IM-3 MI-400

INSTRUCTION MANUAL

MULTI-AMP® POWER-MULTIMETER® Model MI-400

AVO *MULTI-AMP®*

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POWER-MULTIMETER®
Model MI-400

INSTRUCTION MANUAL

CONTENTS

1 — GENERAL DESCRIPTION

The Multi-Amp® Model MI-400 Power-Multimeter® is a hand-held measuring instrument designed to measure either direct or alternating current up to 1000 A without the need to break the current circuit; in addition, the instrument will measure most of the electrical parameters associated with power plant installations.

• DC and AC current	to	1000 A	(AC true RMS)
• DC and AC voltage	to	750 V	(AC true RMS)
• True Power AC - DC	to	199.9 kW	(AC true RMS)
• Apparent Power AC	to	199.9 kVA	(true RMS)
• Power factor (cos ϕ)		0.3 cap . . .	1 . . . 0.3 ind.
• Frequency	to	550 Hz	

Through the use of Hall-effect sensors in the magnetic circuit, both DC and AC current values can be accurately measured. The measured value, together with the corresponding engineering unit being measured, is displayed on a 3½-digit liquid crystal display.

The true RMS measurement provides current, voltage and, hence, power readings which are accurate almost regardless of the shape of the waveform, to a crest factor of 7.

In addition to the 3½-digit liquid crystal display, an analog output of the measured current value can be displayed on an oscilloscope or output to a chart recorder or other measuring instrument. Either true RMS or instantaneous value can be selected for the analog output.

Autoranging for all measuring ranges, automatic display of ~ or + / – to indicate AC or DC, low battery indication, two ranges for surge current reading (display of maximum measured value) and an auto switch-off function all help to make the MI-400 a user-friendly measuring tool.

Only by making use of the very latest CMOS microprocessor technology was it possible to pack so many functions into such a compact, hand-held device.

2 — TECHNICAL FEATURES AND SPECIFICATIONS (subject to change)

2.1 CURRENT MEASUREMENT

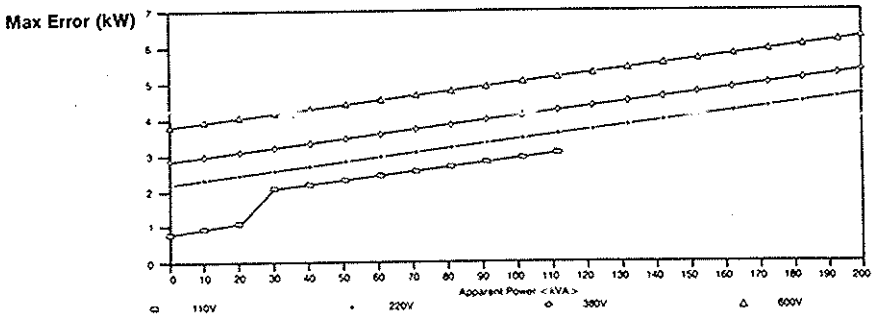
Measurement principle	: Through the use of Hall-effect sensors in the magnetic circuit, both DC and AC true RMS current (DC coupled) can be measured
Ranges (Autoranging)	: 200 A AC - DC; 1000 A AC - DC
Resolution	: 100 mA for 200 A range 1 A for 1000 A range
Accuracy	: 1% of range ±1 A within specified conditions
Temperature coefficient	: 0.1% /k
Frequency range	: Direct current and 15 Hz to 550 Hz
Influence of position of measured cable within jaw area: <2% typical	
Crest factor	: Maximum 7 (peak current, 1200 A)
Maximum overload	: 10,000 A
Signal integration time	: 200 ms
Measuring rate	: Approx. 2 per second

2.2 VOLTAGE MEASUREMENT

Measuring principle	: DC coupled direct and alternating voltage, true RMS
Ranges (Autoranging)	: 200 V AC - DC; 750 V AC - DC
Resolution	: 100 mV for 200 V range; 1 V for 750 V range
Accuracy	: 0.5% of range ± 1 count within specified conditions
Temperature coefficient	: 0.1% /k
Frequency range	: DC and 15 Hz to 550 Hz
Input impedance	: 1 MΩ
Maximum overload	: To 1000 V RMS
Measuring rate	: Approx. 2 per second

2.3 ACTIVE POWER MEASUREMENT

Ranges (Autoranging)	:	20 kW true RMS AC - DC; 200 kW true RMS AC - DC
Resolution	:	10 W for 20 kW range; 100 W for 200 kW range
Frequency range	:	DC and 15 Hz to 66 Hz
Maximum input	:	750 V - 1000 A
Maximum overload	:	To 1000 V/10,000 A
Measuring rate	:	Approx. 1.5 per second
Accuracy	:	Dependent upon input values; typically 2% of range
Temperature coefficient	:	0.1%/k



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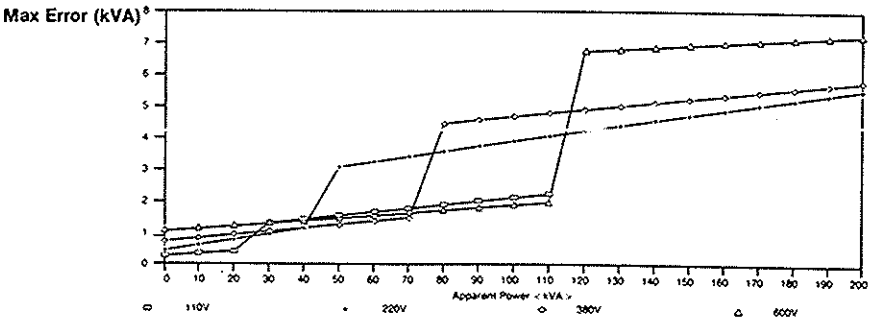
2.4 APPARENT POWER MEASUREMENT

Ranges (Autoranging)	:	20 kVA true RMS; 200 kVA true RMS
Resolution	:	10 VA for 20 kVA range; 100 VA for 200 kVA range
Frequency range	:	15 Hz to 550 Hz
Maximum input	:	750 V - 1000 A
Maximum overload	:	To 1000 V/10,000 A
Measuring rate	:	Approx. 1 per second
Accuracy	:	Dependent upon input values; typically 2% of range
Temperature coefficient	:	0.1%/k



2.5 POWER FACTOR MEASUREMENT (cos ϕ)

Ranges	: (cos ϕ) 0.3 cap. . . . 1.0 . . . 0.3 ind. (ϕ) (72.5° cap. . . . 0° . . . 72.5° ind.)
Resolution	: 0.01
Accuracy	: 1% of range ±1 count (cos ϕ) within specified conditions (±2.5° ±1 digit)
Temperature coefficient	: 0.1%/k
Input voltage	: 20 V to 750 V
Input current	: 20 A to 1000 A
Frequency range	: 10 Hz to 66 Hz
Maximum overload	: 1000 V/10,000 A
Measuring rate	: Approx. 2 per second

2.6 FREQUENCY MEASUREMENT

Ranges (Autoranging)	: 5.0 to 200.0 Hz; 200 to 550 Hz
Resolution	: 0.1 Hz for 10 . . . 200 Hz range 1 Hz for 200 . . . 550 Hz range
Accuracy	: 0.5% ± 1 count within specified conditions
Temperature coefficient	: 0.1%/k
Input voltage	: 20 V . . . 750 V
Maximum overload	: 1000 V
Measurement rate	: Approx. 2 per second

2.7 ANALOG OUTPUT

Output voltage : For 200 A range: 5 mV/A (e.g. full scale)
For 1000 A range: 1 mV/A
Maximum current : 1 mA
Accuracy : Typically 2% of range
Switchable between RMS value and instantaneous value (waveform)

2.8 OTHER DATA

2.8.1 DISPLAY

13 mm (½-inch) high liquid crystal display.
3½-digit (2000 counts). Last measured value displayed for 30 seconds before automatic power-off.
AC/DC and +/– indications are displayed.

2.8.2 ENVIRONMENTAL CONDITIONS

Reference conditions : 23°C ± 1°C (f = 50 Hz, sinusoidal) (with current-carrying cable at the center of the jaws opening)
Working temperature : 0°C to + 40°C
Functional temperature : -10°C to + 50°C
Relative humidity : 80% at 40°C
Mechanical stability : According to VDE 0411

2.8.3 SAFETY

Maximum voltage between current-carrying cables which are not insulated, and ground: 1000 V RMS

Insulation	: 6 kV
Safety	: Class II in accordance with VDE 0411

2.8.4 POWER SUPPLY

Battery	: 9 V alkaline, IEC 6 LR 61
Battery Life	: Approximately one year of normal use (70 hours continuous operation)

2.8.5 DIMENSIONS

Length x width x depth = : 10 x 3½ x 2½ inches (250 x 90 x 65 mm)

2.8.6 JAW OPENING

To accommodate:

Circular cable	: 2 $^1/_3$ inch diameter (60 mm diameter)
Rectangular bars	: 1 x 2 $^1/_3$ inches (25 x 60 mm)

2.8.7 WEIGHT

: 18.0 oz. approx. (500 g)

2.9 ACCESSORIES

Included with instrument:

Test leads with safety connectors
Leads for analog output
Instruction manual
Carrying case

3 — OPERATING INSTRUCTIONS

3.1 SAFETY PROCEDURES

In order to avoid danger to the user, the following procedures should be acted upon every time the instrument is used:

a) When measuring current flowing in a conductor which is not insulated, the voltage between conductor and ground must not exceed 1000 V.

b) If the instrument appears to be physically damaged, or does not function correctly, it should not be used.

c) The instrument should be kept dry.

d) Before removing the battery lid, make sure that the instrument is not connected to any voltage. For certainty, remove the test leads.

e) The instrument should not be opened (other than the removal of the battery lid), except by the manufacturer or the manufacturer's authorized service personnel.

f) By definition, the instrument is used where dangerous currents and voltages are at hand. Only qualified personnel familiar with such surroundings should attempt to make use of the instrument.

3.2 KEY-SWITCH "ON"

This switch turns "on" the instrument. The following modes of operation can also be selected with this switch.

3.2.1 NORMAL MODE

Switch-on, with automatic zero calibration

Short pressure to key-switch "ON" will turn on the instrument.

During 4 seconds, the display shows "CAL" to indicate that the automatic zero calibration for all the measuring ranges has been executed. (For the meaning of the "in between" blinking symbol "CONT," see paragraph 3.2.2 **Continuous Mode**).

The instrument is ready to make measurements when the display shows "O" after the "CAL" procedure has been completed.

Attention: During this "CAL" period, it is important that the instrument is kept away from any current-carrying cable!

Measurement

The clamp-on meter is now ready for use. Depress and hold the key-switch in order to take measurements for any of the electrical values described.

The key-switch has to be depressed during the whole period of measurement (3 seconds minimum).

Automatic "hold" of measured value and switch-off

When the key-switch is released, the measurement is finished during normal mode of operation.

The last measured value will be retained and displayed about 30 seconds. After 30 seconds, the instrument will switch off, unless the key-switch is depressed again.

3.2.2 CONTINUOUS MODE

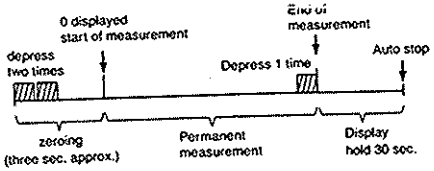
If a measurement is to be made over a longer time period, then a continuous measurement mode is possible, making it unnecessary to hold down the key-switch.

Go through the following procedure:

Turn on the instrument with short pressure to key-switch "ON" (see paragraph 3.2.1).

During the "CAL" procedure the symbol "CONT" will blink for about 2 seconds. During these 2 seconds, depress key-switch "ON" until the symbol "CONT" is displayed without blinking. Now the key-switch need not be held any more and the instrument will do permanent measurements during this continuous mode.

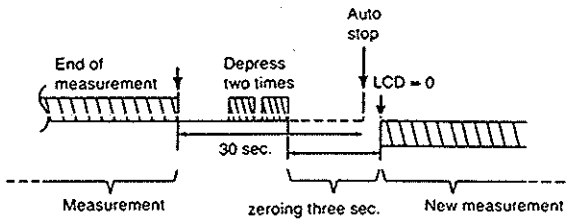
When the key-switch is depressed until the symbol "CONT" disappears, the instrument returns to the normal operating mode and finishes this continuous mode.



3.2.3 ZERO CALIBRATION DURING OPERATION

When higher currents have been measured or the instrument is overloaded, it is possible that the display will not return to 0.000 A. In order to ensure accurate measurement, a new zero calibration is recommended.

Depress and release the "ON" button twice in quick succession (maximum within 0.5 second). The instrument will return to the "CAL" procedure and recalibrate the measuring ranges (as described in paragraph 3.2.1).

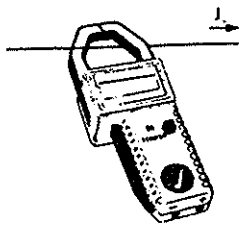


3.2.4 DISPLAY TEST

Testing of all symbols in the display space can be realized by depressing the "ON" key-switch longer as described in 3.2.1 and 3.2.2).

4 — TAKING MEASUREMENTS

4.1 CURRENT MEASUREMENT



a) Turn the rotary switch to "A≂".

b) Switch on the instrument (see paragraph 3.2).

c) After the self calibration cycle (display will show "0" after "CAL"), open the clamp jaws and close them around the current-carrying cable.

d) By depressing and holding the key-switch "ON" (see paragraph 3.2), the current is measured and displayed. (For continuous mode, please see paragraph 3.2.2).

e) When the key-switch is released, the measurement is over and the last measured value remains on the display for about 30 seconds.

After this time, the instrument automatically switches off, unless the key-switch is again depressed for further measurements.

The choice of measuring range (200 A or 1000 A) is automatic. Either ~ or + / – is also automatically selected and displayed to indicate AC or DC current. The measuring range is chosen automatically from the low to the high range, but not backwards.

In case of a heavy overload and the display does not return to zero, the instrument can be re-calibrated again, even if the instrument is not turned off. Keep the instrument away from current-carrying conductors and depress and release the key-switch twice in succession (see paragraph 3.2.3).

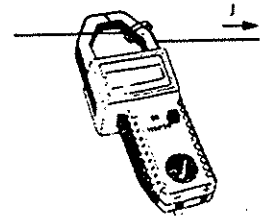
After this re-calibration cycle, the instrument will return to the lower measuring range.

In case of overload, the display shows "1 — — — A."

For current measurement, an analog output of the measured value is also available (see paragraph 4.7) for further data processing.

Attention: During current measurement, the clamp jaws should be closed carefully to increase accuracy. Do not apply pressure to the clamp jaw grip.

Measuring low currents



When measuring low currents, a greater accuracy can be achieved by looping the current-carrying conductor several times through the clamp-on jaws. The displayed value then represents the product of the number of loops, and the actual measured current.

4.2 SURGE CURRENT OR MAXIMUM CURRENT VALUE DISPLAY

Select range "max. hold," either 200 A≂ or 1000 A≂, depending upon whether the maximum expected range is <200 A or >200 A. Current measurement specifications and procedure follow in accordance with paragraph 4.1.

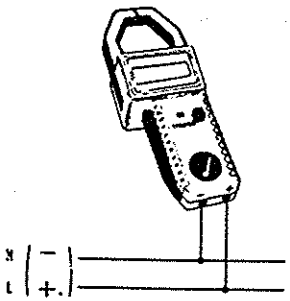
The display shows the maximum value of current measured since the beginning of the measurement, instead of the actual value of current flowing.

Reset is achieved by releasing and again depressing the key-switch for the next measurement.

All other functions correspond with normal current measurement.

The function "maximum current value display" is indicated on the display by the symbol "MAX.".

4.3. VOLTAGE MEASUREMENT



a) Turn the rotary switch to "V≃."

b) Connect the voltage to be measured with the instrument using the safety leads provided.

The leads have a measurement probe on one end and a 4 mm safety terminal on the other end, which plugs into the base of the instrument.

c) Depress the key-switch "ON" and go through zero calibration and measurement as described in paragraph 3.2.

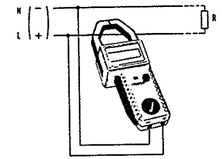
The choice of measuring range (200 V or 750 V) is automatic.

Either ~ or +/- is also automatically selected and displayed to indicate AC or DC voltage.

In case of overload, the display shows "1 — — — V."

Caution: Before removing the battery cap, make sure that all external voltages are disconnected from the instrument.

4.4. POWER MEASUREMENT



a) Turn the rotary switch to "kW=" for active power or "kVA" for apparent power measurement.

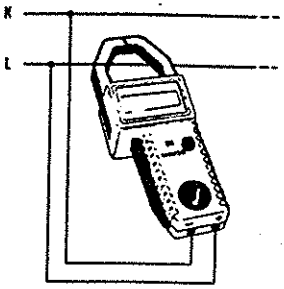
b) Using the leads provided connect the measurement voltage to the instrument. The leads have a measurement probe on one end and a 4 mm safety terminal on the other end, which plugs into the base of the instrument. For an alternating power supply connect "—" on the instrument to N and "+" to L.

c) After the zero calibration cycle (display will show "0" — see paragraph 3.2), open the clamp jaws and close them around the current-carrying conductor (direction of energy flow, as per drawing).

d) Go through measurement by depressing key-switch "ON" (see paragraph 3.2).
The choice of measuring range (20 kW/kVA or 200 kW/kVA) and the direction of energy flow (for active power) is automatic the choice of measuring range is also automatic and depends on active power and input voltage (U>200 V⎓ measuring range: 200 kW).
In case of overload, the display shows "1 — — —" In addition, the display will also indicate which is too high (V, A, kW or kVA).

Attention: The clamp-on multimeter is made for measurement in single-phase systems. It is possible to measure in three-phase system in case an artificial neutral equalizing point is set up.
Impedance of input voltage: 1 MΩ ± 0.1%

4.5. POWER FACTOR MEASUREMENT



a) Turn the rotary switch to "cos ϕ."

b) Connect the measurement voltage to the instrument using the safety leads provided. The leads have a measurement probe on one end and a 4 mm safety terminal on the other end, which plugs into the base of the instrument. For an alternating power supply, connect "—" on the instrument to N and "+" to L.

c) Switch on the instrument by depressing the key-switch "ON" (see paragraph 3.2).

d) After the zero calibration cycle (display will show "0"), open the clamp jaws and close them around the current-carrying conductor (direction of energy flow, as per drawing).

e) Go through measurement by depressing key-switch "ON" (see paragraph 3.2).

In addition to the symbol "cos ϕ," the display shows either "i" to indicate inductive or "k" to indicate capacitive load.

The display also shows + or - to indicate the direction of energy flow, so that measurement in all four quadrants is possible.

Faulty input values will be indicated as follows:

Input voltage U_E too low	:	— — —	V	cosφ
Missing zero-axis crossing U_E	:	DC	V	cosφ
Current I_E too low	:	— — —	A	cosφ
Missing zero-axis crossing I_E	:	DC	A	cosφ
Frequency too low	:	—1 — — —	Hz	cosφ
Frequency too high	:	+1 — — —	Hz	cosφ

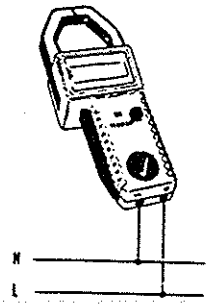
blinking display

Caution: Before removing battery cap, make sure that all external voltage is disconnected from the instrument.

Attention: The clamp-on multimeter is made for measurement in single-phase systems. It is possible to measure in three-phase systems in case an artificial neutral equalizing point is set up.

Impedance of input voltage: 1 MΩ ± 0.1%

4.6. FREQUENCY MEASUREMENT



a) Turn the rotary switch to "Hz."

b) Connect the measurement voltage to the instrument using the probe leads with the 4 mm safety terminals.

c) Depress key-switch "ON" and go through zero calibration and measurement as described in paragraph 3.2.

d) After the self calibration cycle ("0" appears in the display), depress the key-switch "ON" and the frequency is measured and displayed.

The choice of measuring range is automatic.
A faulty input value is displayed as follows:

Frequency too low Voltage too low	— 1 — — — Hz
Missing zero-axis crossing (DC) Frequency too high	+ 1 — — — Hz

Caution: Before removing the battery cap, make sure that all external voltages are disconnected from the instrument.

4.7 ANALOG OUTPUT (CURRENT MEASUREMENT ONLY)

Measured current values (either during normal current measurement or during display of maximum measured current) can be output to an oscilloscope, chart recorder or any other measuring or recording instrument.

For the analog output, use the leads with the special 2 mm contacts. These leads can only be inserted when the 4 mm leads for voltage measurement are not being used.

The special leads with the 2 mm contacts are provided with the instrument. Under no circumstances should these special analog output leads be used for voltage measurement. This would seriously damage the instrument.

For measurement of voltage (V, kW, kVA, cos ϕ and Hz measurements), only use the safety leads with 4 mm contacts.

The user can select either a true RMS output signal (e.g., for a recorder) or an instantaneous (waveform) output (e.g., for an oscilloscope). The switch inside the battery housing must be moved to "RMS" or "Inst." respectively.

Caution: Before removing the battery cap, make sure that all external voltages are disconnected from the instrument.

4.8 CHANGING THE BATTERY

When the battery voltage falls below a minimum set value, the display shows the symbol "Batt."

To change the battery, first remove the voltage test leads. The battery cap is on the reverse side of the instrument.

The instrument will only perform reliably if the specified battery type is used (9 V alkaline manganese battery, type IEC 6 LR 61).

Caution: Before removing the battery cap, make sure that all external voltages are disconnected from the instrument.

AVO INTERNATIONAL

UNITED STATES		CANADA	UNITED KINGDOM	FRANCE
4651 S. WESTMORELAND ROAD DALLAS, TX 75237-1017 USA PHONE: (214) 333-3201 FAX: (214) 333-3533 EXPORT FAX: (214) 337-3038	510 TOWNSHIP LINE ROAD BLUE BELL, PA 19422-2795 USA PHONE: (215) 646-9200 FAX: (215) 643-2670	180 MIDDLEFIELD ROAD SCARBOROUGH, ON M1S 4M6 CANADA PHONE: (416) 298-6770 FAX: (416) 298-7214	ARCHCLIFFE ROAD DOVER, KENT CT17 9EN ENGLAND PHONE: 0304-202620 FAX: 0304-207342	29, ALLÉE DE VILLEMOMBLE 93340 LE RAINCY, FRANCE PHONE: (1)43.02.37.54 FAX: (1)43.02.16.24 TELEX: 240 706 F MEGEYER