blown, only the 10 A range and the battery voltage check continue to function.

Fuse replacement:

- Disconnect the measuring instrument from the measuring circuit!
- Loosen the slotted screw on the bottom of the case and remove the bottom cover.
- Loosen the fuse holder by turning it to the left and replace the unserviceable fuse with a new one. (A spare fuse is provided in the compartment under the bottom cover).

**CAUTION:** Absolutely verify that a fuse FF 2 G/250 V according to DIN 41 571 will only be used. If a fuse of other breaking characteristics, other rated current, or other switching capacity is used, there is danger of damaging power diodes, resistors or other components!



### 5.3 Case

Special maintenance of the measuring instrument is not required. Take care that the surface between the connection terminals is clean. Heavy soiling impairs with the insulation and reduces the input resistance.

## 6. Repair and replacement part service

For warranty claims, repair and replacement part service we recommend out company-owned facilities. We offer you this first-hand service with very short delivery times. In exceptional cases on call. When you need service, please contact:

METRAWATT GmbH
Service Department
Thomas-Mann-Strasse 16 - 20
D-8500 Nürnberg
Tel.: (09 11) 86 02 - 1
Telex: 06-23 729

This address is for the FRG only.

Abroad, our representatives or establishments are at your disposal.

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