



clarke-hess
COMMUNICATION RESEARCH CORP.

manufacturer of precision test and measurement equipment

MORE
WATT
METERS

Watt Meter - Model 2335

- **Dc to more than 1MHz**
- **Inputs up to 10A and 1000V**
- **0.2% Uncertainty**
- **Low Power Factor Accuracy**
- **Peak or RMS Readings**
- **Isolated Inputs**
- **Harmonic Analysis**
- **Multifunction Displays**
- **IEEE-488.2 and RS-232**



TRUE RMS/REALLY BROADBAND

The Model 2335 Sampling Watt Meter is a precision, high accuracy, auto-ranging instrument which simultaneously measures and displays true rms Voltage, true rms Current and true mean Power over a frequency range from dc to more than 1MHz. Full scale Current and Voltage inputs are typically measured within $\pm 0.1\%$ of the reading in amplitude to at least 500kHz. The corresponding Power is typically measured to within $\pm 0.1\%$ of the input Volt-Amperes to 250kHz and to within $\pm 0.2\%$ of the input Volt-Amperes to 500kHz for loads having any Power Factor.

LOW POWER FACTOR ACCURACY.

Five digits or resolution combined with excellent phase matching between the current and voltage channels make the Model 2335 watt meter an exceptionally good instrument for making low power factor measurements up to 1MHz. This makes the instrument ideal for high frequency core loss measurements which are inherently low power factor.

MULTI-FUNCTION

In addition to the rms Voltage, rms Current, and mean square Power the Model 2335 watt meter also measures simultaneously the peak Voltage, the peak Current and the Frequency and calculates the Volt-Ampere product, the Power Factor and the Harmonics of the current and the voltage. These functions may be displayed or may be read over the IEEE-488.2 or RS-232 interfaces.

UNPARALLELED HIGH FREQUENCY ACCURACY

The Model 2335 watt meter allows broadband and high accuracy measurements of both sinusoidal and highly distorted wave shapes. The Current, Voltage, Power, and Power Factor accuracies to 1MHz of the Model 2335 watt meter far exceed any other sampling Watt Meter, or for that matter, with respect to Current or Voltage, almost all conventional multimeters.

Full scale Power ranges exist for loads with impedances from $(0.6V/1.5A) = 0.4\Omega$ to $(600V/1.5mA) = 400k\Omega$.

WIDE MEASUREMENT RANGE

The Model 2335 watt meter has full scale Power ranges from 1.0000mWatt to 10000Watts. With external shunts or current to voltage transducers the upper range may be extended by a factor of ten or one hundred. Full scale Voltage from 2.000V to 2000V (usable to 1000V) and full scale Current ranges from 5.000mA to 5.000A (all rms values) cover a wide range of load impedances. Full scale Current and Voltage inputs may have crest factors up to three while smaller inputs may have even higher crest factors. Sinusoidal inputs with rms values of twice the nominal Full Scale value may be measured with no loss in accuracy.

POSSIBLE MEASUREMENT USES

Measurement of Ultrasonic Equipment of all types and power levels, Finished Transformers, Transformer Core Material, Switching Power Supplies, Fluorescent Lamp Ballasts of all types, Mercury Arc Lamp Circuits, Sodium Lamp Ballasts, Speed Controlled Motors of all types, Efficiency of any device with an electrical input and an electrical output, SCR Controlled Devices of all types, High Frequency and/or Distorted Currents from any source, Voltage Response of any device from DC to 1MHz, and the Characteristics of Electric Automobile Drives.

EASY TO CALIBRATE AND MAINTAIN

The Model 2335 watt meter is an all solid state instrument with optically isolated input channels. DC coupling in both channels allows calibration and/or verification with high accuracy dc sources. Internal software calibration routines allow most recalibrations to be accomplished **without opening the instrument and without screwdriver adjustments**.

UNIQUE SAMPLING APPROACH / ISOLATED INPUTS

The Voltage and Current inputs of the Model 2335 watt meter are simultaneously sampled (with 16 bit resolution), converted to digital form, and transmitted via optical links to the main chassis. This allows both the Current and Voltage inputs to be completely isolated from each other and from the main chassis. The asynchronous sampling frequency is controlled by the system microprocessor in such a fashion that neither it nor any of its harmonics can come close to the measured input frequency or any of its harmonics. This precaution prevents "beats" with their accompanying jitter in the displayed values.

REMOTE CONTROL

The Model 2335 watt meter is equipped with an IEEE-488.2 interface and an RS-232 interface which both incorporate all of the IEEE-488.2 Common Commands and Queries. Any function that can be entered via the front panel can be controlled via either interface. In addition, any or all of the functions which can be displayed, can be queried and sent simultaneously to the Controller over the either interface. The status (e.g. Current range, Voltage range, etc) of the instrument may also be queried and sent over either interface..

The bus address for the IEEE-488 interface is set from the front panel and is displayed both at turn-on and when the Local key is depressed. A Remote lamp indicates that the Model 2335 watt meter has been placed in its Remote state by the IEEE-488 Controller.

SPECIFICATIONS

CURRENT AND VOLTAGE

Range, Resolution and Input Impedance (Voltage Channel)

Full Scale Voltage	Max. Peak Value	Resolution	Input Impedance
2.000V	6V	1mV	1.05M/15pF
20.00V	60V	10mV	1.01M/15pF
200.0V	600V	100mV	1.00M/15pF
2000 V	3000V	1 V	1.00M/15pF

The 2000V range is useable to 1000V rms

Range, Resolution and Input Impedance (Current Channel)

Full Scale Voltage	Max. Peak Value	Resolution	Input Impedance
5.000mA	15mA	1uA	20
50.00mA	150mA	10uA	2.1
500.0mA	1500mA	100uA	0.27
5000 mA	15A	1mA	0.039
EXTernal (100mV)	300mV	-	20

The Display on the EXT range is factory settable to read any value up to 5000, with any positioning of the decimal point, for a 100mV input.

Uncertainty (rms) For the peak uncertainty, multiple the table values by 2

	0% - 100% of Full Scale	100% - 200% of Full Scale
Frequency	$\pm(\% \text{ of Reading} + \% \text{ of Range})$	% of Reading
dc	$\pm(0.10 + 0.10)$	± 0.20
5Hz - 250kHz	$\pm(0.10 + 0.10)$	± 0.20
250kHz - 500kHz	$\pm(0.20 + 0.20)$	± 0.40
500kHz - 1.0MHz	$\pm(0.40 + 0.40)$	± 0.80

Isolation A ± 1000 Vdc may be placed between the LO Voltage Terminal and Chassis

POWER AND POWER x 10

Ranges Eight decade Full Scale ranges from 1.0000mWatt to 10,000Watt. The ranges are all combinations of a Full Scale Current range multiplied by a Full Scale Voltage range plus a corresponding set of combinations with ten times the sensitivity which occur when the Px10 range is activated.)

Resolution 1 part in 10000 of the Full Scale range

Uncertainty

	0% - 100% of Full Scale	100% - 200% of Full Scale
Frequency	$\pm(\% \text{ of V-A} + \% \text{ of Range})$	% of V-A
dc	$\pm(0.20 + 0.10)$	± 0.30
5Hz - 250kHz	$\pm(0.20 + 0.10)$	± 0.30
250kHz - 500kHz	$\pm(0.40 + 0.20)$	± 0.60
500kHz - 1.0MHz	$\pm(0.80 + 0.40)$	± 1.20

(for any Power Factor) (V-A is the Volt-Ampere product)

Power x 10 Any Px10 range may be selected when both the Peak Current and the Peak Voltage are less than 0.316 of their Peak Range values.

VOLT-AMPERES

Calculated as the product of the rms Current and the rms Voltage. It has the same Full Scale ranges, resolution and uncertainty as POWER.

POWER FACTOR

Calculated as the ratio of Power to Volt-Amperes. It has a range from 0 to ± 1.0000 and a resolution of .0001 for Volt-Ampere products greater than 7.5% of Full Scale. The resolution

decreases as the Volt-Ampere product decreases. The uncertainty is $\pm 0.002 \pm 10$ digits up to 250kHz, $\pm 0.004 \pm 20$ digits from 250kHz to 500kHz, and $\pm 0.008 \pm 40$ digits from 500kHz to 1000kHz

HARMONICS

The Harmonics are specified for Fundamental values between 20Hz and 20kHz and for periodic waveforms with rise times greater than 0.5% of the period. The resolution of the Fundamental and Harmonics of the voltage and the current is identical to the specified values for the corresponding rms voltage and current. The uncertainty of the Fundamental value is also the same as the rms value. The total Harmonic uncertainty is the same percentage as the total Fundamental uncertainty. For Fundamental values greater than 20kHz, the harmonic values are still calculated but the uncertainty may increase because of some jitter in the readings.

FREQUENCY

Frequency of Voltage or Current from 5.0000Hz to greater than 2MHz with five digits of resolution and an uncertainty of $\pm 100\text{ppm} \pm 1$ digit.

DISPLAYS

Three LED (10.9mm/.43 inch high) Displays. Two four digit displays for Current and Voltage and a six digit display for Power and the other functions.

IEEE-488.2 INTERFACE SUBSETS: SH1, AH1, T6, L4, SR1, RL1, PP0, DT0, DC1

RS-232 CHARACTERISTICS: 9600 Baud, 1 start bit, 8 data bits and 2 stop bits.

DISPLAY UPDATE 10 times a second

SETTLING TIME 5 seconds to reach 0.1% of Full Scale

TEMPERATURE RANGE

Operating	0°C to 40°C
Within Specifications	18°C to 25°C
Storage	-40°C to 75°C
Derate specifications by a factor of 2 when operating outside the 18°C to 25°C temperature bracket.	

RELATIVE HUMIDITY Less than 90%

WARM-UP TIME Thirty minutes for all specifications

POWER REQUIREMENTS

100V $\pm 10\%$, 120V $\pm 10\%$, 220V $\pm 10\%$, 240V $\pm 10\%$ (Rear Panel switch selectable)
50Hz to 400Hz. 1/2A AGC Fuse for 120V operation.
Power Consumption less than 24Watt (60Hz-120V).

PHYSICAL

Rack Mount kit available as an option

Weight: 6.85kilograms (15pounds)

Size: 43.2cm x 13.3cm x 33.0cm (17" x 5.25" x 13")

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